Enabling PV in the MENA Region

The Emerging PV Market in Jordan

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Deutsche Gesellschaft für
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Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
T +49 (0) 6196-79-0
F +49 (0) 6196-79-7291

E info@giz.de
I www.giz.de

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Responsible:
Anita Richter, GIZ

Authors:
Jan Michael Knaack
Supported by Ahmad Al Ghandoor, Christian Grundner, Céline Najdawi

Bundesverband Solarwirtschaft e.V.
Quartier 207
Friedrichstrasse 78
10117 Berlin
Tel. 030 2977788-0
Fax 030 2977788-99
info@bsw-solar.de
www.solarwirtschaft.de

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Diamond media GmbH, Miria de Vogt, Cheryl Juhasz

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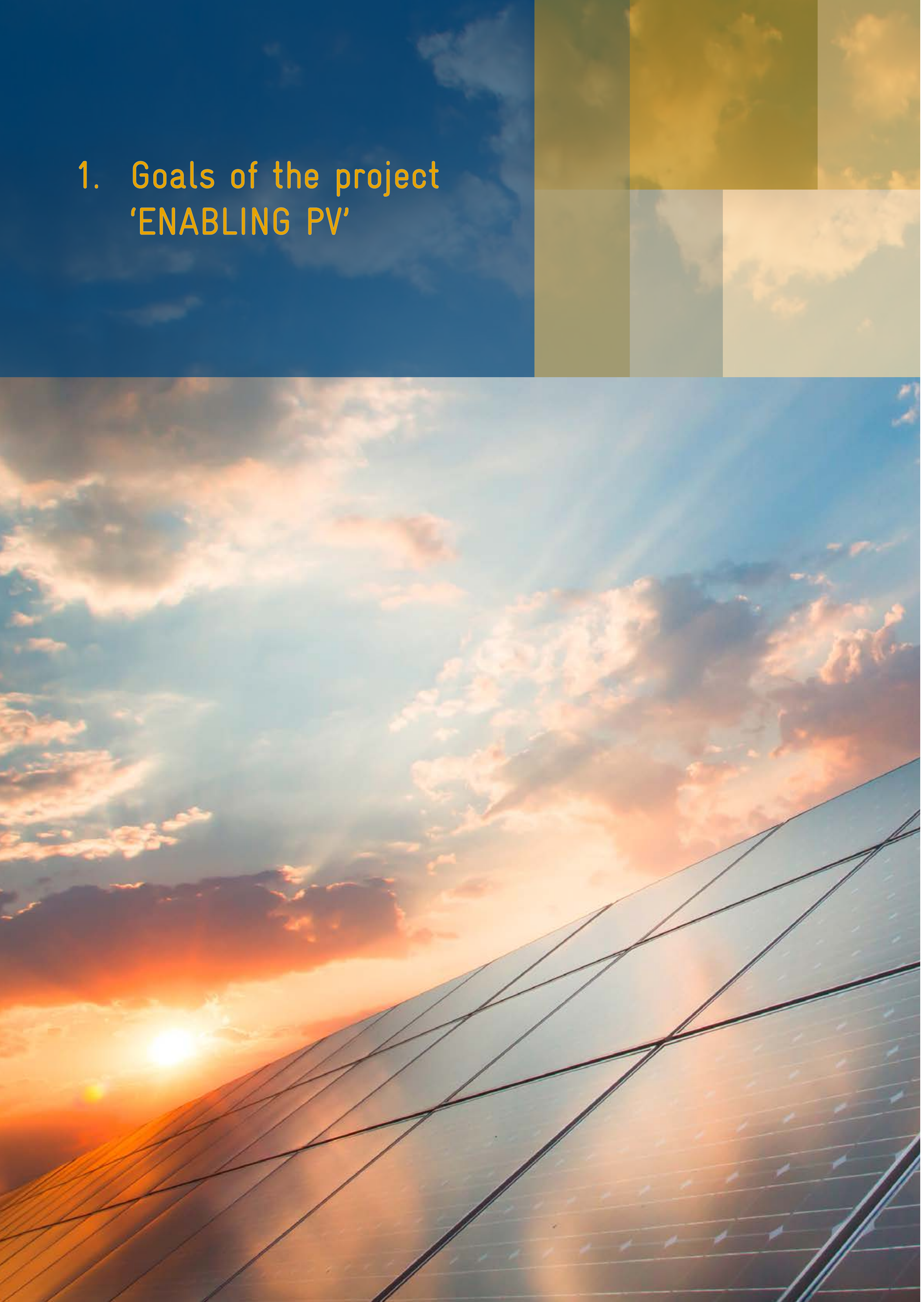
Abbreviations

A	Annum
BSW-Solar	German Solar Industry Association
CEGCO	Central Electricity Generating Company
CO_2	Carbon dioxide
DSO	Distribution system operators
EDCO	Electricity Distribution Company
ENA	Energy Network Association
EOI	Expression of interest
EPC	Engineering, procurement & construction
ERC	Electricity Regulatory Commission
€	Euro
GDP	Gross domestic product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GWh	Gigawatt hours
(ICI)	International Climate Initiative
IDECO	Irbid District Electricity Company
IPP	Independent power producers
JD	Jordanian Dinar
kVA	Kilovolt ampere
kWp	Kilowatt peak
LNG	Liquefied natural gas
MEMR	Ministry for Energy and Mining Resources
MOU	Memorandum of understanding
MSP	Mediterranean Solar Plan
MWp	Megawatt peak
NEPCO	National Electric Power Company
PPA	Power purchase agreement
PV	Photovoltaics
REEL	Renewable Energy and Efficiency Law 64
SEPGCO	Samra Electric Power Generation Company
SPV	Special purpose vehicle
TSO	Transmission system operator

1. Goals of the project 'ENABLING PV'



Electricity from photovoltaics (PV) is about to reach grid parity in many countries of the MENA region, as well as generation parity in some countries of the region. More and more governments are promoting large or small decentralized forms of PV projects, which are coupled with the conventional electricity grids. Within this context, the overall goal of the project "Enabling PV" is to contribute to the sustainable use of PV in the MENA region. As the first show case, the project focuses on the emerging solar markets of Tunisia and Jordan.

"Enabling PV" as a project is coordinated by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) within the framework of the regional project "Mediterranean Solar Plan (MSP) – Technology Cooperation". It has been financed in the framework of the International Climate Initiative (ICI) of the German Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). The German Solar Industry Association (BSW-Solar) and the consulting company eclareon GmbH are responsible for executing the "Enabling PV" in Tunisia and Jordan. The project also aims at supporting local renewable energy associations in MENA countries.

"ENABLING PV" focuses on the following activities in Tunisia and Jordan:

- Identifying viable business models for solar PV in Jordan and Tunisia on the basis of real-life experiences of local and foreign project developers and investors.
- Analyzing the legal and administrative process flows for each identified business model and making the results available to local and international investors.
- Detecting existing barriers to the implementation of business models.
- Formulating concrete recommendations for removing these barriers and discussing them with decision-makers.
- Strengthening cooperation and transferring knowledge between relevant stakeholders, in particular from the private sector in Jordan, Tunisia and Germany.

2. Introduction

The Hashemite Kingdom of Jordan represents a very promising market for photovoltaics. Located in the north of the Arabian Peninsula, with a yield of around 1,800 kWh per kWp per annum in many regions and more than 300 days of sunshine each year, PV has a strong potential for contributing to the national electricity mix. This is especially true since Jordan consumes more energy in summer than in winter. Unlike neighboring countries, Jordan lacks substantial fossil energy resources, with the exception of unexploited shale oil reservoirs in eastern Jordan. Domestic resources only cover around 4% of Jordan's energy demand. Today, electricity is mainly produced with heavy fuel oil that has been imported at world market prices since regular interruptions of the gas supply from Egypt have been occurring following the events of the Arab Spring of 2011. This has increased the costs for the generation and distribution of electricity for the National Electric Power Company (NEPCO) to more than JD 0.146 [€ 0.155] per kWh in 2012.[1] High generation costs from conventional power plants in combination with subsidized electricity rates for many small electricity consumers, which are down to JD 0.033 [€ 0.035] per kWh, have led to a massive deficit for NEPCO. By contrast, unsubsidized consumers pay high electricity rates of up to JD 0.292 [€ 0.310] per kWh in 2014.[2] The current policy for Jordan provides for further price increases of between 5% and 15% per year until 2017 for many consumer categories.[3] From an economic point of view it is important for NEPCO as well as for consumers paying high prices for energy to look for cheaper alternatives of electricity supply. This is especially true since the overall political situation in the region remains unstable, making the option of cheap gas or electricity imports less probable in the near to mid-range future. Alternative energy sources such as shale oil or nuclear power require at least several years of exploration and development activities before deployment, and the LNG terminal for gas in Aqaba is still under construction. A growing population and the corresponding increase in energy consumption require solutions that can quickly generate additional electricity capacities.

¹ *http://www.nepco.com.jo/store/docs/web/2012_en.pdf / 1 Jordanian Dinar approx. 1.02 euro (June 2014)*

² *Jordanian energy tariffs subsidize small residential, public, commercial and industrial consumers, while some tariff categories (e.g. large commercial consumers, banks etc.) pay high rates, above generation and distribution costs.*

³ *http://www.memr.gov.jo/LinkClick.aspx?fileticket=PHxs463H8U0%3d&tabid=255*

a. Latest Market Developments for PV in Jordan

In Jordan the Renewable Energy and Efficiency Law 13 (REEL) of 2012 as well as bylaws enable Independent Power Producers (IPP) to provide electricity from renewable sources to NEPCO within long-term Power Purchase Agreements (PPA). Private investors may also invest in their own PV system up to 5 MWp to directly consume the electricity produced and offset it against their entire demand within a net-metering scheme. The REEL even allows the generation of electricity at a different site than where the actual consumer is located – so-called energy wheeling. As a result, there are two promising business cases that enable investments in PV: Direct Proposals for PPAs under consecutive rounds of "expressions of interest" and "net-metering".

Apart from off-grid installations, around 3 to 4 MWp of solar PV systems under the net-metering scheme had been realized by April 2014, with another 4 to 5 MWp pending within the application process waiting list.

b. Examples

Example No. 1 displays a plant on a warehouse in Amman with a 90-kWp PV system. The investment, made in 2013, generates around 162,000 kWh of electricity per year. The owner of the warehouse saves around JD 27,216 per year over a 20-year lifetime at current prices. The payback period of the system is 4.2 years. Apart from monetary savings, the system will enable savings of around 97,200 kg of CO_2-emissions per year.

In 2014, electricity consumers falling in the "commercial tariff" category usually pay between JD 0.12 and JD 0.168 / kWh, depending on the amount of consumption.

Example No. 2 displays a public electricity system on an educational building in Amman. The 40.1 kWp system was installed in 2012 and is currently extended to 92 kWp. The current electricity tariff for this user category is up to JD 0.259 per kWh. In the first year since connection to the grid, the system has produced around 1,840 kW per kWp (EVO monitoring) and is expected to save around JD 19,100 in 2014. Its payback time is approximately around 3 years under the 20-year net-metering contract with JEPCO.

Example No. 3 is a 6 kWp PV system on a residential house in Amman with 8 inhabitants. The system produces 10,800 kWh / year and generates savings of JD 1,400 / year. The payback period is 6.4 years and it saves 6,480 kg CO_2 per year.

Residential consumers pay energy tariffs of between 0.033 and JD 0.259 / kWh, depending on consumption.

Example No. 4: This university housing project in Maan is one of the biggest systems in Jordan to date, totaling 1,028 kWp. It was installed in April 2014 and will produce around 1,900,000 kWh per year. At current electricity rates, the payback period is around 3 years, since it will save approximately JD 500,000 / year over 20-year grid connection contract. The current electricity tariff for this user category is up to JD 0.259 per kWh.

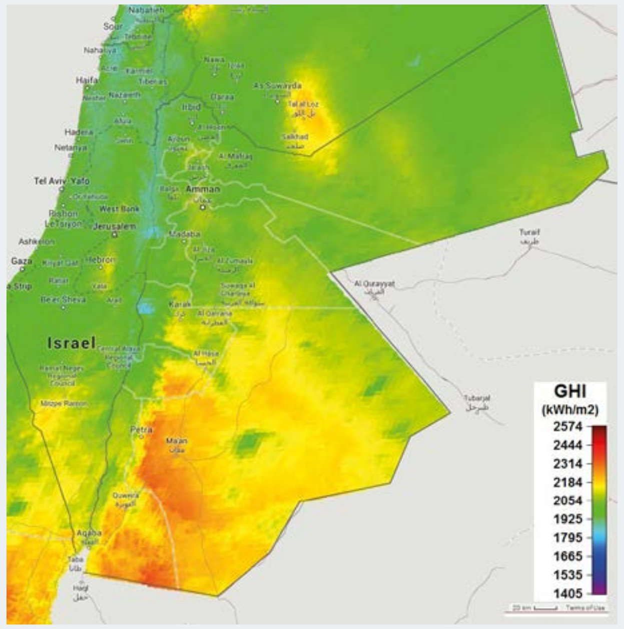
3. Market Profile Jordan

The Hashemite Kingdom of Jordan covers an area of 89,342 km² on the northern Arabian Peninsula. It borders with Syria, Israel, Iraq, Saudi Arabia and the West Bank (Palestine) as well as the Red Sea, with only 1.5% of its surface being arable land.[4] 80% of its approximate 8 million citizens live in urban areas, mainly multi-family houses. 99.9% of the population has access to landline electricity. Jordan is a middle-income country with a GDP of approximately US$ 34.08 billion or an average of US$ 6,100 per capita. It is heavily dependent on the import of foreign energy resources: 96% of the energy resources have to be imported. Although fuel for the transport sector covers around 49% of energy imports, electricity has to be produced either with imported gas or fuel. In 2012, 14,274 GWh of electricity, or an equivalent of around 2,227 kWh per capita, was consumed in Jordan, with a steady increase of around 5% per year over recent years. Electricity imports (784 GWh) and exports (104 GWh) were negligible.[5] In 2011, the Egypt-to-Syria interconnection became dysfunctional due to the civil war in Syria and the political instability in Egypt. The imports have caused a heavy burden on Jordan's foreign debt; approximately 20% of its GDP has been spent on energy imports since 2012.

[4] *https://www.cia.gov/library/publications/the-world-factbook/geos/jo.html, 14 July 2014*

[5] *http://www.nepco.com.jo/store/docs/web/2012_en.pdf, 14 July 2014*

Figure 1: Solar irradiation map of Jordan



Source: (Google) http://www.solar-med-atlas.org

a. Solar PV in Jordan

Renewable energies have played an insignificant role in the Jordanian energy mix. Nevertheless, a 2005 study of German Aerospace Institute DLR comes to the conclusion that the potential of solar energy and wind energy for power generation could cover more than 50 times the energy demand forecasted for the year 2050 in Jordan.[6] Natural conditions for solar are excellent in Jordan, which averages between 1600 and 2300 kWh per m² irradiation per year.[7]

Development of the Solar Sector in Jordan

PV off-grid: Solar PV has mainly been used for powering off-grid installations such as telecommunication towers, water pumping, and desalination of brackish water, as well as to provide dwellings in remote areas that are not connected to the electricity grid and where desalination had not been installed. Until the publication of the Renewable Energy Law in 2012, an estimated 236.4 kWp had been installed in Jordan.[8]

PV on-grid: According to interviewees, around 3 to 4 MW of PV systems had been installed on a decentralized level, with around 5 MW more under construction in late April 2014, all connected to the distribution grid under the **net-metering** scheme.[9] It was estimated that more than 400 registered installation companies exist in Jordan, although only around 10 companies are actively doing business in the field for on-grid markets in early 2014.

In addition, 12 projects with 170 MWp were to be constructed under the **1st Round of Direct Proposals for PPAs** that was initiated in October 2011. By April 2014 none of these projects had been realized yet, but negotiations were in their final stage, with financial closure to be accomplished by autumn 2014.

In addition, two tendered PV projects, one totaling 2 MWp, financed by Spain in the Azraq area, and another totaling 65 – 75 MWp in Quweirah (Aqaba), financed through a fund of Abu Dhabi, were to be evaluated by the Ministry for Energy and Mining Resources (MEMR) in 2014.

[6] *http://www.dlr.de/Portaldata/1/Resources/portal_news/newsarchiv2008_1/algerien_med_csp.pdf, 14 July 2014*

[7] *http://www.edama.jo/Content/Presentations/5113b-ca3-e3b9-4575-9119-f189f76f4bfc.pdf , 14 July 2014*

[8] *NERC2012a*

[9] *Source: Interviewee JEPCO*

Jordan's Solar & Renewable Energy Strategy

In 2007 Jordan updated its Master Strategy for Energy in Jordan for the Period of 2007 to 2020, which had initially been drafted in 2004.[10] The strategy aims at reducing energy imports through diversification of the energy mix by using local resources such as shale oil, nuclear power and renewable energies. Although at the moment the strategy still serves as a guideline for renewable energies, its assumptions can be considered to be outdated, especially since it assumes that nuclear and shale oil will cover a considerable share of Jordan's energy demand by 2015 and 2020.[11]

b. The Jordanian Electricity Sector

To gain an understanding of Jordan's electricity market, one has to identify the different stakeholders in the electricity sector. The **Ministry for Energy and Mining Resources (MEMR)** sets the framework for the production, transmission, and distribution of electricity. The **Electricity Regulatory Commission (ERC)**, established in 2001 as an independent Commission, mediates between consumers, utilities and producers and makes recommendations regarding tariffs and remunerations.

The **National Electric Power Company (NEPCO)** is a public shareholding company owned by the Jordanian Government. As the National Transmission System Operator (TSO), NEPCO is in charge of building, operating and maintaining the Jordanian transmission grid. NEPCO buys the electricity from the Jordanian generating companies and transfers it to the distribution grid operators.

Three private companies act as Distribution System Operators (DSO) in Jordan:

- The **Jordanian Electric Power Company (JEPCO)** is responsible for distributing electrical energy for about 66% of the country's total consumers. It serves 5,000 km2 (Amman, Zarqa, Madaba and Al-Balqaa) and is made up of more than 5,600 main stations and substations with a total of 19,000 kilometers of underground and overhead lines.
- The **Electricity Distribution Company (EDCO)** was established in 1997 and is now responsible for distributing electrical energy to the southern part of the Kingdom, including Aqaba, Maan, Karak, Tafila, Jordan Valley, Azraq, Safawi, Royweshed, and Reshah.
- The **Irbid District Electricity Company (IDECO)** was established in 1957 and is now responsible for distributing electrical energy to the northern part of the Kingdom, which includes Irbid, Jerash, Mafraq and Ajloun.

Four main generators are active in Jordan:

- The private company **Central Electricity Generating Company (CEGCO)**, with a nominal capacity of 1,669 MW (2011), which produces around 52% of the electricity in Jordan (2010).
- The **Samra Electric Power Generation Company (SEPGCO)** is responsible for the operation of the conventional energy power plant in Al-Risha. In 2011 it had a nominal capacity **of around 880 MW**.
- IPP1 (AES Jordan) and IPP2 (**Al-Qatraneh Power Generation Company**) are combined cycle plants with a nominal capacity of 380 MW each.

The total nominal capacity of the generation system is about 3,309 MW. The peak load of the system reached 2,660 MW "during the summer season" in the year 2011.[12]

Table 1: NEPCO's Electricity sales (GWh)

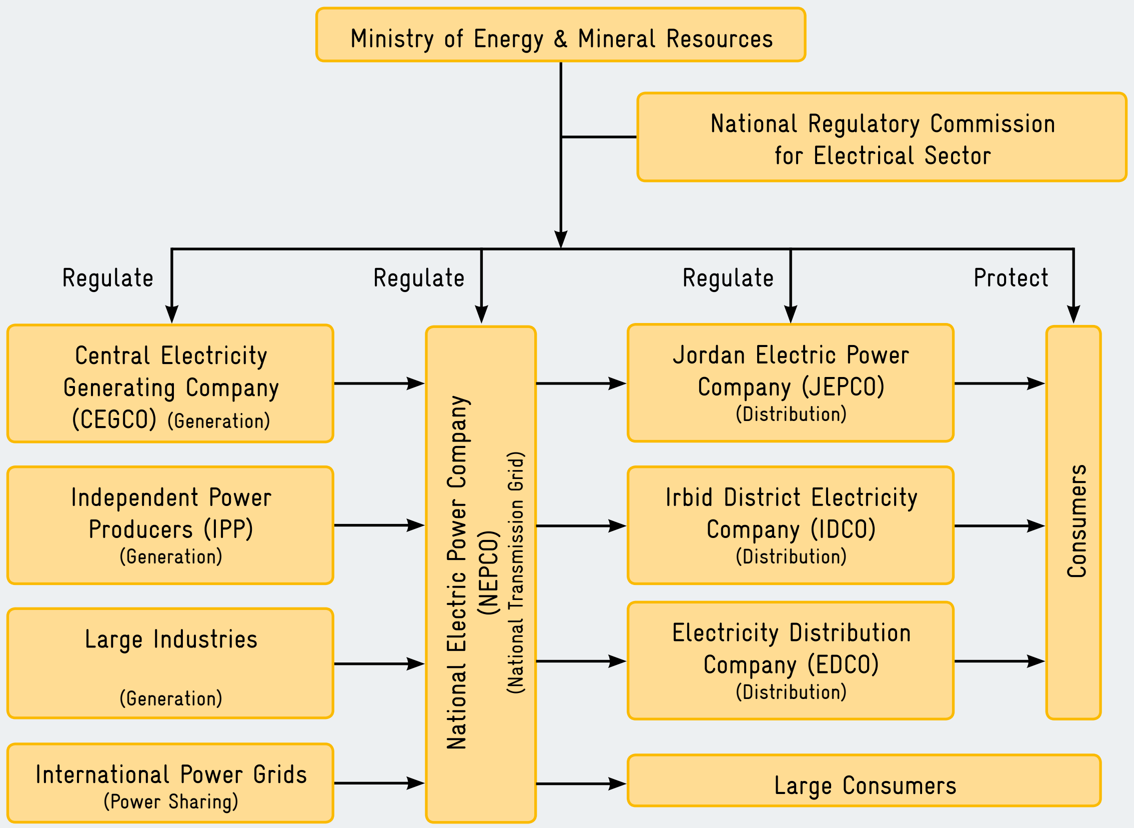
	2011	2012	%
Distribution companies	14260.70	15113.10	5.98
JEPCO	9217.50	9813.30	6.46
EDCO	2666.70	2845.80	6.72
IDECO	2376.50	2454.00	3.26
Large consumers	785.50	906.30	15.38
Exported energy	85.60	103.50	20.91
Total	15131.90	16123.00	6.55

[10] *http://www.nerc.gov.jo/Download/english%20-energy%20strategy.pdf*

[11] *For more information, see: http://www.nerc.gov.jo/Download/english%20-energy%20strategy.pdf*

[12] *http://www.erc.gov.jo/English/Pages/ElectricityAndNationalEconomy.aspx , 21 May 2014*

Figure 2: The electricity sector in Jordan



Source: CEGCO, http://www.cegco.com.jo/?q=en/node/46, 14 June 2014

c. Electricity Tariffs

The electricity tariff structure in Jordan takes into account social aspects as well as the economic capacities of consumers. In 2014, the electricity prices for the end consumer ranged from JD 0.033 per kWh for small residential consumers with less than 150 kWh per month demand to JD 0.292 per kWh for the banking sector.[13] In 2012 the generation and distribution costs were JD 0.146 per kWh, whereas the average selling price was JD 0.0636 per kWh.[14] The difference in price had to be covered by the state-owned NEPCO, thereby creating a substantial deficit of JD 2.3 billion by the end of 2012.[15]

[13] *http://www.memr.gov.jo/LinkClick.aspx?fileticket=PHxs463H8U0%3d&tabid=255 , 14 June 2014*

[14] *http://www.edama.jo/Content/Events/Presentations/ea3d28cc-e94f-40d5-8ba1-e98135c95800/08ce47f6-15a8-490a-9715-e640e06ed5f2.pdf , 14 uly 2014*

[15] *http://www.memr.gov.jo/LinkClick.aspx?fileticket=PHxs463H8U0%3d&tabid=255, 14 July 2014*

d. Business Models for PV in Jordan

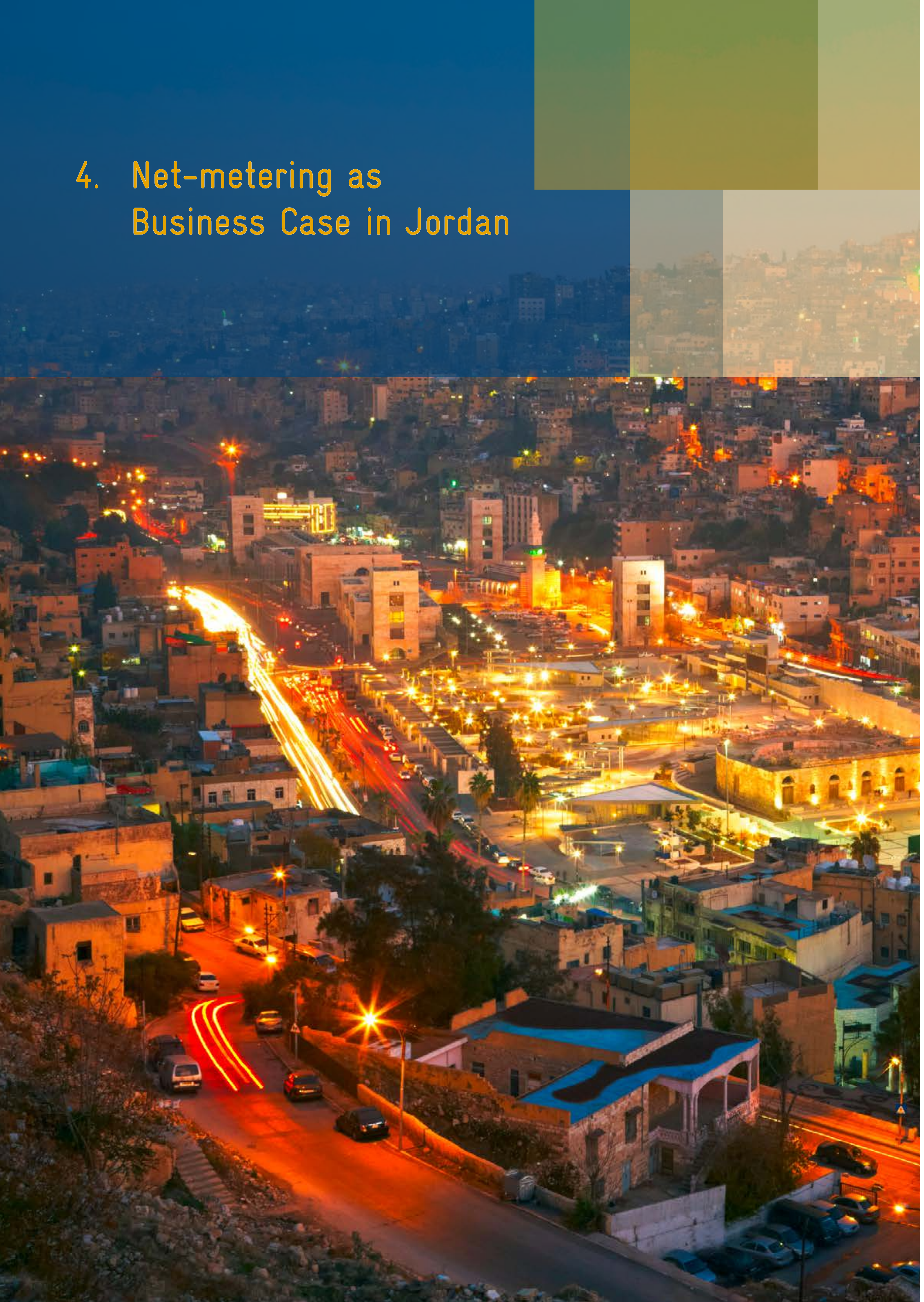
In many countries in the past, the installation of solar PV and other renewable energies in the electricity sector was supported by incentive programs to integrate electricity into the market through guaranteed offtake options such as feed-in tariffs, subsidies or direct grants, tax credits or subsidized loans. Other forms such as renewable energy portfolios required energy producers to provide a certain share of renewable energy within their energy mix, thereby triggering investments and renewable energy production. Today, the levelized energy generation costs of solar PV over a typical 20-year investment period have been reduced below retail costs (grid parity) in many countries, while in some countries such as Jordan, costs are now below the generation costs for conventional electricity sources. The use of renewable energy sources can be lucrative on the macro and micro economic scale. Nevertheless, fluctuating and decentralized energies such as wind and solar do not necessarily fit into the energy system of central power plants that is focused in base load. These energy forms therefore need specific regulations to smoothly integrate into the existing energy market.

This analysis will focus in more detail on **net-metering with PV**, its **sub-option of energy wheeling**, as well as on **Power Purchasing Agreements** with the MEMR and its state-owned company NEPCO as contract partner. And although tender-based projects exist on government lands, they will not be the focus of this study.[16]

[16] *Other business models are excluded for the following reasons*

- *Self-consumption is to be considered as a sub-form of net-metering, which is only applied if the latter is not applicable, since it should aim at maximizing consumption by changing demand pattern or storing energy, which might involve extra effort or costs.*
- *Current legislation allows the leasing of a PV system but not the sale of electricity, which makes this business model not viable. The off-taker either has to be the owner of a system, since PPAs are only possible with the MEMR.*
- *Mini-grids for parallel or off-grid use and mini-PV are not considered, though they might be highly profitable for running diesel generation sets in remote areas. Nevertheless, their economics vary in terms of transport and fuel costs. In addition, the relevant market is very small due to the high electrification rate of around 99% of dwellings in Jordan, thus providing only a small but profitable market niche.*

4. Net-metering as Business Case in Jordan



At the time of the interviews for the study in late April 2014, the most common way to employ PV systems in Jordan was net-metering at the site of a consumer. Around 3 to 4 MWp had been installed under the scheme, with 4 to 5 MWp under review by the relevant DSOs.[17] According to the directive concerning net-metering,[18] the overall **limit for net-metering** is fixed at 1% of the gross capacity of the low voltage distribution grid, or approximately 28 MWp, and 1.5% of gross capacity of the medium voltage distribution grid, approximately 42 MWp. This limit was described as purely regulative and to be reviewed if necessary.[19]

Reasoning and Description of Net-metering

As mentioned above, electricity prices can reach up to JD 0.294 per kWh for certain consumer categories.[20] The levelized costs of PV electricity over 20 years are well below this tariff rate – depending on site, system price and operation and maintenance costs, the cost can be as low as JD 0.10 per kWh.

From a rational economic point of view, all of those consumers would prefer to cover part of their electricity demand with PV-generated electricity instead of buying all their electricity from the utility if it is cheaper to directly produce and consume it, with all costs for the PV system, maintenance and operations, financing etc. included.[21] As the difference between the price of PV electricity and grid electricity widens, more electricity consumers will opt for PV self-consumption if they can.

In Jordan the electricity tariff for many consumers shifts from a subsidized to a non-subsidized tariff, depending on the consumed quantity and the tariff category. Many consumers only have an incentive to reduce the amount of energy they consume until they pay the (highly) subsidized tariffs.

However, economics alone do not guarantee the development of the self-consumption market, as it is not possible for most consumers to self-consume 100% of the electricity produced. Therefore, if costly storage solutions are to be avoided, regulations have to be found to define what to do with excess electricity.

Net-metering as model to facilitate PV production

To enable large-scale PV electricity production, the Renewable Energy and Efficiency Law (REEL) (13) of 2012 allows electricity consumers who operate PV systems for self-consumption ("self-consumers") to receive energy credits for any PV electricity their systems generate in excess of the amount of electricity consumed within a billing period.

This is particularly relevant for residential consumers whose demand curve does match PV generation. This case is illustrated in the following figure:

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[17] *Interview with a DSO representative.*

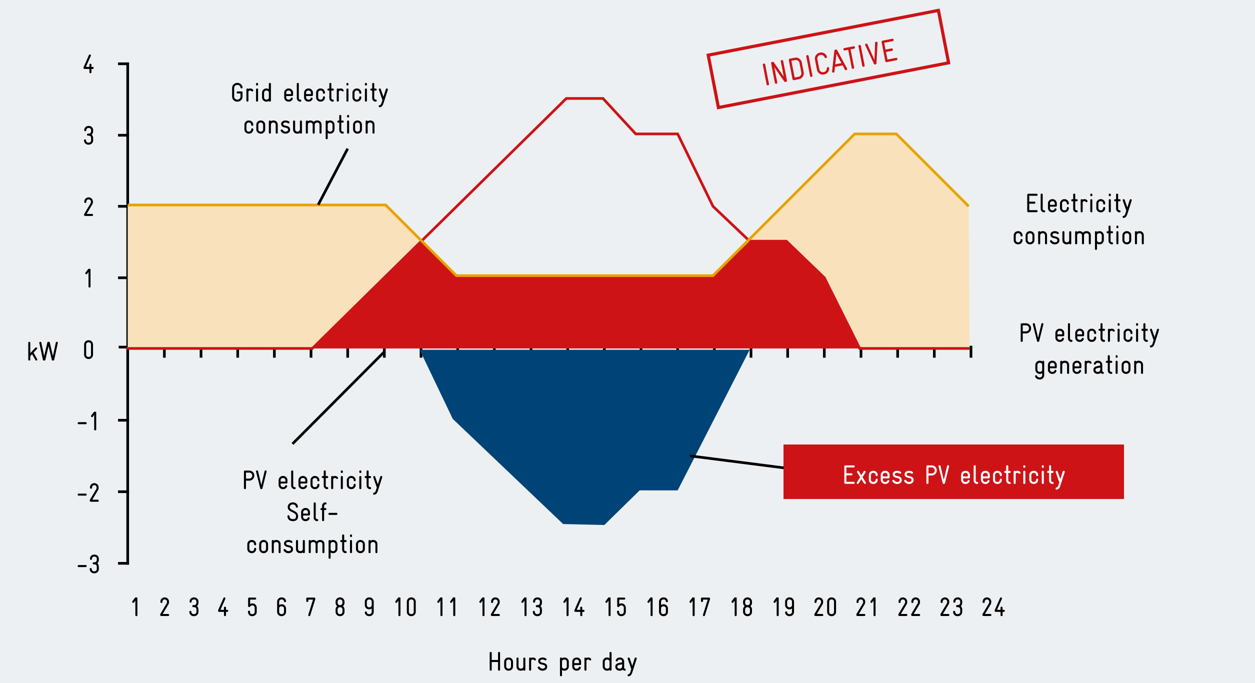
[18] *The Directive Governing the Sale of Electrical Energy Generated from Renewable Energy Systems issued by the Council of Commissioners of Electricity Regulatory Commission Pursuant to Article (10/B) of the Renewable Energy and Energy Efficiency Law No. (13), for the Year 2012*

[19] *Interview with ERC representative and NEPCO representative.*

[20] *http://www.memr.gov.jo/LinkClick.aspx?fileticket=PHxs463H8U0%3d&tabid=255 ,14 July 2014*

[21] *Opportunity costs for alternative investments should also be considered.*

Figure 3: Daily household electricity consumption and PV generation



Source: ECLAREON analysis

Under the Jordanian net-metering scheme, the excess electricity fed into the grid is credited for later consumption. This excess electricity that is credited can be used to offset electricity used at other times, when there is little or no PV electricity production (e.g. at night).

Table 3: Main parameters of Jordan's net-metering scheme

	Parameter	Description
Self-consumption	Revenues for self.-consumed PV electricity	• Savings on the variable price of electricity from the grid
	Cost associated with self-consumption	• The cost of the PV system throughout its lifetime • Additional costs associated with the use of a self-consumption system (e.g. fees and costs for the use of the grid for wheeling)
Excess electricity	Compensation for excess electricity	• Energetic: credit in kWh, "net-metering" • Economical: credit in monetary unit, "net billing"
	Compensation period	• 1 year
Other characteristics	Consumer segment	Consumer categories, e.g. • Small to large residential consumers • Public or ordinary consumers
	Flexibility	• Remote self-consumption (wheeling): Excess electricity can be consumed at a site that is different from the site of production
	Rate structure	• Tariffs for different consumer categories and aspects related to time of use

a. Involved Stakeholders for Net-metering

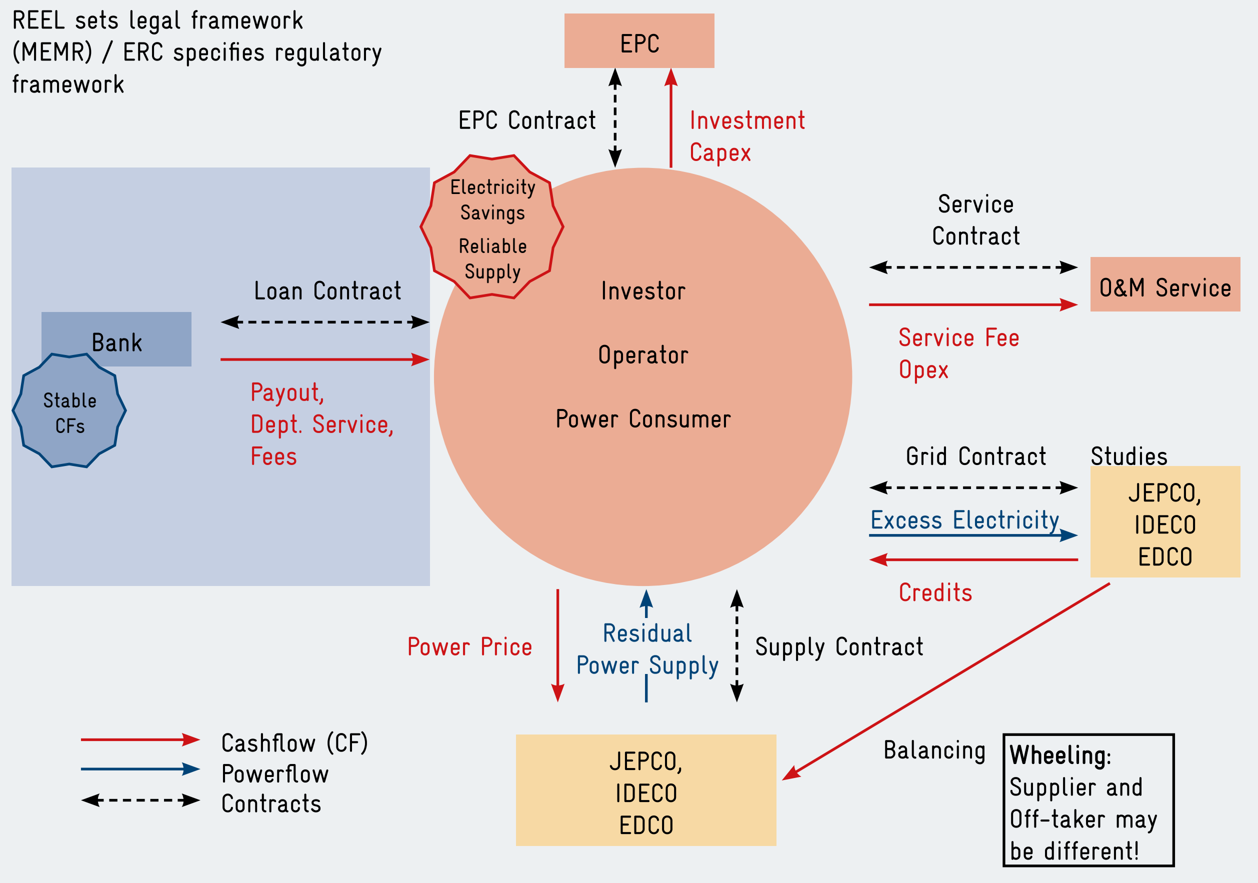
In Jordan, the **investor, the plant operator and the power consumer** must be the same legal entity, and the main goal is to save on the electricity bill. Loans may be obtained from the **bank** if the credit history allows so for a suitable interest rate, though banks are not yet very familiar with PV. An **Engineering, Procurement, Construction (EPC)** company can take over certain construction risks through the EPC contract. An **Operation and Maintenance (O&M)** service provider will ensure reliable operations and may take over some operational risks via a service contract, though for small systems it might not be necessary since only cleaning is required from time to time. The excess electricity will be fed into the **public grid** of a Distribution or Transmission System Operator (DSO or TSO) via a grid connection contract.

At the distribution level, grid operators and electricity provider are usually the same: either **JEPCO, EDCO**, or **IDECO**. If connected to the transmission line, consumers will be served and billed according to the procedures of the state-owned **NEPCO**. The excess electricity will be balanced with the consumed residual electricity for a certain period and a certain price, which further reduces the power consumer's electricity bill.

Financial service companies that provide needed funds to the system owners to finance the PV systems are repaid during the tenor of the respective credit agreements.

All those companies act within the legal framework of the REEL, which is set by the **Ministry of Energy and Mineral Resources (MEMR)**, and are also subject to relevant bylaws and regulations. The **Energy Regulatory Commission (ERC)** issues new instructions for determining the connection costs of the renewable energy facility with the distribution network and sets reference prices for the compensation of excess energy.

Figure 4: Framework for net-metering / wheeling



b. Legal Framework for Net-metering in Jordan

In Jordan, the legal basis for net-metering is the 2012 Renewable Energy and Energy Efficiency Law No. (13) (REEL). Article 10a regulates access to the electricity grid: *"Any person, including small Renewable Energy Facilities and homes that have Renewable Energy Systems for the generation of electrical power, may sell the generated electrical power to the Bulk Supply Licensees and to the Retail Supply Licensees"*, which in Jordan are the national transmission grid operator NEPCO and three utilities JEPCO, EDCO, IDECO.[22]

Article 10 b provides guidelines for the remuneration of renewable energy sources: *"The size and nature of such Renewable Energy Facilities and the selling price of the generated electrical power shall be specified in accordance with instructions to be issued by the [Electricity Regulatory] Commission. The selling price of such power shall not be lower than the purchase tariff specified by the licensees, provided that such instructions shall be published in at least two daily newspapers."*[23]

The producer of renewable electricity is therefore able to sell the electricity at the tariff of its purchase, effectively reducing his electricity costs to the electricity generation costs of renewable energies.

Guidelines for application of net-metering in Jordan

The REEL gives a general permission for net-metering, while the bylaws and regulations of the utilities (in Arabic only) make several restrictions concerning the size, access to a connection point, maximal capacity as well as the balancing and remuneration process for excess electricity.[24, 25] In practice, an investor might offset all consumed energy by auto production if he complies with system criteria and defined rules.

[22] *http://www.memr.gov.jo/LinkClick.aspx?fileticket=vblQv7AybK8%3d&tabid=291 , 13 June 2014*

[23] *http://www.memr.gov.jo/LinkClick.aspx?fileticket=vblQv7AybK8%3d&tabid=291 , 10 June2014*

[24] *http://www.memr.gov.jo/LinkClick.aspx?fileticket=FvIicUCGFTU%3D&tabid=291 , 10 June 2014*

[25] *The Directive Governing the Sale of Electrical Energy Generated from Renewable Energy Systems issued by the Council of Commissioners of Electricity Regulatory Commission Pursuant to Article (10/B) of the Renewable Energy and Energy Efficiency Law No. (13) for the year 2012.*

System definition and specifications

Small systems: These are systems that can be connected to the distribution grid and do not exceed 16 kVA (approximately 3.68 kWp) for each phase, with ENA connection standard **G83/1**, that do not produce more than 15% of the feeder peak load and not more than 20 kVA, and do not require the grid operator to install additional equipment.

Large renewable energy systems: These are systems that are larger than the small systems described above and do not exceed 5 MW. The connection standard is **ENA G59/1**. In addition, a preliminary study and a grid impact study are usually required.

Restrictions

- The sum of the capacity installed (small and/or large systems) should not exceed **5 MWp at any single geographical access** point (Art. 3c).[26]
- Existing or new users of the distribution low voltage grid (< 1 kVA) or mid voltage grid (1 to 33 kVA) shall not produce more than their existing / assumed overall electricity demand (Art. 3a, 3b).
- An overall upper limit for the amount of installation per DSO is fixed by Art. 4a, 4b at a maximum of 1% and 1.5% of peak load of the low and medium distribution grids.
- Article 9 states that *"Distributor shall prepare a guideline that includes procedures for application and connection with the Distributor's network in addition to related forms including contracts to be signed between the Distributor and the User, collection, financial clearance, and other forms, as well as procedures for the termination of energy net-metering. Such guideline shall be approved by the [Electricity Regulatory] Commission"*.
- Each small or large system should not exceed the **average monthly consumption** of the previous year or a consumption assessment for new buildings / consumers from the date of application for connection to the renewable energy system.
- Certain **fees** have to be paid for the application, site visits by utility staff, relevant preliminary and grid impact studies for large systems, and in case of failures to comply, for certain repeated visits by utility staff.
- The relevant distributor should make the **meter** functional and **read the meter** on a monthly basis and issue a monthly bill that indicates the energy flow through the meter to the user from the grid as well as the energy flow through the meter from the renewable energy system to the grid.
- Energy from the grid should be paid for by the consumer; excess energy should be balanced against consumption during the following months and remunerated at the end of a billing year.

[26] *Under Art. 3c notwithstanding the provisions in paragraphs (a, b) of that article, the installed capacity of* ***renewable energy systems*** *in a single geographical site shall not exceed 5 megawatt (MW) regardless of the number of applications in such site.*

Description of the Legal and Administrative Processes for Net-metering

The following overview depicts the legal administrative processes involved in net-metering in Jordan.

Figure 5: Basic structure of the net-metering process and wheeling

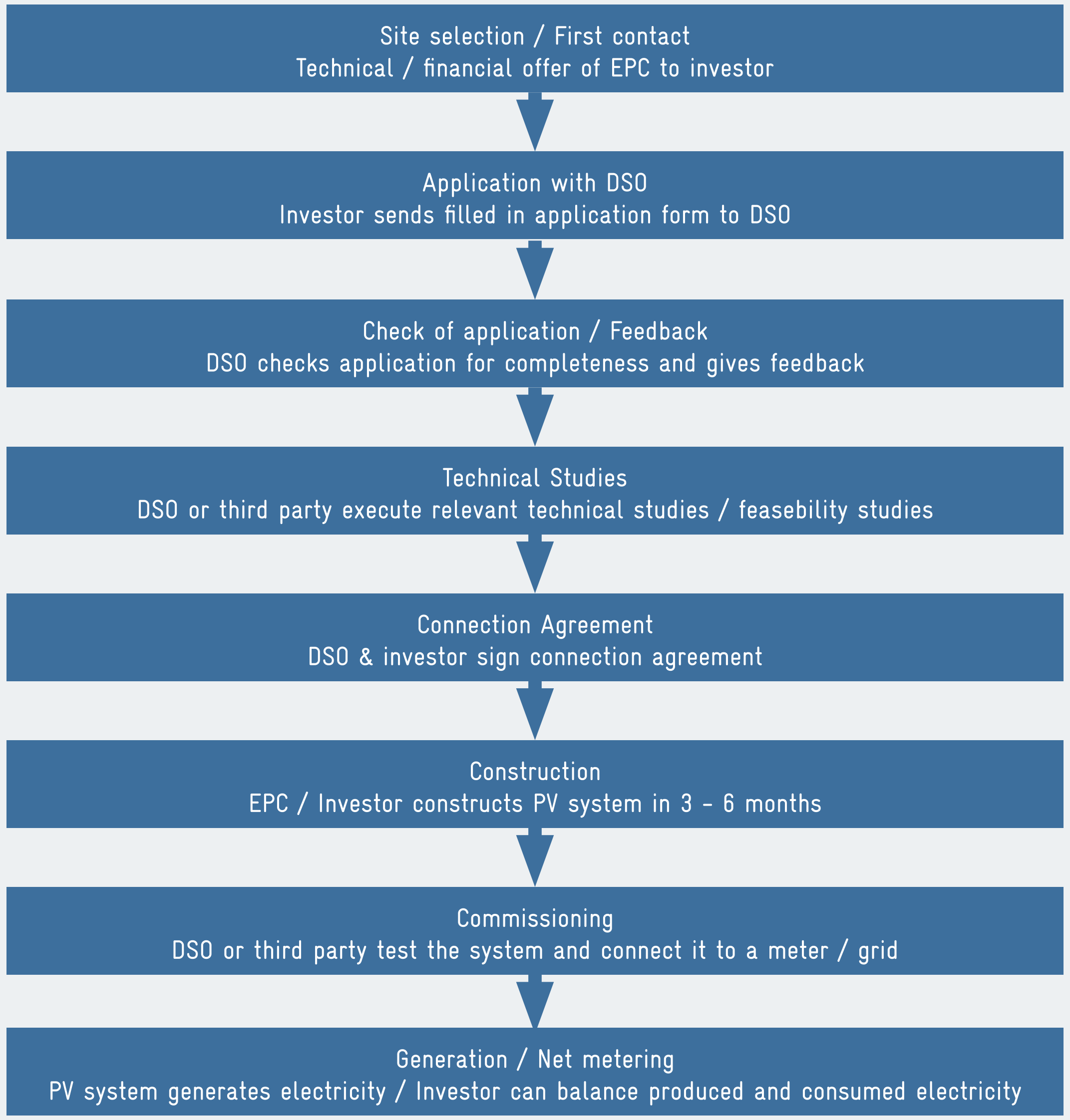


Table 4: Thorough description of simple net-metering

Process Steps Net-metering		
1. Site selection / First contact with installer	Description	An investor seeks a suitable company to realize a PV net-metering project at the site of consumption. In practice, installers / EPC seek investors as PV technology is not yet well known and clients still have to be convinced of the investment. Bigger projects are often called out for tenders in relevant media.
	Actor	Installer / Project developer (EPC) / Investor
	Duration	Customer-specific
2. Offer	Description	The installer makes technical and financial offers to the investor, including a first assessment and simulation of output and power generation. It includes information on equipment (modules, inverters etc.) as well as the total cost of the installation.
	Actor	Installer / Project developer (EPC)
	Duration	Installer-specific < 1 week

3. Application	Description	After accepting the offer, the investor must fill in an application form provided by the relevant utility and pay the relevant fees.
		This application form usually includes:
		• Identification card of the applicant
		• Information on equipment to be used
		• Electric scheme of the installation
		• Plan of the site of the PV system
		• Certificate of conformity to ENA standards, ENA G83/1 (small systems) or ENA G59/1 (large systems)
		• Payment of the application fees of
		  • JD 50 / per kWp and JD 150 minimum for small systems, which will be refunded in case of successful project completion
		  • JD 300 for systems up to 50 kWp and 300 + JD 1 / kW for systems > 50 kWp which will be refunded in case of successful project completion
		• Other relevant documents
		In practice, the installer fills in the relevant forms for the investor.
		After submitting the application to the relevant utility, the latter will process it and reply to the applicant concerning the completeness of the application within
		• 10 business days for small systems
		• 15 business days for large systems
		[Restriction: If the application is incomplete, the applicant can submit missing information to prevent cancelation of the application within
		• 5 business days for small systems
		• 10 business days for large systems]
		After the completion of the application, the applicant must meet with a DSO representative at the site of the construction within 10 days for large systems. Usually this site visit is not carried out in practice.

	Actors	Installer / Project developer (EPC) / Investor / Relevant DSO
	Duration	3-4 weeks for small systems / at least 4-8 weeks for large systems
4. Technical studies	Description	Once the application is complete, relevant technical studies are required. • For small systems, the relevant DSO executes a technical study free of charge • For large systems, a preliminary study and, upon request, a grid impact study must be executed. Both studies are usually required and can either be contracted to a third party or conducted by the relevant DSO. Fees for conducting the studies vary according to DSO and any changes carried out.* The study can be conducted after signing an agreement naming fees, period, field objective of the study etc., which has to be offered by the DSO within 5 days. The grid impact study should include flow current, fault current, protection devices, impacts on the grid system, stability of grid system, and voltage drop. For any system with a capacity of 2 MW or less, the study may be waived for the impacts on the grid system and voltage drop analyses. The study has to be conducted within 60 business days after payment of the fee.
	Actors	Installer / Project Developer Investor / Relevant DSO / [third party]
	Duration	For small systems not necessary, for large systems at least 2 to 4 months
5. Connection Agreement	Description	After the execution of the study, a Connection Agreement must be provided by the DSO within 10 business days and has to be signed by the applicant within 30 business days. **[Restriction: If the study comes to the conclusion that the grid infrastructure has to be modified for connecting the system, the project is either cancelled or the applicant can agree to pay for relevant modifications at his own expense and then sign the connection agreement.]**
	Actors	Installer / Project Developer Investor / Relevant DSO
	Duration	At least 2 weeks

* *JEPCO charges a minimum of JD 1,500 for systems up to 100 kWp and JD 1,500 + JD 15 per extra kWp for bigger systems.*

Process Steps Net-metering		
6. Construction	Description	After the signature of the Connection Agreement the investor has to construct and make the PV system operational within • 3 months for small systems • 6 months for large systems
	Actors	Installer / Project Developer
	Duration	Company-specific, but at least 1 week for small systems
	Description	The investor must request a site visit by the DSO to either test or monitor a third-party test of the system at least 20 business days ahead of putting the PV system into operation. The DSO must respond within 20 days. If a third party must conduct the testing, the investor must send to the distributor checklist and timetables of all inspection and testing procedures to be carried out, and must carry out all inspections and testing in the presence of the distributor, inform the distributor that the system is ready for operation and set the date of operation. **[Restrictions: In case the DSO considers the system to be not yet operational, the investor has 10 days to make relevant modifications for small systems and must pay JD 20 for a second site visit.]** If the system is complete and operational, the meter will be replaced or upgraded in order to measure the output of the PV system. **[Restrictions: If the system is not considered operational, the Connection Agreement is considered to be cancelled.]**
7. Site Visits / Tests / Bring into operation	Actors	Installer / Project Developer (EPC) / Investor / Relevant DSO / Third Party
	Duration	At least 2 weeks
	Description	Measurement of energy flows: The distributor must read the meter on a monthly basis and issue a monthly bill that indicates the energy flow through meter to the user from the grid, as well as the energy flow through the meter from the renewable system to the grid. Net-metering bill: • If the energy flow through the meter from the grid is greater than the energy flow from the renewable system to the grid, the user should pay the difference at his applicable tariff. • If the energy flow through the meter from the renewable energy system to the grid is greater than the energy flow from the grid, the distributor should roll over the surplus into the next month. • If there is excess energy at the end of the year, the user can ask for compensation.
8. Generation and payment process	Actors	Investor / Relevant DSO
	Duration	Ongoing

c. Net-metering with Wheeling

So far, there have been few specifications for off-site PV power production and net-metering in Jordan. The regulations were published in January 2014. By June 2014, however, no project had yet been realized under the scheme. It remains to be seen if such projects can be implemented in practice. Nevertheless, this area presents a highly lucrative potential if implemented and should therefore be closely considered by consumers with high electricity demand and high tariffs.

For the net-metering option with **wheeling, combinations of grid connections** have to be considered, since each applicant (consumer) is connected to the **distribution or transmission grid**, but could feed electricity into either the distribution (JEPCO, IDCO, EDECO) or transmission grid (NEPCO). In addition, each type of grid has a certain amount of **electricity loss** that has to be considered for the economic evaluation.

Table 5: Connection options for net-metering with wheeling

	Feed-in with DSO	Feed-in with TSO
Consumer connected to DSO	Possible, most common case	Possible
Consumer connected to TSO	Not possible	Possible

Table 6: Process steps net-metering with wheeling (user connected to DSO / feed-In to DSO)

Process steps net-metering with wheeling (user connected to DSO / feed-In to DSO) (delays not included)		
1. Site selection / First contact with installer	Description	An investor / applicant seeks a suitable company to realize a PV net-metering project off the site of consumption to connect it to the public distribution (or transmission) grid. In addition, a suitable site has to be found and secured by concluding a land lease or acquisition agreement. In practice, installers / EPC seek investors as PV technology is not yet well-known and clients still have to be convinced. For bigger projects, by contrast, calls for tender would be published in relevant media.
	Actor	Installer/ Project developer (EPC) / Investor / Land Owner
2. Offer	Description	The installer makes a technical and commercial offer to the investor, including a first assessment, grid connection options and simulation of output and power generation. It includes information on equipment (modules, inverters etc.) as well as the total cost of installation.
	Actor	Installer/ Project developer (EPC)

Process steps net-metering with wheeling (user connected to DSO / feed-In to DSO) (delays not included)		
3. Application	Description	After the acceptance of the offer by the investor, the later has to fill in an application form provided by the relevant utility and pay the relevant fees, which will be determined by the DSO according to the application. Utilities can be the DSO or TSO. This information form usually includes : • Dimensioning of the system according to previous average monthly consumption or less (for small systems: not exceeding 15% of feeder peak load / 20 kVA / phase (small systems)) • Identification card of the applicant • Information on equipment to be used • Electric scheme of the installation • Plan of the site of the PV system & geographical location • Certificate of conformity to ENA standards, ENA G83/1 (small systems) or ENA G59/1 (large systems) • Third-party certificate of compliance with international safety standards • Other relevant documents In practice, the installer usually fills in the relevant forms for the investor. After submitting the application to the relevant utility, the latter will process it and reply to the applicant concerning the completeness of the application: • within 10 business days for small systems • within 15 business days for large systems **[Restrictions: If the application is incomplete, the applicant can submit the missing information to prevent cancelation of the application within** **• 10 business days for small systems (extendable)** **• 15 business days for large systems (extendable)]** After the completion of the application, the applicant meets with a DSO / TSO representative at the site of the construction within 20 days for all system types. Small systems: The applicant then receives information on the requirements for grid connection and costs involved, and must pay these costs within 20 business days.
	Actors	Installer / Project Developer (EPC) / Investor / Relevant DSO

Process steps net-metering with wheeling (user connected to DSO / feed-In to DSO) (delays not included)		
4. Technical studies	Description	Once the application is complete, relevant technical studies are required: • For small systems, the relevant DSO executes an evaluation study to determine the connection cost for the investor, free of charge • For large systems, the costs for required studies have to be provided by the DSO within 30 business days of a site visit. A preliminary study must be executed, as well as a grid impact study upon request. Both studies are usually required and can either be contracted to a third party or conducted by the relevant DSO. Fees for the studies are at least JD 500 and JD 5 per additional kWp for the preliminary study, and at least JD 1,000 and JD 10 per additional kWp for the grid impact study. • The studies can be conducted after signing an agreement specifying the study's fees, time period, field objective etc.; the DSO must provide this within 10 days. • The Grid Impact study should include flow current, fault current, protection devices, impacts on the grid system, stability of grid system, and voltage drop. • After the signature of the agreement within 30 business days and the payment of the fees by the applicant, the studies can be conducted. • For any system with a capacity of 2 MW or less, the study may be waived with regard to impacts on the grid system, stability and voltage drop analyses. • The study must be conducted within 60 business days, starting with payment of the fee.
	Actors	Installer / Project Developer (EPC) / Investor / Relevant DSO / [third party]
5. Signing of connection agreement	Description	After the execution of the study a connection agreement must be provided by the DSO within 20 business days and must be signed by the applicant within 30 business days. Payments for the required system connection have to be delivered within 20 business days. **[Restriction: If the study comes to the conclusion that the grid infrastructure has to be modified for connecting the system, the project is either cancelled or the applicant can agree to pay for the relevant modifications himself and then sign the connection agreement.]** For large systems > 1 MWp a license should be requested from the ERC.
	Actors	Installer / Project Developer Investor / Relevant DSO
6. Construction of the PV system	Description	After the signing of the connection agreement, the investor must construct and make the PV system operational within • 3 months for small systems • 6 months for large systems.
	Actors	Installer / Project Developer (EPC)

Process steps net-metering with wheeling (user connected to DSO / feed-In to DSO) (delays not included)		
7. Testing and make operational of the systems	Description	The investor must request a site visit by the DSO to either test or monitor a third party test of the system at least 20 business days ahead of putting the PV system into operation. The DSO must conduct this site visit within 20 days of the request for a visit. If a third party must conduct the testing, the investor must send checklists and timetables of all inspection and testing procedures that will be carried out to the distributor, and must carry out all inspections and testing in the presence of the distributor. He must also inform the distributor that the system is ready for operation and specify the date of operation. Fees for testing by the DSO are JD 1 / kWp. **[Restrictions: In case the DSO considers the system to be not yet operational, the investor has 10 days to make relevant modifications for small systems and must pay JD 20 for a second site visit.]** If the system is complete and operational, the meter will be replaced or upgraded in order to measure output of the PV system. **[Restrictions: If the system is not considered operational, the connection agreement is considered to be cancelled.]**
	Actors	Installer / Project Developer (EPC) / Investor / Relevant DSO
8. Generation and payment process	Description	**Measurement of energy flows:** The distributor must read the meter on a monthly basis and issue a monthly bill that indicates the energy flow through meter to the user from the grid, as well as the energy flow through meter from the renewable system to the grid. **Net-metering bill:** • If the energy flow through the meter from the grid is greater than the energy flow from the renewable system to the grid, the user should pay the difference at his applicable tariff. • If the energy flow through the meter from the renewable energy system to the grid is greater than the energy flow from the grid, the distributor should roll over the surplus electricity into the succeeding month. • If there is excess energy at the end of the year, the user can ask for compensation according the ERC reference price list.
	Actors	Investor / Relevant DSO

d. Economics for PV Systems in Jordan using Net-Metering

In order to calculate the economics of sample projects in Jordan, one has to make several assumptions based on factual data, if it is available, to determine the key input parameters[27]. Otherwise, one must resort to data given by interviewees, or base applicable cases on reasoning or past developments. In addition, since the average lifetime of a solar system is considered to be at least 20 years, one has to estimate future developments in terms of prices, inflation, etc.

Typical consumption
Since concrete data were not available for the study, typical consumption patterns had to be based on reasoning and international comparisons.

Case Selection

The relevant cases were selected in order to give a broad overview of different examples. Since tariff categories are similar, the reader can draw conclusions regarding other tariff categories, e.g. commercial consumers and hotels (flat tariff) that have a very similar tariff structure. Though it does not reflect a thorough simulation due to different consumption patterns, one can assume that a profitable investment for commercial consumers would be profitable for hotels as well.

Qualitative interviews and local consultation provided some insight on the calculations, and on whether these examples might be recommendable to use in the calculation.

Table 7: Typical consumption assumptions

Residential	Consumption		Public	Consumption
Small household	600 kWh/month		Small schools	2,000 kWh/month
Medium household	1,000 kWh/month		Medium schools	10,000 kWh/month
Large household	2,000 kWh/month		Large schools	30,000 kWh/month
Commercial			**Industry**	
Small commercial	3,000 kWh/month		Small industries	30,000 kWh/month
Medium commercial	25,000 kWh/month		Medium industries	120,000 kWh/month
Large Commercial	50,000 kWh/month		Large industries	400,000 kWh/month
Tourism				
Small hotels	20,000 kWh/month			
Medium hotels	50,000 kWh/month			
Large hotels	250,000 kWh/month			

[27] Key input parameters include the initial investment, operation and maintenance costs, expenditure for financing and taxation. On the revenue side, the investor has to consider the overall PV electricity generated during the system's life time, the self-consumption ratio, the retail price of electricity as well as the salvage value of the PV-system at the end of its useful life. With the parameters it is possible to calculate the indicators to evalutate the economics of the project such as the net present value (NPV), the internal rate of return (IRR), the payback period (PB) and levelized cost of energy (LCOE).

Table 8: Simulations chosen

Case	Consumption / month	Electricity tariffs JD / kWh 2014	Electricity price increase 2014 – 2017 in % per year	Size PV system	IRR in simulation in %*	Amortization in years
Small residential rooftop	600 kWh	0.033 – 0.14	0	2 kWp	2.45	16.41
Large residential rooftop	2,000 kWh	0.033 -0.259	5	8 kWp	35.78	3.57
Small ordinary (public) consumer rooftop	4,000 kWh	0.04 – 0.259	5	15 kWp	60.11	1.75
Midsized commercial rooftop	15,000 kWh	0.12 – 0.168	5	60 kWp	43.09	2.66
Midsized industrial	25,000 kWh	0.063 (daytime tariff)	5	150 kWp	14.53	10.17
Large industrial wheeling (other industries)		0.124	5	2 MWp	28.54	5.71

* *Please take assumptions into account.*

e. General Assumptions for PV Projects under the Net-Metering Scheme

The only fixed data were electricity prices at their current levels and energy yield per solar system in different regions of Jordan. Assumptions were made on the cost of PV, financing, energy yield, electricity demand and price development for the time beyond 2017 for different consumer categories, future development of loans and interest rates, etc. It should be noted that many assumptions might still be subject to change once more experience with PV systems has been gathered; they should therefore be critically examined by investors and policy-makers.

Electricity prices
In Jordan, the "National Strategic Plan for Dealing with NEPCO's Losses" prescribes the electricity price development for different consumer categories until the year 2017.[28] Nevertheless, electricity is subsidized for many categories, e.g. for consumers with low electricity consumption. Therefore the greater the consumption, the bigger the savings become in terms of self-consumption and net-metering.

For the calculation, average electricity prices for one consumer across all categories have to be calculated before installing a PV system and after self-consumption and net-metering, in order to calculate average savings on an annual basis.[29]

[28] *http://www.memr.gov.jo/LinkClick.aspx?fileticket=PHxs463H8U0%3d&tabid=255*

[29] *Unfortunately this method does not allow the monthly balancing to accurately predict savings since PV electricity generation will be higher in summer (as is consumption for cooling needs) and lower in winter. Since Jordan has a summer electricity peak, this impreciseness is deemed to be acceptable for most consumer categories, especially those involved with people and services.*

Table 9: Excerpt for consumer categories and electricity prices according to NEPCO*

2017	2016	2015	2014	01.08.2013 to 31.12.2013	Current Tariff	Sector	
Price in Fils/kWh							
						a. Household consumers	
33	33	33	33	33	33	From 1 to 160	kWh/month
72	72	72	72	72	72	From 161 to 300	kWh/month
86	86	86	86	86	86	From 301 to 500	kWh/month
114	114	114	114	114	114	From 501 to 600	kWh/month
188	175	163	152	141	141	From 601 to 750	kWh/month
224	209	194	181	168	168	From 751 to 1,000	kWh/month
296	285	271	259	235	235	Over 1,000	kWh/month
86	86	86	86	86	86	From 301 to 500	kWh/month
						b. Ordinary consumers	
53	48	44	40	36	33	From 1 to 160	kWh/month
116	105	96	87	79	72	From 161 to 300	kWh/month
139	126	114	104	95	86	From 301 to 500	kWh/month
184	167	152	138	120	114	From 501 to 600	kWh/month
202	188	175	163	152	141	From 601 to 750	kWh/month
214	204	194	185	176	168	From 751 to 1,000	kWh/month
300	286	272	259	247	235	Over 1,000	kWh/month

* *http://www.memr.gov.jo/LinkClick.aspx?fileticket=PHxs463H8U0%3d&tabid=255*

2017	2016	2015	2014	01.08.2013 to 31.12.2013	Current Tariff	Sector	
Price in Fils/kWh							
						d. Commercial consumers	
183	159	138	120	105	91	From 1 to 2,000	kWh/month
255	222	193	168	146	127	Over 2,000	kWh/month
						g. Small industries	
100	87	75	66	57	57	From 1 to 10,000	kWh/month
115	100	87	75	66	57	Over 10,000	kWh/month
						h. Medium industries	
3.79	3.79	3.79	3.79	3.79	3.79	1. Max. demand JD/kW/ month	
127	110	96	83	72	63	2. Daytime	tariff
107	93	81	70	61	53	3. Nighttime	tariff

Prices of PV systems
In Jordan, prices for PV systems are rather competitive and do not differ much from international market prices. The absence of import taxes, compulsory local content requirements, competitive labor cost as well as a the presence of a sufficiently qualified labor force like electricians and engineers lead to internationally competitive end consumer prices for PV installations. Though no official price index for PV systems in Jordan exists, interviewees presented quite similar assessments regarding price range, namely between JD 1,750 / Wp for very small installations to below JD 1,000 / Wp for very large ones. Costs of PV systems are based mainly on the costs of the hardware (60-80%), depending on quality and origin. In the study the following data was incorporated:

For simulations in the study, high quality hardware (tier 1 or 2 modules) was assumed. As a result, system price assumptions can be considered as moderate to conservative.

Table 10: Assumptions on end consumer prices for the study

System size	Costs for end customer / kWp
1-2 kWp (one phase)	JD 1750
2-10 kWp (three phases)	JD 1400
3-20 kWp (three phases)	JD 1250
3-100 kWp (three phases)	JD 1150
3 to 500 kWp (three phases)	JD 1050
Bigger than 500 kWp	JD 1000

As shown, small system prices are considerably higher than larger ones. This seems to be reasonable since economies of scale in procurement, planning, development, logistics and installation cannot be achieved. Savings can be made on the administrative processes, which for small systems (< 10.8 kWp) have simpler requirements.

Operating and maintenance costs
Operation and maintenance costs are considered to be between JD 1.5 and 3.5 / kWp of the total cost per kWp, depending on the size of the system. These values refer per year and are rather conservative.

Financing costs
In Jordan, end consumers can currently receive bank loans with interest rates of around 6-10% / year with a tenor of 5 to 10 years.[30] Nevertheless it has to be said that solar PV is not yet a well-known investment product to most banks in Jordan, so that appropriate information has to be provided to prospective lenders and many investors will have to finance their PV system using equity or other sources of funding.

Inflation
Though it is lower at the moment, over the past 37 years average inflation rate in Jordan was around 5.7% p.a.[31]

Irradiation
Irradiation in Jordan varies. Nevertheless, as more than 80 per cent of Jordan's population lives in urban areas, for the business case of net-metering with the system based directly on the grounds of the consumer, it seems reasonable to consider urban sites and the irradiation there. Assumptions are difficult for the case of wheeling since the system could be located anywhere in the country, and close to an existing electricity line. Nevertheless, sensitivities[32] were given for each case providing an outlook on changes in the assumptions.

- Central and northern areas – Amman: 5.711 kWh/m²/day at horizontal surface.
- Southern area – Aqaba: 6.021 kWh/m²/day at horizontal surface. [33]

Performance ratio
Typical performance ratios of PV for the two regions are as follows, with deviations mainly due to differences in the average temperature:

- 82% for Amman.
- 77% for Aqaba.

For modeling purposes, an average of 80% has been used.

Taking into account that the optimal tilt range in Jordan is 25-30 for a fixed PV system facing south, the solar irradiance levels become approximately 6.1 and 6.44 kWh/m2/day for Amman and Aqaba respectively.

For PPAs, we need to add another 3% loss from transformers, resulting in performance ratios of 0.79 and 0.74 for Amman and Aqaba, respectively. [34]

Yield
If one combines the factors performance ratio and irradiation, the expected yield for Amman is 6.1 x 365 x 0.82 = 1825 kWh/kWp, while for Aqaba it is 6.44 x 365 x 0.77 = 1810 kWh/kWp. Nevertheless, module degradation and performance loss has to be considered in the calculations. For the calculations, a high value of 0.8% per year was considered. Operation and maintenance activities to avoid dust and sand pollution are required to prevent degradation.

Assumptions for Wheeling
Wheeling involves some extra costs that would have to be considered for the evaluation. First there are specific losses as well as charges for different kind of connections. With a maximum potential of 5 MWp, the most common solution seems to be for users connected to the distribution grid to feed electricity into the distribution grid. The relevant losses and charges are taken into account.

[30] *http://www.tradingeconomics.com/jordan/interest-rate*
[31] *http://www.tradingeconomics.com/jordan/inflation-cpi*
[32] *Sensitivities give an indication of changes if one of two variables change; e.g. if irradiation increases or decreases the output of a PV system also changes.*
[33] *Source: Data reference for solar irradiance and temperatures: National Center for Research and Development. Jordan Solar Irradiance and Ambient Temperatures Bulletin for the Years 2004-2010.*
[34] *Data reference for solar irradiance and temperatures: National Center for Research and Development. Jordan Solar Irradiance and Ambient Temperatures Bulletin for the Years 2004-2010.*

Table 11: Wheeling charges and energy losses

Type of Connection	Electricity Losses (%)	Charge (JD/kWh)
Connection to transmission system for a user connected to the transmission system	2.3	0.0045
Connection to distribution system for a user connected to the distributed system	6	0.007
Connection to transmission system for a user connected to the distribution system	8.3	0.0115

Parameters of the PV System, Prices, Investment

PV system
All aspects must be taken into consideration to calculate price, energy yield etc.

- **System size:** Size of the PV system in kWp.
- **Specific investment cost:** Total cost of the PV system per kWp in JD, including equipment, cabling, engineering, installation and relevant fees.
- **Absolute investment costs:** Cost of the entire system in JD, including equipment, cabling, engineering, installation and relevant fees.
- **Specific yield:** kWh produced per kWp installed in the given year of operation.
- **Direct consumption rate:** Percentage of electricity which is produced and directly and physically consumed on the site and which therefore is not taken from the electricity grid. This has implications for the levelized average costs of electricity if a consumer is in a tariff scheme with different tariff categories. [35]
- **Net-metering rate:** Percentage of electricity that is fed into the grid and therefore used on a monthly basis to offset electricity consumption.
- **Operation and maintenance:** Percentage of the total system costs per year as additional costs needed to maintain the PV system operational, including cleaning, exchange of inverter etc.

Price parameters
Below are all the inputs needed to calculate economics of electricity prices.

- **Monthly consumption:** Amount of kWh consumed per month by a given consumer, determining the tariff category.
- **Average grid electricity price:** Average price of electricity per kWh at given consumption without PV system, divided by different tariff categories.
- **Average net-metering electricity price:** Price of electricity per kWh at given consumption, deducting the percentage of direct consumption (e.g. 30%) from the highest tariff categories once a PV system has been installed.
- **Electricity price escalation:** Price increase per year assumed over 20 years (minimum operational period of PV system).
- **Inflation:** Increase in average cost of living and depreciation of purchasing power of a currency.

Investment parameters
Aspects with an impact on the profitability of a given project are the following:

- **Project duration:** Length of the utilization of the PV system, usually 20 years.
- **Equity:** Percentage of money available to the investor, which could also be used for other investments but PV.
- **IRR:** Internal rate of return in percentage per year on the equity employed.
- **Amortization:** Time elapsed until 100 per cent of the equity employed has been recovered, before inflation.

All these parameters have been considered in simulating the profitability of various alternative investment decisions. This would be then the so called Discount Rate.

[35] *E.g. a consumer reduces the amount of electricity he purchases from the grid by 30% and therefore leaves a more expensive tariff category.*

Table 12: Assumptions for small residential consumer

PV System		
System Size	kWp	2
Specific investment cost	JD/kWh	1,750
Absolute investment cost	JD	3,500
Specific yield	kWh/kWp/a	1,800
Direct-consumption rate	%	30%
Net-metering rate	%	70%
Degradation	%	0.8%
Operation & maintenance	JD/kWp/a	35
Price Parameter		
Monthly consumption	kWh	600
Average grid electricity price	JD/kWh	0.0733
Net-metering electricity price	JD/kWh	0.0667
Electricity price escalation*	% p.a.	5%
Inflation	% p.a.	5.7%
Investment		
Project duration	Years	20
Equity	%	100%
Equity IRR	%	1.53%
Amortization	Years	17.53

* *after 2017*

Example 1: Small Residential Consumer PV System with 2 kWp

Particularities:

- High costs of the PV system due to the small size of 2 kWp.
- Low electricity tariffs due to subsidies and no price increase until 2017 due to government subsidy policy; beyond that timeframe a price increase of 5% per year was assumed.
- Payment of 100% of the system with equity at the beginning of the first year.

Market segment:
All residential households with little electricity consumption and highly subsidized tariffs.

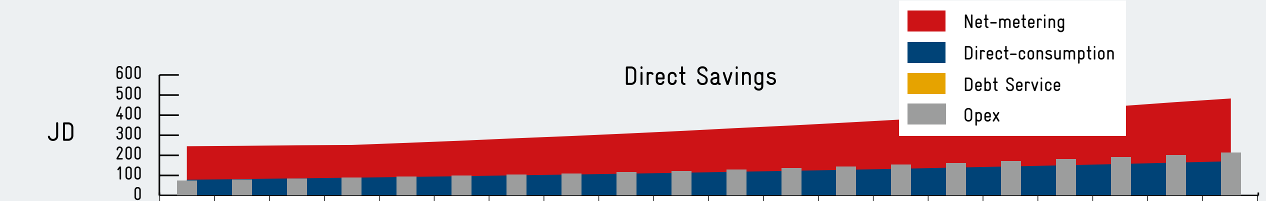
Attractiveness of PV for investors is very low, for the following reasons:

- The investments have very long payback times.
- The user group often has insufficient equity for this investment and many other investment opportunities.
- The effort for the investor is high relative to savings.

Regulatory ways to increase attractiveness:

- Enable third-party ownership (e.g. leasing) to allow EPC to realize larger projects on multi-family houses / wheeling with economies of scale.
- Shift subsidies and cross-subsidies from electricity tariffs to PV promotion.
- Provide grants or subsidies for PV systems that can produce electricity at a lower rate than NEPCO retail costs (< JD 0.146).

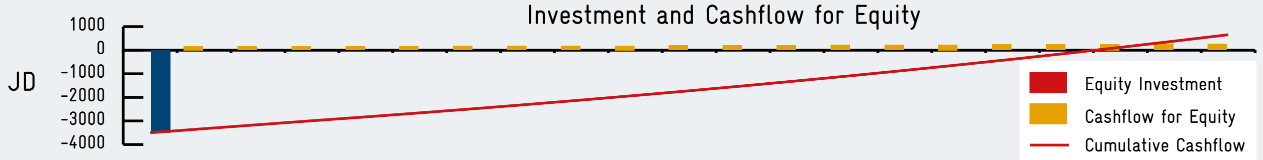
Figure 6: Small residential PV system savings on energy



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Net-metering	167	166	165	163	170	177	185	192	200	208	217	226	235	245	256	266	277	288	301	313
Direct-consumption	78	82	85	89	92	96	101	104	109	113	118	123	128	133	139	145	151	157	164	170
Debt Service	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Opex	74	78	83	87	92	98	103	109	115	122	129	136	144	152	161	170	180	190	201	212

Operation Year

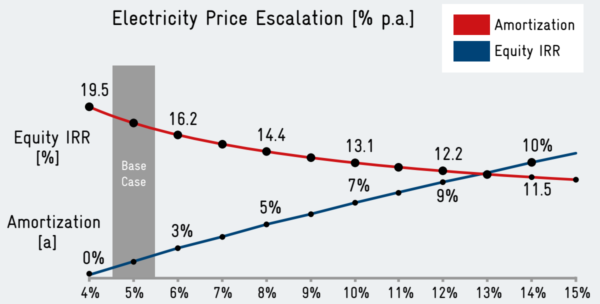
Figure 7: Small residential PV system investment & cashflows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(3,500)																				
Cashflow for Equity	-	171	169	167	164	170	175	182	187	193	199	207	212	219	226	234	240	248	255	264	271
Cumulative Cashflow	(3,500)	(3,329)	(3,160)	(2,992)	(2,828)	(2,658)	(2,483)	(2,301)	(2,114)	(1,921)	(1,722)	(1,515)	(1,302)	(1,083)	(857)	(623)	(383)	(135)	120	384	655

Operation Year

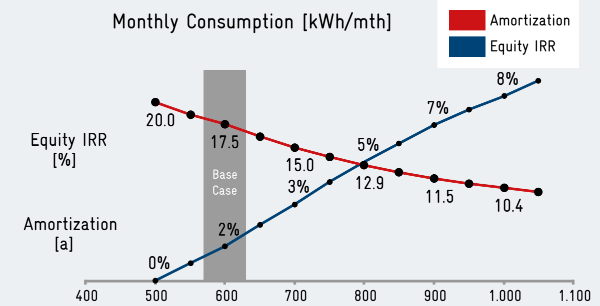
Figure 8: Small residential PV system electricity price sensitivity analysis



Explanation:
A strong increase in electricity prices will lead to a moderate improvement in the internal rate of return for equity employed.

Evaluation:
A strong price increase for small electricity consumers is politically not considered to be opportune and therefore is a rather unrealistic case.

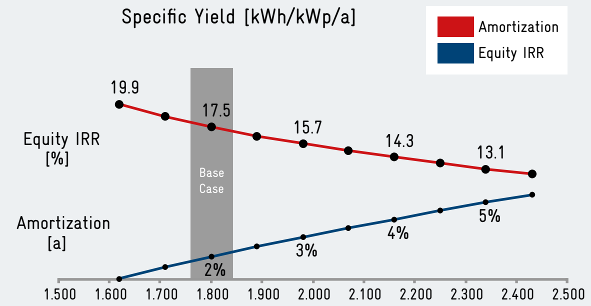
Figure 9: Small residential PV system consumption sensitivity analysis



Explanation:
Households with higher electricity consumption face improved internal rates of return for equity employed.

Evaluation:
For households with high electricity consumption it is more attractive to invest in PV systems. Nevertheless, IRR starts to approach acceptable levels when more than 1000 kWh / month are being consumed.

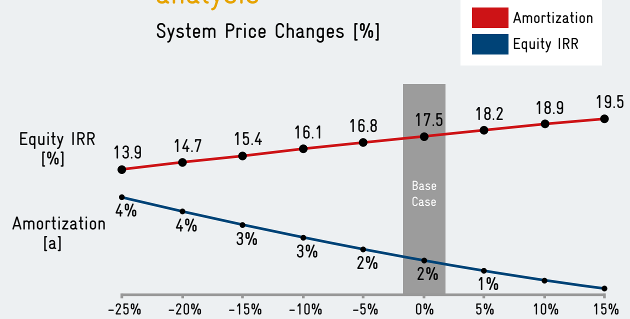
Figure 10: Small residential PV system yield sensitivity analysis



Explanation:
A strong increase in specific yield per kWp will lead to a considerable improvement in the internal rate of return for equity employed.

Evaluation:
A strong increase in yield will either require more high-performance PV technologies and / or different sites with extreme sunshine, most of which are not populated.

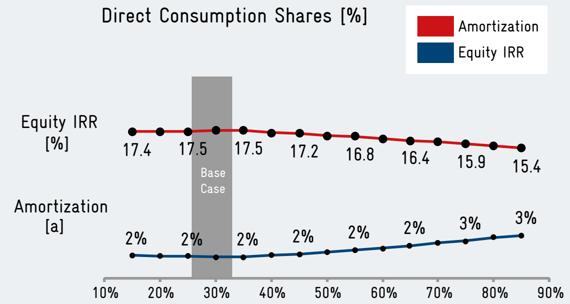
Figure 11: Small residential PV system equipment price sensitivity analysis



Explanation:
A strong decrease in specific system price per kWp will lead to a moderate improvement in the internal rate of return for equity employed.

Evaluation:
A strong decrease in the prices is currently not very probable, since PV prices in Jordan are already relatively competitive at international level.

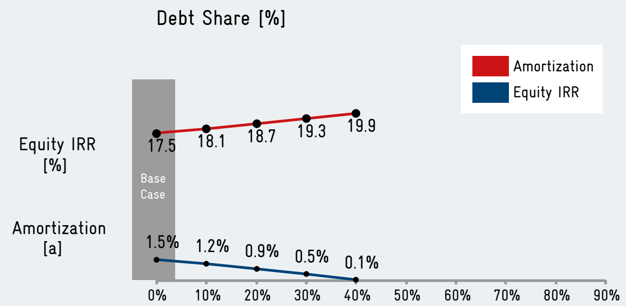
Figure 12: Small residential PV system direct consumption share sensitivity analysis



Explanation:
A strong increase in the direct consumption share hardly has an effect on the internal rate of return for equity employed.

Evaluation:
A strong increase in the direct consumption share is hardly possible for residential consumers.

Figure 13: Small residential PV system debt share sensitivity analysis



Explanation:
A strong increase in the debt share of the PV system share has hardly any effect on the internal rate of return for equity employed.

Evaluation:
Even if it were possible for small residential consumers to get a loan for a PV system, it would even decrease the economic attractiveness of the investment.

Table 13: Assumptions for a large residential consumer

PV System		
System size	kWp	8
Specific investment cost	JD/kWh	1,400
Absolute investment cost	JD	11,200
Specific yield	kWh/kWp/a	1,800
Direct-consumption rate	%	30%
Net-metering rate	%	70%
Degradation	%	0.8%
Operation & maintenance	JD/kWp/a	26
Price Parameter		
Monthly Consumption	kWh	2,000
Average grid electricity price	JD/kWh	0.1855
Net-metering electricity price	JD/kWh	0.1709
Electricity price escalation	% p.a.	5%
Inflation	% p.a.	5.7%
Investment		
Project duration	Years	20
Equity	%	30%
Debt tenor	Years	7
Interest rate	%	10%
Discount rate	%	10%
Net present value	JD	12,894
Equity IRR	%	31.41%
Amortization	Years	4.53

Example 2: Mid-sized Residential Consumer PV System of 8 kWp

Particularities:

- Equity share of the investment is 30%.
- Average electricity prices are high since the consumer has a high level of unsubsidized electricity consumption.
- High to medium system price.
- Continuous price increase of 5% / year from the first year on for the tariff categories substituted with PV.
- Administrative processes not too time consuming since the category is still considered to be small (no exhaustive technical studies).

Market segment:
All residential households with high electricity consumption with only partially subsidized tariffs. Mainly one- or two-family dwellings or larger settlements with spacious dwellings.

Attractiveness of PV for investors is very high, for the following reasons:

- The investment has a short payback time.
- The user group often has enough securities to receive a bank loan.

Regulatory ways to increase attractiveness:

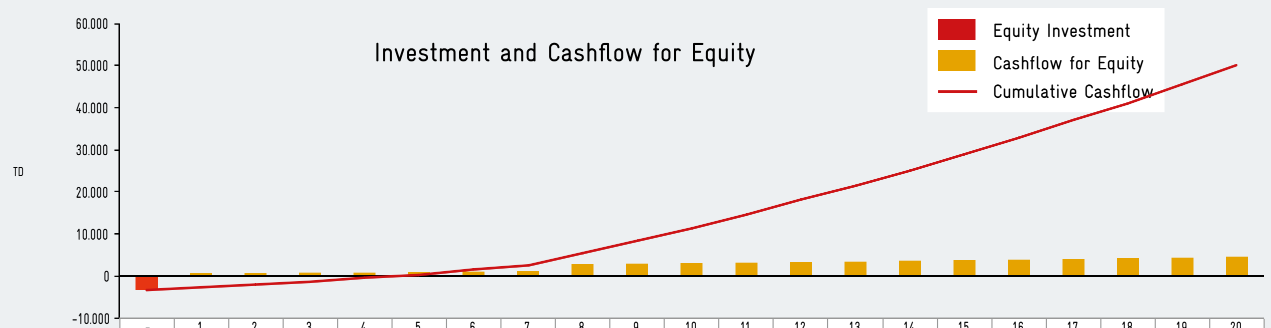
- Provide easy access to credits.
- Remove subsidies for electricity tariffs to make it attractive to offset 100 % of the electricity.

Figure 14: Mid-sized residential PV system savings on energy

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Net-metering	1.709	1.780	1.859	1.931	2.012	2.095	2.188	2.273	2.368	2.466	2.576	2.676	2.787	2.903	3.032	3.149	3.281	3.417	3.569	3.707
Direct-consumption	795	789	784	776	808	842	879	913	951	991	1.035	1.075	1.120	1.167	1.218	1.266	1.318	1.373	1.434	1.490
Debt Service	1.635	1.635	1.635	1.635	1.635	1.635	1.635	-	-	-	-	-	-	-	-	-	-	-	-	-
Opex	220	232	246	260	274	290	307	324	343	362	383	405	428	452	478	505	534	564	596	630

Operation Year

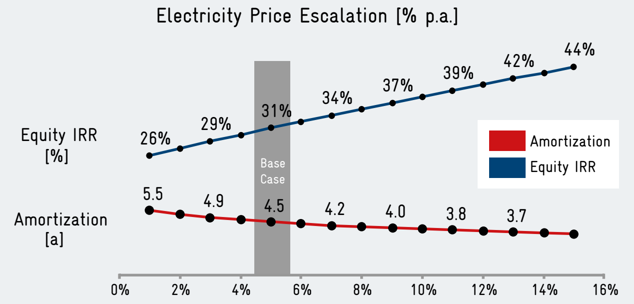
Figure 15; Mid-sized residential PV system investment & cashflows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(3.412)																				
Cashflow for Equity	-	650	702	763	813	911	1.013	1.127	2.863	2.977	3.095	3.228	3.346	3.479	3.618	3.773	3.910	4.065	4.226	4.407	4.567
Cumulative Cashflow	(3.412)	(2.762)	(2.060)	(1.297)	(484)	427	1.440	2.566	5.429	8.405	11.501	14.729	18.075	21.554	25.172	28.945	32.855	36.920	41.146	45.552	50.119

Operation Year

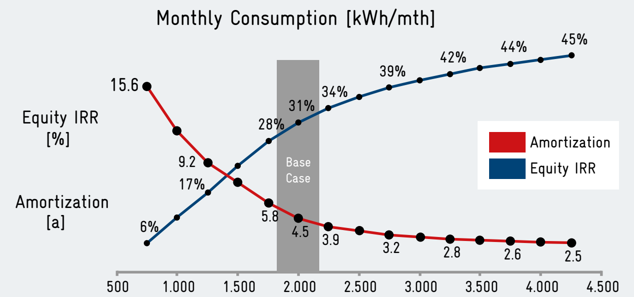
Figure 16: Mid-sized residential system electricity price sensitivity analysis



Explanation:
A strong increase in electricity prices will lead to a moderate improvement in the internal rate of return of equity employed.

Evaluation:
A strong increase for large residential electricity consumers is foreseen, but the investment is already attractive.

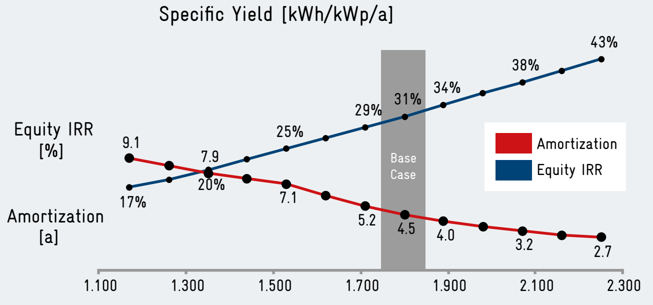
Figure 17: Mid-sized residential PV system consumption sensitivity analysis



Explanation:
The more energy is consumed, the more attractive the investment in a PV system becomes to offset the energy bill.

Evaluation:
A strong increase in consumption for small electricity consumers makes it more attractive to invest in PV systems. Nevertheless, the investment is already attractive.

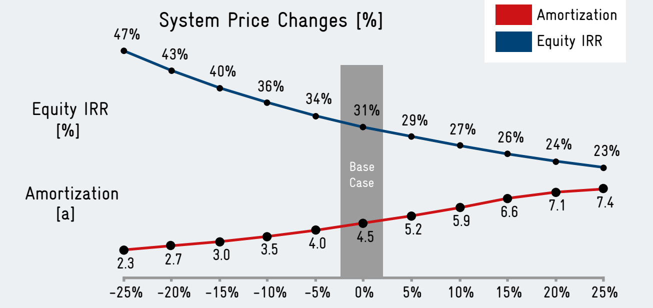
Figure 18: Mid-sized residential PV system yield sensitivity analysis



Explanation:
A strong increase in specific yield per kWp will lead to a considerable improvement in the internal rate of return of equity employed.

Evaluation:
A strong increase in yield will either require more high-performance PV technologies and/or different sites with extreme sunshine, most of which are not populated.

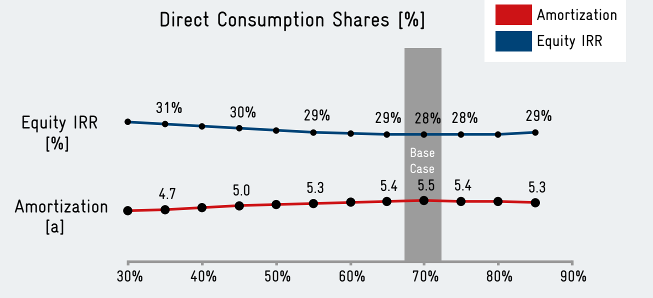
Figure 19: Mid-sized residential PV system equipment price sensitivity analysis



Explanation:
A strong decrease in specific system price per kWp will lead to a considerable improvement in the internal rate of return of equity employed.

Evaluation:
A strong decrease in the prices is currently not very probable, since PV prices in Jordan are already relatively competitive at international level. Nevertheless, once EPC companies are established and customers know the product, economies of scale might lead to price reductions.

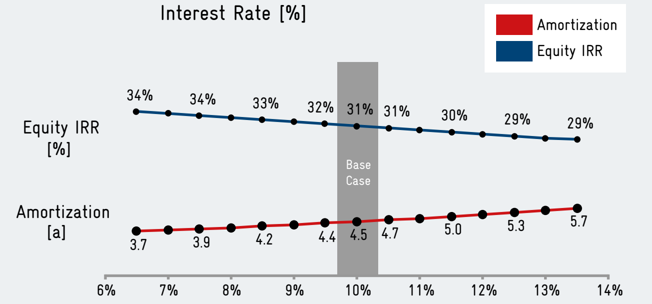
Figure 20: Mid-sized residential PV system direct consumption share sensitivity analysis



Explanation:
A strong increase in the direct consumption share has hardly any effect on the internal rate of return of equity employed, since the reduction of the electricity price by direct consumption is only marginal.

Evaluation:
A strong increase in the direct consumption share is hardly possible for residential consumers.

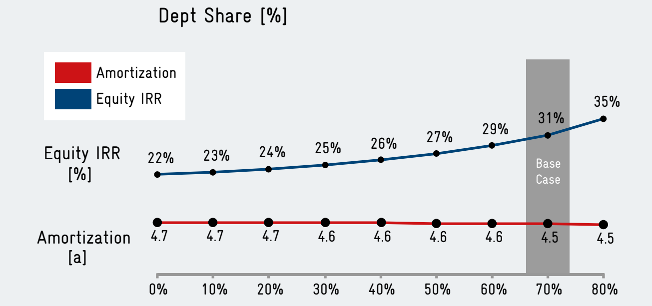
Figure 21: Mid-sized residential PV system interest rate sensitivity analysis



Explanation:
A strong increase in the interest rate of the PV system share has moderate negative effects on the internal rate of return of equity employed.

Evaluation:
Even if the interest rate would be considerably higher, the investment would still be economically attractive.

Figure 22: Mid-sized residential PV system debt share sensitivity analysis



Explanation:
A change in the debt share of the PV system has considerable effects on the internal rate of return of the equity employed.

Evaluation:
The best possible option would be to finance the entire PV system through a bank loan, if possible.

Table 14: Assumptions for a mid-sized ordinary consumer

PV System		
System size	kWp	15
Specific investment cost	JD/kWh	1,250
Absolute investment cost	JD	18,750
Specific yield	kWh/kWp/a	1,800
Direct consumption rate	%	70%
Net-metering rate	%	30%
Degradation	%	0.8%
Operation & maintenance	JD/kWp/a	23
Price Parameter		
Monthly consumption	kWh	4,000
Average grid electricity price	JD/kWh	0.2252
Net-metering electricity price	JD/kWh	0.2060
Electricity price escalation	% p.a.	5%
Inflation	% p.a.	5.7%
Investment		
Project duration	Years	20
Equity	%	30%
Debt tenor	Years	7
Interest rate	%	10%
Discount rate	%	10%
Net present value	JD	42,161
Equity IRR	%	54.63%
Amortization	Years	1.97

Example 3: Mid-sized/Ordinary Consumer (Public) PV System of 15 kWp

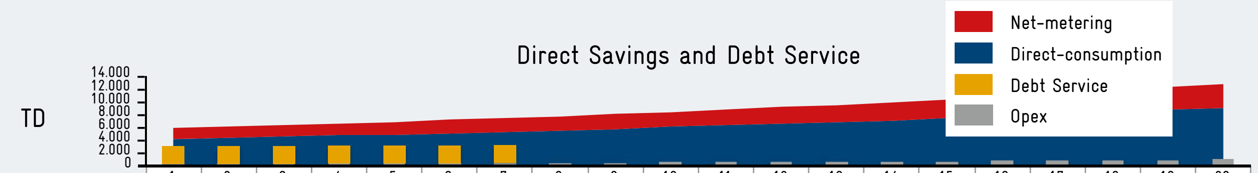
Particularities:
- High direct consumption rate of 70%.
- Equity share of the investment is 30%.w
- Average electricity prices are very high since the consumer has a high percentage of unsubsidized electricity consumption.
- Medium, already attractive system price.
- Continuous price increase of 5% per year from the first year on for the tariff categories substituted with PV.

Market segment:
All public buildings such as hospitals, schools, universities, mosques, government and administrative buildings, residential households with a high electricity consumption with only partially subsidized tariffs

Attractiveness of PV for investors is very high, for the following reasons:
- The investment has a very short payback time.
- The user group might have enough securities to receive a bank loan.
- Large number of buildings available in that segment.

Regulatory ways to increase attractiveness:
- Provide easy access to credits.
- Remove subsidies from further tariff categories to make it attractive to offset 100 % of the electricity consumed.

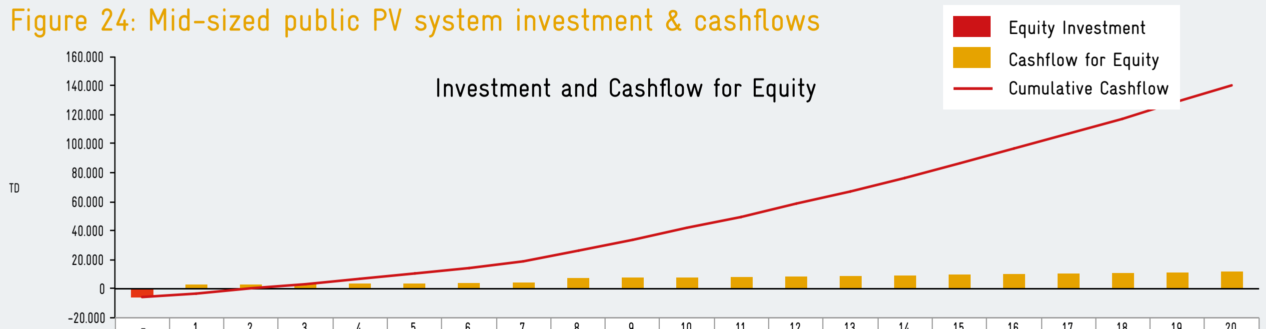
Figure 23: Mid-sized public PV system savings on energy



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Net-metering	1.655	1.724	1.801	1.871	1.948	2.029	2.120	2.202	2.293	2.389	2.495	2.592	2.700	2.812	2.937	3.051	3.178	3.310	3.457	3.591
Direct-consumption	4.223	4.398	4.594	4.772	4.970	5.177	5.407	5.617	5.850	6.094	6.365	6.611	6.886	7.173	7.492	7.782	8.106	8.443	8.818	9.160
Debt Service	2.736	2.736	2.736	2.736	2.736	2.736	2.736	-	-	-	-	-	-	-	-	-	-	-	-	-
Opex	357	377	399	421	445	471	498	526	556	588	621	656	694	733	775	819	866	915	968	1.023

Operation Year

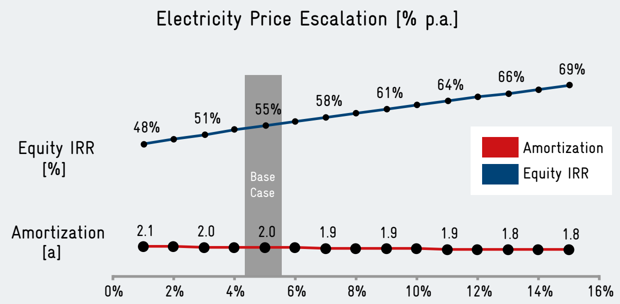
Figure 24: Mid-sized public PV system investment & cashflows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(5.712)																				
Cashflow for Equity	-	2.785	3.009	3.260	3.485	3.737	4.000	4.293	7.293	7.588	7.895	8.239	8.547	8.892	9.251	9.653	10.013	10.417	10.837	11.308	11.728
Cumulative Cashflow	(5.712)	(2.927)	82	3.342	6.827	10.564	14.563	18.856	26.149	33.737	41.632	49.871	58.418	67.310	76.561	86.215	96.228	106.645	117.483	128.790	140.518

Operation Year

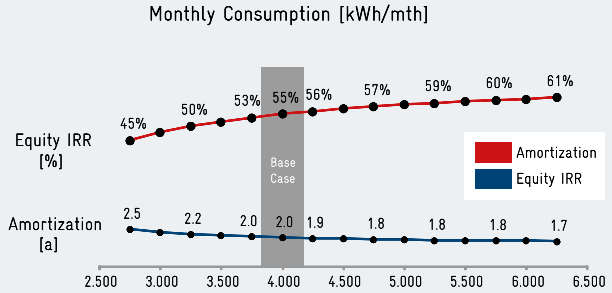
Figure 25: Mid-sized public PV system electricity price sensitivity analysis



Explanation:
A strong increase in electricity prices will lead to a moderate improvement in the internal rate of return of equity employed.

Evaluation:
A strong increase for public electricity consumers is foreseen, but the investment is already very attractive.

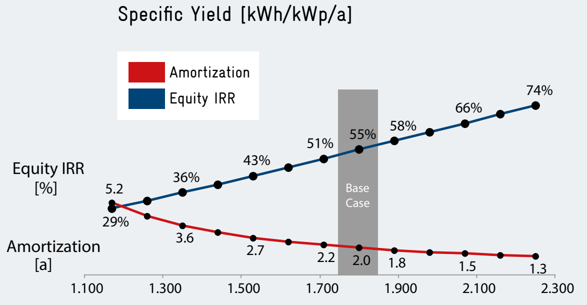
Figure 26: Mid-sized PV system consumption sensitivity analysis



Explanation:
A strong increase in electricity consumption will lead to a moderate improvement in the internal rate of return of equity employed.

Evaluation:
A strong increase in consumption for small electricity consumers makes it a bit more attractive to invest in PV systems. Nevertheless, the investment is already very attractive.

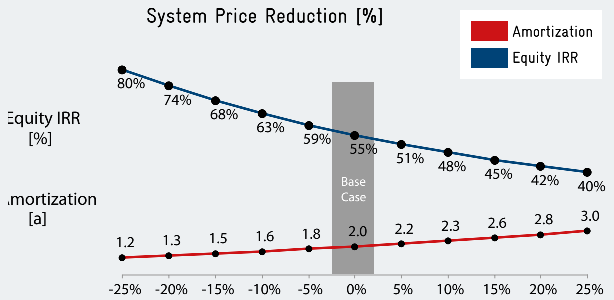
Figure 27: Mid-sized public PV system energy yield sensitivity analysis



Explanation:
A strong increase in specific yield per kWp will lead to a considerable improvement in the internal rate of return of the equity employed.

Evaluation:
A strong increase in yield will either require more high-performance PV technologies and / or different sites with extreme sunshine, most of which are not populated.

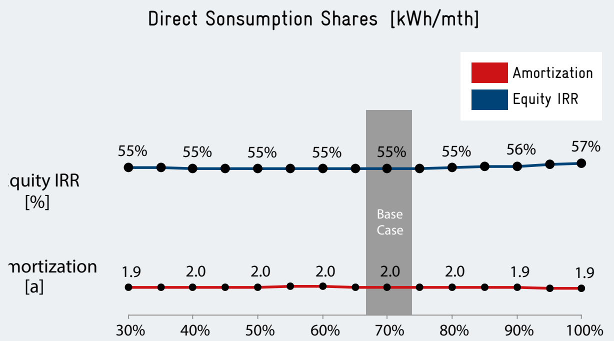
Figure 28: Mid-sized public PV system equipment price sensitivity analysis



Explanation:
A strong decrease in specific system price per kWp will lead to a considerable improvement in the internal rate of return of equity employed.

Evaluation:
A strong decrease in the prices is currently not very probable, since PV prices in Jordan are already relatively competitive at international level. Once EPC companies are established and customers know the product, economies of scale might lead to price reductions.

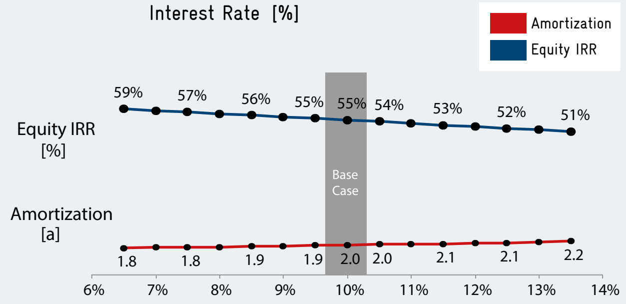
Figure 29: Mid-sized public PV system direct consumption share sensitivity analysis



Explanation:
A strong increase in the direct consumption share has hardly any effect on the internal rate of return of equity employed, since the reduction of the electricity price by direct consumption is only marginal.

Evaluation:
Changes in the amount of the direct consumption share are possible for public consumers, though there might already be considerable overlap.

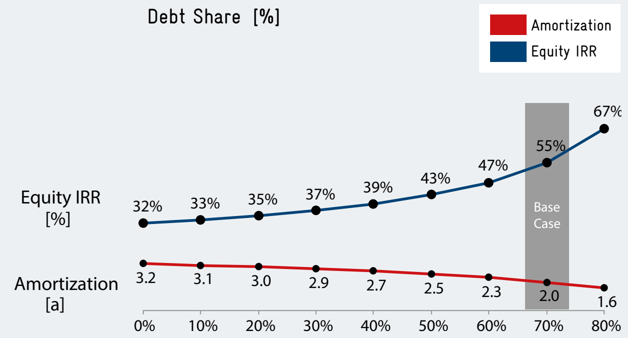
Figure 30: Mid-sized public PV system interest rate sensitivity analysis



Explanation:
A strong increase in the interest rate of the PV system share has moderately negative effects on the internal rate of return of equity employed.

Evaluation:
Even if the interest rate would be considerably higher, the economic attractiveness of the investment would still be very high.

Figure 31: Mid-sized public PV system debt share sensitivity analysis



Explanation:
A change in the debt share of the PV system has considerable effects on the internal rate of return of equity employed.

Evaluation:
The best possible option would be to finance the entire PV system through a bank loan, if possible.

Table 15: Assumptions for a mid-sized commercial consumer

PV System		
System size	kWp	60
Specific investment cost	JD/kWh	1,150
Absolute investment cost	JD	69,000
Specific yield	kWh/kWp/a	1,800
Direct consumption rate	%	70%
Net-metering rate	%	30%
Operation & maintenance	JD/kWp/a	20
Price Parameter		
Monthly consumption	kWh	15,000
Average grid electricity price	JD/kWh	0.1616
Net-metering electricity price	JD/kWh	0.1576
Electricity price escalation	% p.a.	5%
Inflation	% p.a.	5.70%
Investment		
Project duration	Years	20
Equity	%	30%
Debt tenor	Years	7
Interest rate	%	10.00%
Discount rate	%	10%
Net present value	JD	106,310
Equity IRR	%	38.91%
Amortization	Years	3.19

Example 4: Mid-sized Commercial Consumer PV System of 60 kWp

Particularities:

- Equity share of the investment is 30%.
- Average electricity prices are medium since the consumer has a high percentage of unsubsidized electricity consumption.
- Medium to low system price.
- Continuous price increase for electricity of 5% / year from the first year on for the categories substituted with PV Direct-consumption rate of 70%.

Market segment:
All kinds of commercial activities such as service industries, supermarkets, malls, shops etc., residential households with a lot of electricity consumption with only partially subsidized tariffs, Similar consumer tariff category like hotels.

Attractiveness of PV for investors is high, for the following reasons:

- The investment has a short payback time.
- The user group often has enough securities to receive a bank loan.

Regulatory ways to increase attractiveness:

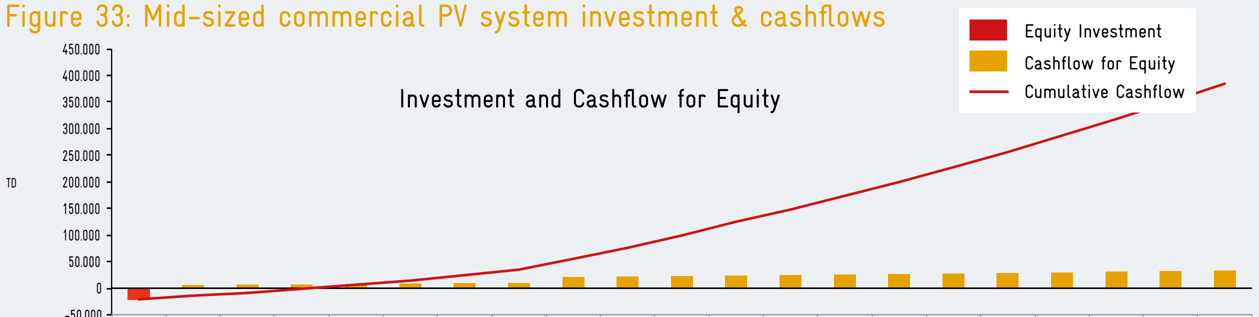
- Provide easy access to credits.
- Remove subsidies from further tariff categories.

Figure 32: Mid-sized commercial PV system savings on energy

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Net-metering	5.064	5.275	5.509	5.723	5.961	6.209	6.485	6.736	7.017	7.308	7.633	7.929	8.259	8.603	8.985	9.333	9.721	10.126	10.576	10.986
Direct-consumption	12.119	12.623	13.185	13.695	14.265	14.859	15.519	16.121	16.791	17.490	18.267	18.975	19.765	20.587	21.502	22.335	23.264	24.232	25.309	26.290
Debt Service	10.070	10.070	10.070	10.070	10.070	10.070	10.070	-	-	-	-	-	-	-	-	-	-	-	-	-
Opex	1.268	1.341	1.417	1.498	1.583	1.674	1.769	1.870	1.976	2.089	2.208	2.334	2.467	2.608	2.756	2.913	3.079	3.255	3.440	3.636

Operation Year

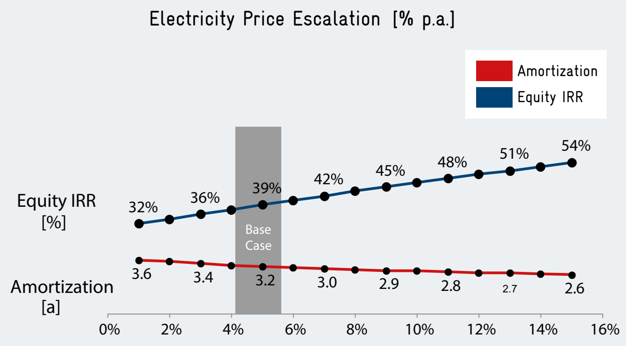
Figure 33: Mid-sized commercial PV system investment & cashflows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(21.019)																				
Cashflow for Equity	-	5.845	6.488	7.207	7.851	8.573	9.324	10.165	20.987	21.831	22.709	23.693	24.570	25.557	26.582	27.731	28.755	29.906	31.103	32.445	33.640
Cumulative Cashflow	(21.019)	(15.173)	(8.686)	(1.479)	6.372	14.945	24.269	34.435	55.422	77.253	99.962	123.655	148.225	173.782	200.364	228.094	256.849	286.756	317.859	350.304	383.943

Operation Year

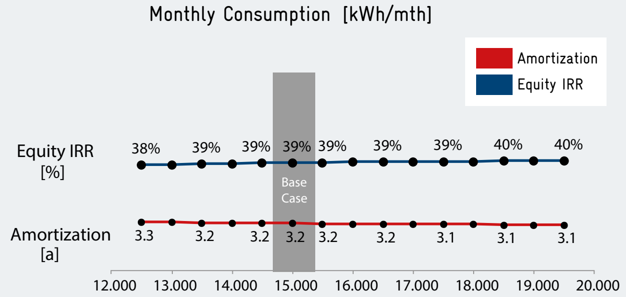
Figure 34: Mid-sized commercial PV system electricity price sensitivity analysis



Explanation:
A strong increase in electricity prices will lead to a moderate improvement in the internal rate of return of equity employed.

Evaluation:
A strong increase for public electricity consumers is foreseen, but the investment is already very attractive.

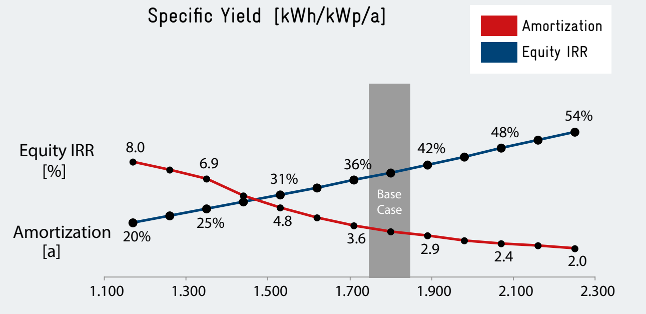
Figure 35: Mid-sized commercial PV system consumption sensitivity analysis



Explanation:
A strong increase in electricity consumption will lead to a moderate improvement in the internal rate of return of equity employed.

Evaluation:
A strong increase in consumption for small electricity consumers makes it a bit more attractive to invest in PV systems. Nevertheless, the investment is already very attractive.

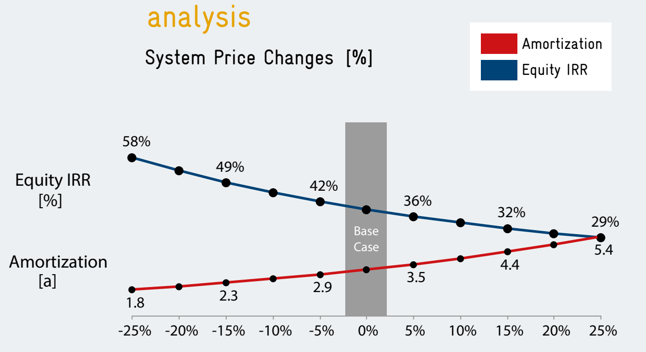
Figure 36: Mid-sized commercial PV system yield sensitivity analysis



Explanation:
A strong increase in specific yield per kWp will lead to a considerable improvement in the internal rate of return of equity employed.

Evaluation:
A strong increase in yield will either require more high-performance PV technologies and/or different sites with extreme sunshine, most of which are not populated.

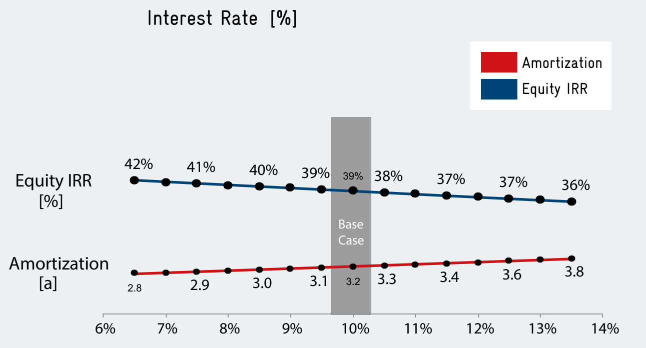
Figure 37: Mid-sized commercial PV system equipment price sensitivity analysis



Explanation:
A strong decrease in specific system price per kWp will lead to a considerable improvement in the internal rate of return of equity employed.

Evaluation:
A strong decrease in the prices is currently not very probable, since PV prices in Jordan are already relatively competitive at international level. Nevertheless, once EPC companies are established and customers know the product, economies of scale might lead to price reductions.

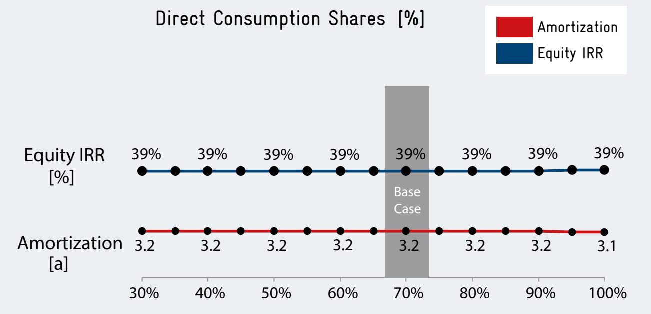
Figure 38: Mid-sized commercial PV system interest rate sensitivity analysis



Explanation:
A strong increase in the interest rate of the bank credit for the PV system has moderately negative effects on the internal rate of return of equity employed.

Evaluation:
Even if the interest rate would increase considerably, the investment would still be economically attractive.

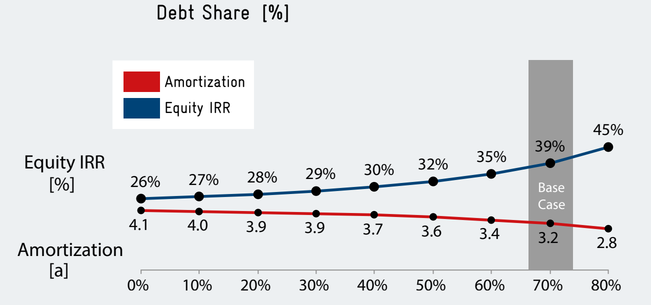
Figure 39: Mid-sized commercial PV system direct consumption share sensitivity analysis



Explanation:
A strong increase in the direct consumption share has hardly any effect on the internal rate of return of equity employed, since the reduction of the electricity price by direct consumption is only marginal.

Evaluation:
A strong increase in the direct consumption share is hardly possible for commercial consumers.

Figure 40: Mid-sized commercial PV system debt share sensitivity analysis



Explanation:
A change in the debt share of the PV system has considerable effects on the internal rate of return of equity employed.

Evaluation:
The best possible option would be to finance the entire PV system through a bank loan, if possible.

Table 16: Assumptions for a mid-sized industrial consumer

PV System		
System size	kWp	150
Specific investment cost*	JD/kWh	1,100
Absolute investment cost*	JD	165,000
Specific yield	kWh/kWp/a	1,800
Direct consumption rate	%	70%
Net-metering rate	%	30%
Degradation	%	0.8%
Operation & maintenance	JD/kWp/a	18
Price Parameter		
Monthly consumption	kWh	25,000
Average grid electricity price	JD/kWh	0.0714
Net-metering electricity price	JD/kWh	0.0664
Electricity price escalation	% p.a.	5%
Inflation	% p.a.	5.7%
Investment		
Project duration	Years	20
Equity	%	30%
Debt tenor	Years	8
Interest rate	%	6.13%
Discount rate	%	10%
Net present value	JD	27,150
Equity IRR	%	13.48%
Amortization	Years	10.51

* *after subsidies*

Example 5: Mid-sized Industrial-Consumer PV System of 150 kWp

Particularities:

- Equity share of the investment is 30%.
- Average electricity prices are medium since the consumer has a high percentage of unsubsidized electricity consumption.
- Low system price and low interest rate.
- Continuous price increase for electricity of 5% / year from the first year on for the categories substituted with PV.
- Direct consumption rate is 70%.
- Tenor of 8 years.

Market segment:
All kinds of industries with highly subsidized tariffs, including food processing units, chemical industry, manufacturing plants etc.

Attractiveness of PV for investors is low, for the following reason:

- The investment has a long payback time.

Regulatory ways to increase attractiveness:

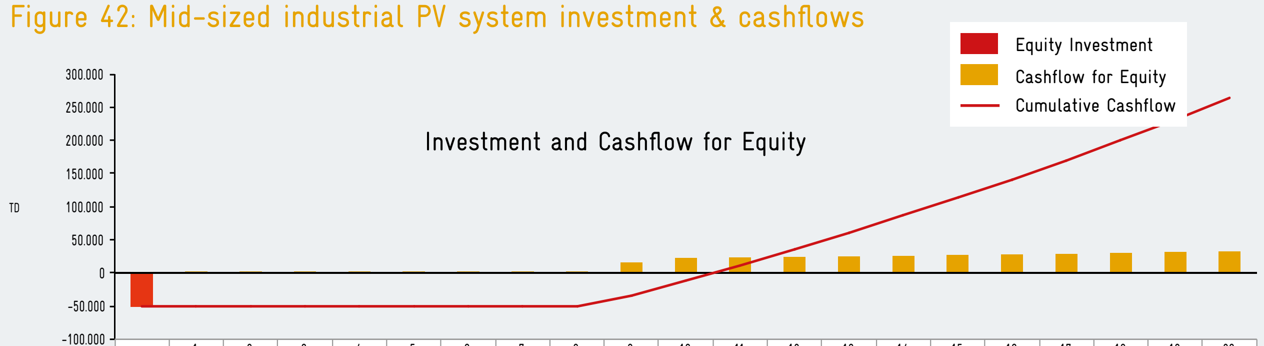
- Shift subsidies and cross-subsidies from electricity tariffs to PV promotion.
- Support investments in PV with low interest loans or small grants financed from the difference in savings on subsidized electricity.
- Alternatively, allow production over 100% and provide an attractive PPA price, i.e. hybrid net-metering and FIT to create further economies of scale.

Figure 41: Mid-sized industrial PV system savings on energy

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Net-metering	5.338	5.560	5.807	6.032	6.283	6.544	6.835	7.100	7.395	7.703	8.045	8.357	8.705	9.067	9.470	9.837	10.246	10.672	11.147	11.579
Direct-consumption	13.387	13.944	14.563	15.128	15.757	16.413	17.142	17.806	18.547	19.319	20.178	20.960	21.831	22.740	23.751	24.671	25.697	26.766	27.956	29.040
Debt Service	18.903	18.903	18.903	18.903	18.903	18.903	18.903	18.903	-	-	-	-	-	-	-	-	-	-	-	-
Opex	2.854	3.017	3.189	3.370	3.562	3.765	3.980	4.207	4.447	4.700	4.968	5.251	5.551	5.867	6.201	6.555	6.928	7.323	7.741	8.182

Operation Year

Figure 42: Mid-sized industrial PV system investment & cashflows

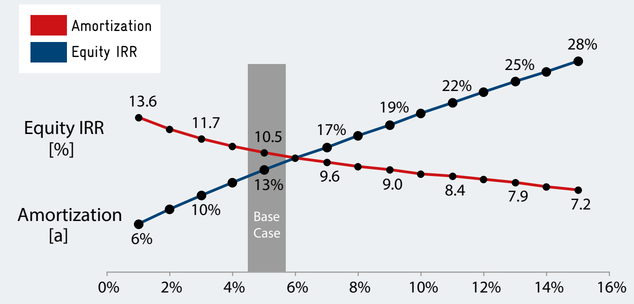


	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(50.243)																				
Cashflow for Equity	-	-	-	-	-	-	-	-	-	15.966	22.322	23.255	24.065	24.986	25.940	27.019	27.953	29.015	30.115	31.362	32.436
Cumulative Cashflow	(50.243)	(50.243)	(50.243)	(50.243)	(50.243)	(50.243)	(50.243)	(50.243)	(50.243)	(34.277)	(11.955)	11.300	35.365	60.351	86.290	113.309	141.262	170.277	200.392	231.755	264.191

Operation Year

Figure 43: Mid-sized industrial PV system electricity price sensitivity analysis

Electricity Price Escalation [% p.a.]

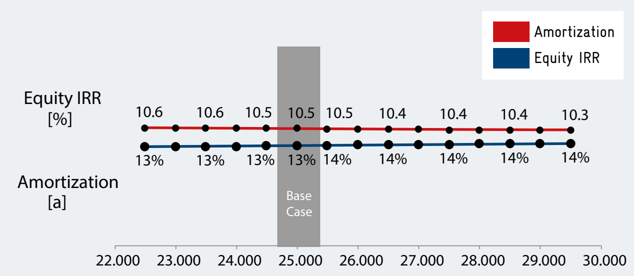


Explanation:
A strong increase in electricity prices will lead to a considerable improvement in the internal rate of return of equity employed.

Evaluation:
A moderate increase for industrial users is foreseen, but not sufficient to actually be attractive for the investor.

Figure 44: Mid-sized industrial PV system consumption sensitivity analysis

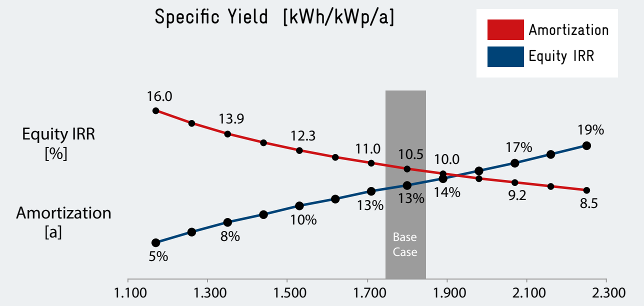
Monthly Consumption [kWh/mth]



Explanation:
A strong increase in electricity consumption will hardly lead to improvements of the internal rate of return of equity employed.

Evaluation:
A strong increase in consumption will not increase attractiveness of the investment due to low subsidized energy tariffs.

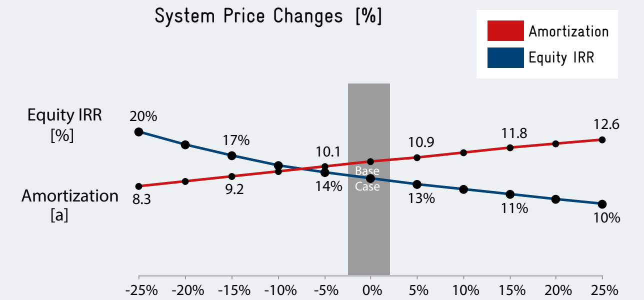
Figure 45: Mid-sized industrial PV system energy yield sensitivity analysis



Explanation:
A strong increase in specific yield per kWp will lead to a considerable improvement in the internal rate of return of equity employed.

Evaluation:
A strong increase in yield will either require more high-performance PV technologies and/or different sites with extreme sunshine, most of which are situated in unpopulated areas.

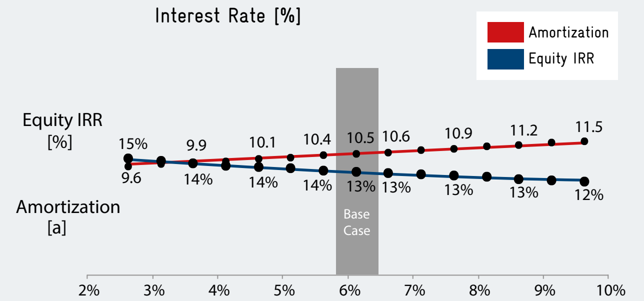
Figure 46: Mid-sized industrial PV system equipment price sensitivity analysis



Explanation:
A strong decrease in specific system price per kWp will lead to a considerable improvement in the internal rate of return of equity employed.

Evaluation:
A strong decrease in the prices is currently not very probable, since PV prices in Jordan are already relatively competitive at international level.

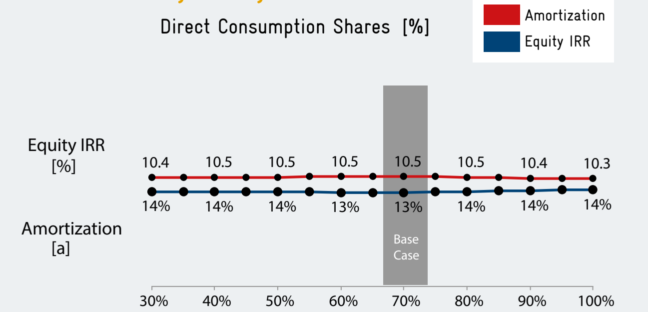
Figure 47: Mid-sized industrial PV system interest rate sensitivity analysis



Explanation:
A strong increase in the interest rate of the bank credit for the PV system has moderately negative effects on the internal rate of return of equity employed.

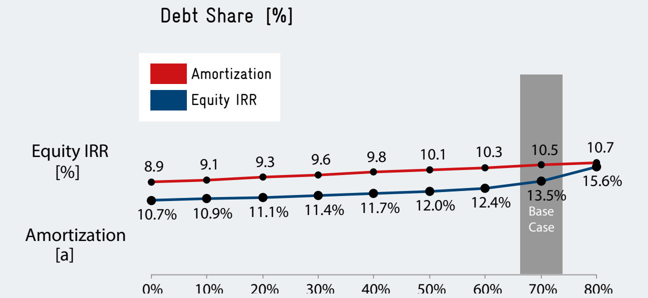
Evaluation:
Even if the interest rate would be considerably lower, it would not lead to economic attractiveness of the investment.

Figure 48: Mid-sized industrial PV system direct consumption share sensitivity analysis



Explanation:
A strong increase in the direct consumption share has no effect on the internal rate of return of equity employed, since the reduction of the electricity price by direct consumption is only marginal.

Figure 49: Mid-sized industrial PV system debt share sensitivity analysis



Explanation:
An increase in the debt share of the PV system has a slightly positive effect on the internal rate of return of equity employed.

Evaluation:
The best possible option would be to finance the entire PV system through a bank loan, if possible.

Table 17: Assumptions for a large industrial consumer including wheeling

PV System		
System size	kWp	2,000
Specific investment cost	JD/kWh	1,000
Absolute investment cost	JD	2,000,000
Specific yield	kWh/kW-p/a	1.800
Wheeling share	%	100%
Degradation	%	0.8%
Operation & maintenance	JD/kWp/a	16
Price Parameter		
Monthly consumption	kWh	25,000
Wheeling electricity price	JD/kWh	0.1240
Electricity price escalation	% p.a.	5%
Wheeling fees	JD/kWh	0.007
Wheeling losses	JD/kWh	6%
Inflation	% p.a.	5.70%
Investment		
Project duration	Years	20
Equity	%	30%
Debt tenor	Years	5
Interest rate	%	6.13%
Discount rate	%	10%
Net present value	JD	2,053,157
Equity IRR	%	27.38%
Amortization	Years	5.83

Example 6: Large-sized Industrial PV System of 2 MWp for Tariff Category for Other Industries

Particularities:

- Equity share of the investment is 30%.
- Average electricity prices are medium-ranged, but still subsidized, other large industries exist (mining, quarrying industries with much higher electricity tariffs).
- Low system price.
- No direct consumption due to remote location of plants.
- Wheeling charges + energy transmission losses.
- Continuous price increase for electricity of 5% / year from the first year.

Market segment:
All kinds of large industries, such as food processing units, chemical industry, manufacturing plants etc. with subsidized tariffs

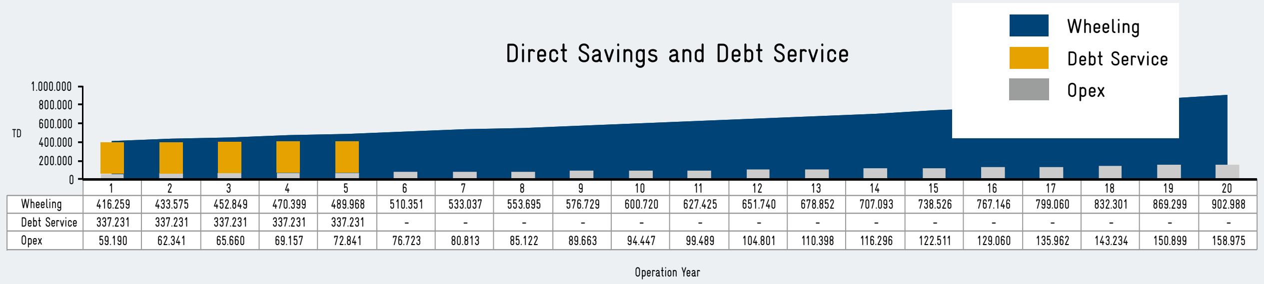
Attractiveness of PV for investors is medium, for the following reason:

- The investment has a medium payback time.

Regulatory ways to increase attractiveness:

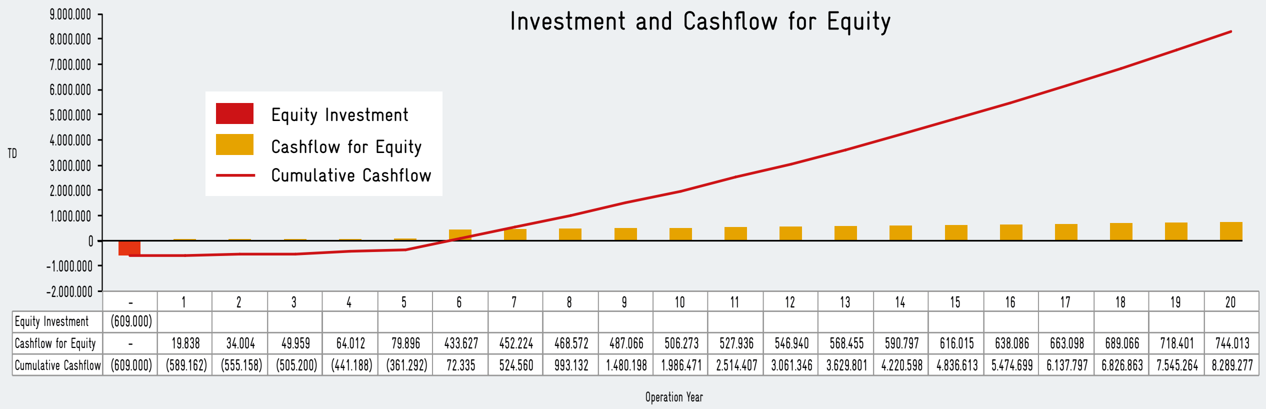
- Shift subsidies and cross-subsidies from electricity tariffs to PV promotion.
- Support investments in PV with low interest and longer term loans financed from the difference in savings on subsidized electricity.
- Increase debt ratio to 100%.
- Alternatively allow production over 100% and provide an attractive PPA price, i.e. hybrid net-metering and feed-in tariff to create further economies of scale.

Figure 50: Large-sized industrial Small residential PV system savings on energy with wheeling option



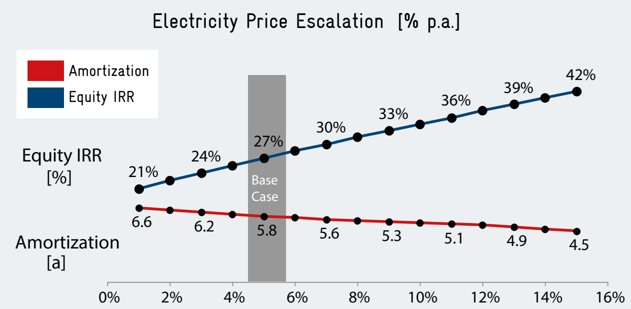
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Wheeling	416.259	433.575	452.849	470.399	489.968	510.351	533.037	553.695	576.729	600.720	627.425	651.740	678.852	707.093	738.526	767.146	799.060	832.301	869.299	902.988
Debt Service	337.231	337.231	337.231	337.231	337.231	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Opex	59.190	62.341	65.660	69.157	72.841	76.723	80.813	85.122	89.663	94.447	99.489	104.801	110.398	116.296	122.511	129.060	135.962	143.234	150.899	158.975

Figure 51: Large industrial PV system investment & cashflows with wheeling option



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(609.000)																				
Cashflow for Equity	-	19.838	34.004	49.959	64.012	79.896	433.627	452.224	468.572	487.066	506.273	527.936	546.940	568.455	590.797	616.015	638.086	663.098	689.066	718.401	744.013
Cumulative Cashflow	(609.000)	(589.162)	(555.158)	(505.200)	(441.188)	(361.292)	72.335	524.560	993.132	1.480.198	1.986.471	2.514.407	3.061.346	3.629.801	4.220.598	4.836.613	5.474.699	6.137.797	6.826.863	7.545.264	8.289.277

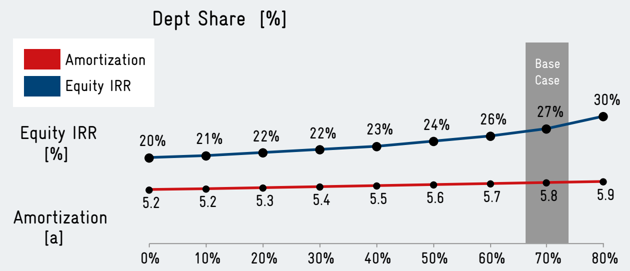
Figure 52: Large industrial PV system electricity price sensitivity analysis with wheeling option



Explanation:
A strong increase in electricity prices will lead to a considerable improvement in the internal rate of return of equity employed.

Evaluation:
A strong increase in tariffs for electricity consumers from "other" industries will considerably increase the attractiveness of the investment.

Figure 53: Large industrial PV system with wheeling option debt share sensitivity analysis

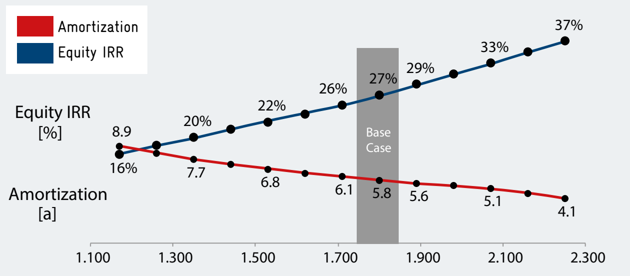


Explanation:
A change in the debt share of the PV system has moderate effects on the internal rate of return of equity employed.

Evaluation:
The best possible option would be to finance the entire PV system through a bank loan, if possible.

Figure 54: Large industrial PV system energy yield sensitivity analysis for wheeling option

Specific Yield [kWh/kWp/a]

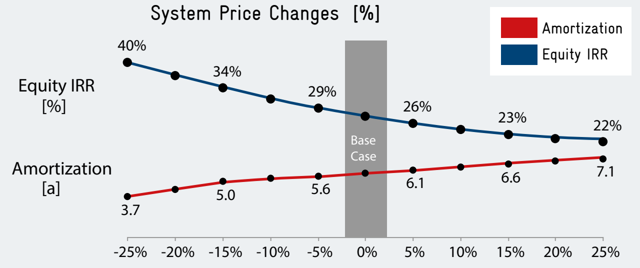


Explanation:
A strong increase in specific yield per kWp will lead to a considerable improvement of the Internal Return Rate of the equity employed.

Evaluation:
A strong increase in yield might be possible because wheeling allows to install systems at locations with high irradiation in unpopulated areas.

Figure 55: Large industrial PV system equipment price sensitivity analysis for wheeling option

System Price Changes [%]

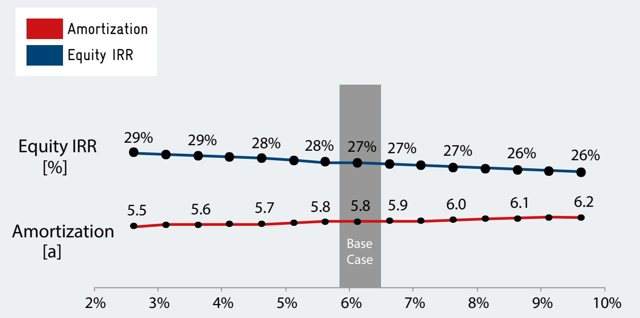


Explanation:
A strong decrease in specific system price per kWp will lead to a considerable improvement in the internal rate of return of equity employed.

Evaluation:
A strong decrease in the prices is currently not very probable, since PV prices in Jordan are already relatively competitive at international level. Once EPC companies are established and customers know the product, economies of scale might lead to price reductions

Figure 56: Large industrial PV system with wheeling option interest rate sensitivity analysis

Interest Rate [%]



Explanation:
A strong increase in the interest rate for the loan of the PV system has moderately negative effects on the internal rate of return of equity employed.

Evaluation:
Even if the interest rate would be considerably higher, the economic attractiveness of the investment would still be acceptable.

f. Barriers, Recommendations and Next Steps

Short-term Outlook

Net-metering and wheeling present the same business case, although wheeling is slightly more complex and yet not tested in practical terms.

The following section looks at various barriers that have been identified. The barriers vary according to focus group but could be addressed by policy-makers and interest groups.

Table 18: Regulative barrier grid restrictions

Regulative barrier: Overall grid capacity restrictions	
Barrier	According to the directive concerning net-metering,* the limit for net-metering is fixed at 1% (low voltage) and 1.5% (medium voltage) for the distribution grid. It remains unclear, however, whether this is based on capacity or purely on definition. This should be determined, given that the market will quickly reach the limit, at least within the distribution grid. In addition, companies have been uncertain as to what the grid capacity for net-metering is in any given DSO grid.
Recommendation	A public system directory should be created to monitor available grid capacities within the distribution and transmission grid. Technical studies should objectively define the capacities of the grid at the different voltage levels, as well as describe ways to increase capacities for renewable energy sources. In order to guarantee the smooth development of the market, the capacities should be adapted in timely manner in order to avoid market disruptions.
Next steps	Creation of a directory to monitor installation numbers Execution of relevant studies in the distribution and transmission grids

* *The Directive Governing the Sale of Electrical Energy Generated from Renewable Energy Systems Issued by the Council of Commissioners of Electricity Regulatory Commission Pursuant to Article (10/B) of the Renewable Energy and Energy Efficiency Law No. (13) for the year 2012*

Table 19: Regulative barrier definitions

Regulative barrier: Grid capacity definition per single system	
Barrier	The maximum allowance is 5 MWp at one geographical site. For small systems, not more than 15% of the feeder peak load and 20 kVA may be connected to the grid. This regulation excludes big consumers from dimensioning their system size according to their maximum demand. For small systems, the regulation might easily block access to the grid, since consumers can operate on a "first come, first served basis". Single users might occupy all available capacity at a given site (e.g. multi-family dwellings).
Recommendation	Allowance should be given to construct bigger systems according to the results of grid impact studies; the 5 MWp threshold should be considered as indicative but not binding.
Next steps	Review technical foundation for the limitations.

Table 20: Policy barrier energy strategy

Policy barrier: Outdated energy strategy	
Barrier	The National Energy Strategy for 2020 of the year 2004 was updated in 2007. Considering the current price of electricity, the shortages of cheap gas or fuel, the low costs of renewable energies, the time needed to develop shale oil, nuclear as well as infrastructural projects, it seems to be outdated and offers no accurate guideline for investors for the mid-range future.
Recommendation	The National Energy Strategy for 2020 should be reviewed and should focus on stronger integration of renewable energy into the energy mix until 2020 and beyond.
Next steps	Define the economic potential of renewable energies using the current policy instruments.

Table 21: Technical barrier grid expansion

Technical barrier: Grid expansion	
Barrier	Especially large wheeling systems might become dependent on the availability of sufficient distribution and transmission lines. Though a so-called Green Corridor is supposed to be constructed to enhance the transmission grid, it remains unclear whether capacities will be sufficient to host PPA-electricity and electricity from wheeling systems at the same time.
Recommendation	An evaluation of the grid capacity at national and DSO level should be seen as a necessity for hosting large quantities of renewable electricity, and should be included in a long-term strategy for the Jordan electricity market.
Next steps	Bring together stakeholders from utilities and technology providers of different electricity technologies to evaluate the costs and grid expansion necessities of different electricity generation and transmission technologies.

Table 22: Regulative barrier building code

Regulative barrier: Building code (in)appropriate for PV	
Barrier	For the mounting of panels, solar PV requires adequate space on rooftops or ground-based areas, as well as structural integrity of buildings. Many sites lack space and structural integrity to support panel installation.
Recommendation	The building code should provide clear guidelines for structural load.
Next steps	Review the building code to check whether regulations are appropriate for PV installations.

Table 23: Other barriers communication

Other barriers: Communication	
Barrier	Net-metering and especially wheeling regulations are not yet fully understood or require clarifications: • This leads to poor quality of applications and complaints by some interviewees. • Wheeling is yet undefined in many aspects, especially with regard to the question if 1-to-1 or 1-to-n consumers might be served; this could provide excellent opportunities for investors with many branches (e.g. banks & hotels). If confusion over interpretation of the current policies and regulations continues, stakeholders will find it difficult to commit to solar PV investments, while misinformed investments will continue.
Recommendation	Policy-makers and utilities must make an effort to make supporting schemes as clear as possible by distributing information on best practices or examples of different projects.
Next steps	Involve the relevant interest groups to distribute simple information for consumers and technicians. Provide relevant information on a central website.

Table 24: Technical barrier quality

Technical barrier: System and installation quality	
Barrier	PV is not yet well known among investors, installers and financial institutions. Quality of equipment and installation is not guaranteed and the price varies according to quality. Although it remains the risk of the investor, it is in the general interest to use durable, quality PV systems in order to guarantee longevity and consumer confidence in the technology. In addition, the qualification of many of the actors in this new market (installers) was considered to be an area of concern by most interviewees, which could potentially cause harm for the technology's reputation. This risk holds true in particular for SME and small investors with limited technical knowledge and access to information sources.
Recommendation	• Guidelines for banking institutions should be developed according to international / national testing standards. • Installer trainings should be offered by qualified national or international institutions. • Information material should be provided. • Quality certificate might be developed for PV systems and the installation process.
Next steps	The industry sector should develop quality guidelines for PV installations and provide information about quality issues.

Table 25: Financial barrier financing

Financial barrier: Financing of PV projects	
Barrier	So far, potential financiers are not sufficiently aware of PV technology and the profitability of PV installations. In addition, the financial security offered by PV system might not be enough, since PV systems can easily lose value. The benefit of energy savings can in itself hardly be taken under consideration since the offtaker might cease operation, whereby savings will no longer be generated. In addition, it has not been specified whether, in this case, excess generation is remunerated and can serve as security like a feed-in-tariff.
Recommendation	• The banking sector should be informed about PV technology, quality issues and profitability of PV investments. This could be done through workshops, information campaigns or seminars, conferences or cooperation with banking associations / multipliers. Nevertheless, since PV net-metering is most beneficial to the banking sector, which has the highest electricity rates in the country, pilot cases might easily develop in this sector. • Financing criteria, including quality standards for PV projects, should be disseminated among the sector. • A framework for contracts should be developed for DSO and investors to guarantee the offtake electricity for a fixed price in the case that the offtaker no longer consumes electricity.
Next steps	• Seminars on PV and site visits by decision-makers to PV systems could be arranged. • Examples from other countries with more PV experience and their regulations might be translated or transferred.

Table 26: Financial barrier ownership

Financial barrier: Third-party ownership of PV projects	
Barrier	Third-party ownership such as leasing, small-scale PPA, contracting, etc. are not yet legal in Jordan, though they might present an alternative for all those consumers who are not granted a bank loan or who have no interest in operating a PV system, but merely want to reduce their electricity bill. In addition, professional financiers might control quality of systems and installations, since their business model would depend on the output and smooth operation of the systems and therefore help to distribute information and create a competitive market.
Recommendation	Third-party ownership should be considered and regulated, also to prevent an illegal market from evolving.
Next steps	Stakeholders such as policy-makers, associations, solar businesses and potential consumers should come together as advocate for the legalization or partial legalization (only for large consumers) of third-party sales. The key is to convey the benefits of these business models to policy-makers.

Long-term Outlook

Regulatory risks

As depicted below, once all the regulations are clear, net-metering and especially wheeling will become a very attractive investment option for certain investor groups and will offer very quick investment returns. Particularly in the short term, since the business model has to be established in the market, this will hold true only once all barriers and doubts about regulations and technical issues have been eliminated.

Table 27: Regulatory threats for the business model

Potential regulatory risks	Stakeholder(s) involved	Term	Effect on profitability
• Introduction of grid usage fees for excess electricity	DSO, ERC, MEMR	Mid-term	Negative
• Increased connection costs by the utilities, once the system is operational	DSO, ERC	Short-to mid-term	Negative
• Change in electricity tariffs according to the time-of-use periods of electricity (daytime electricity becomes cheaper)	MEMR, ERC	Mid-term	Negative
• Changes in remuneration of gross exported energy below the current reference prices	MEMR, ERC	Mid-term	Negative
• Setting of limitations for the amount of electricity exported into the grid etc.	DSO	Short-term	Negative
• Additional costs and service charges to compensate for reduced energy sales of DSOs?	DSO, ERC	Short-term	Negative
• Introduction of import taxes / custom duties or local content regulation that increase system costs	MEMR, Ministry of Finance	Mid-Term	Negative
• Regulations / requirements to more evenly produce energy throughout the day to better comply with overall demand by using tracking systems or installations with east-west orientation	MEMR	Mid-term	Neutral / slightly negative
• Introduction of subsidies as an incentive to install small-scale systems	MEMR	Mid-term	Positive

NEPCO deficit / electricity market cross-subsidies

The current regulation is very attractive for all those actors who pay high or very high unsubsidized tariffs, while those who pay highly subsidized electricity rates have little financial incentive to use their scarce income for PV investments. For the first group (e.g. banks and telecommunication companies) it is attractive to either offset the entire annual consumption or to lower the electricity demand to subsidized levels (e.g. residential consumers). As mentioned before, generation and distribution costs were at around JD 0.146 / kWh in 2012 for NEPCO.[36] This creates a situation in which all those consumers paying less than this amount per kWh will add to the deficit of NEPCO. If many consumers in the high tariff categories offset their energy demands, they will no longer help to offset the monetary deficit of NEPCO.

At the moment this is not assumed to be an urgent issue, since only a small volume of PV has been installed under the net-metering scheme. At the moment it seems to be more important to kick start the market to make PV technology and its profitability more widely known. Nevertheless, with a necessary review of the regulative barriers concerning grid capacities, this issue should be considered.

Recommendations:
- Adapt the tariff scheme to provide an incentive for those consumers that can benefit from subsidized tariffs to offset the electricity production to 100% with renewable energies.
- Increase the tariffs for small energy consumers, which is a socially sensitive issue, or provide incentives / programs for the installation of solar PV systems to those consumers that cannot invest in PV either due to a lack of funding resources or because energy savings would not make it financially attractive (e.g. all those residential / ordinary consumers below 600 kWh consumption per month). Those subsidies might be counter-financed with savings from the NEPCO deficit, since each kWh that can be provided at a cost below JD 0.146 currently reduces the financial loss of NEPCO.

[36] *This very high cost is caused by the use of imported oil for electricity production in the energy mix and might become less once the gas pipeline with Egypt is working well again, the LNG terminal in Aqaba is constructed and domestic shale oil can be exploited.*

Utility perspective – capacity issues for generation and the grid

Currently, Jordan has midday and an evening peak. While the midday peak can be optimally covered with PV, the evening peak either requires alternative energy sources or storage solutions. Gas- or oil-fired power plants will always be able to serve as a backup solution at the large scale, although they will have to be activated only for peak periods and might not be profitable for the electricity generator. In addition, it is most profitable to install PV systems on a fixed, south-facing structure to create midday peak production.

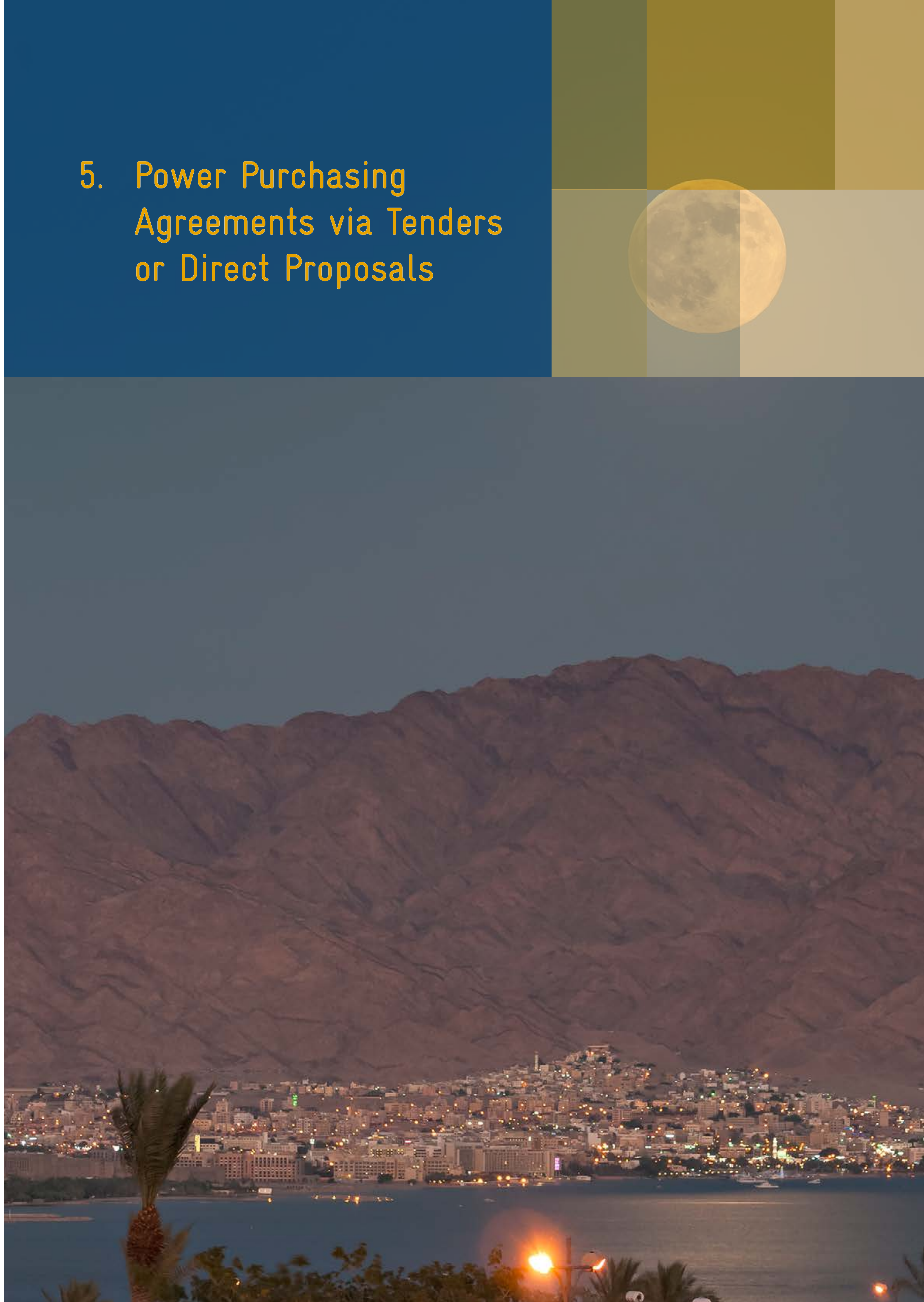
Recommendation:
Once a critical mass of PV has been installed in the distribution grid, regulators might consider the following options:
- Tariff variation for daytime and night-time might also be a solution to influence consumer behavior via incentives (e.g. lower prices) or obligations.
- Consider promoting east-west installations or tracking systems to balance output of PV systems more evenly during the day or according to consumer behavior, in order to avoid electricity surpluses at certain midday hours.
- PV systems used for wheeling should take those regulations in particular into consideration that facilitate their smooth integration into the grid.

Stakeholder / utility issues

Although the overall electricity demand in Jordan is increasing, the three utilities (JEPCO, EDCO, IDECO) will lose market shares if more and more consumers become producers and consumers at the same time (so called "prosumers"). During the interview process, some installers complained about delays caused by the utilities. If the utilities do not have incentives to actively benefit from an increase in decentralized energy production, there might be little economic interest to enhance grid infrastructure to absorb PV electricity.

Recommendation:
With future reforms, utilities should participate through cost-covering fees for the use and enhancement of grid infrastructure for PV fed into the grid. An orientation might be the moderate grid levies contained in wheeling regulation. In addition, further incentives might be given to motivate utilities to better integrate renewable energies into their grids.

5. Power Purchasing Agreements via Tenders or Direct Proposals



Another attractive option to install PV systems in Jordan is to become an **independent power producer (IPP)** through the installation of renewable energy plants. **Power purchase agreements (PPA)** are not new to Jordan however; there have been two IPPs producing and selling electricity with combined cycle plants since 2009.[37] By June 2014, no renewable energy plants had been constructed under the first round of the tender scheme and the following two rounds of direct proposals. In the first round, initiated in 2011, PPAs covering 170 MWp of solar PV were initially signed between 12 IPP companies or consortia and the Ministry for Energy and Mining Resources (MEMR). Until April 2014, these were in the process of financial negotiations between investors and the potential IPPs. Those systems were due to be constructed and connected to National Electric Power Company's (NEPCO) transmission lines within the next 16 months. Most were to be connected with the Maan Development Area substation, which was to be completed in June 2015 at the latest. In the following two rounds of direct proposals, another 400 MWp of solar PV systems had been tendered for direct proposals, including four 50 MW plants and two 100 MW plants.

a. Description of the Business Model

A power purchase agreement (PPA) is a contract between an electricity producer and an electricity consumer or reseller (offtaker).[38] In the case of Jordan there is only one offtaker for the PPA model, namely the state-owned transmission system operator (TSO) NEPCO on behalf of the MEMR.

A PPA fixes a price for the electricity provided by the investor (IPP) to the offtaker (NEPCO) over a fixed period of time; in Jordan, this period is 20 years, as is fixed in a long-term agreement between the MEMR and the IPP. The investor sells all the electricity produced to the TSO, who in the Jordanian case is obliged to buy electricity from the producer due to legal obligations at a fixed price, which has to be negotiated in advance for the period of 20 years.[39]

[37] ***IPP1 (AES Jordan)*** *is a combined cycle with a nominal capacity of 380 MW,* ***IPP2 (Al-Qatraneh Power Generation Company)*** *is a combined cycle with a nominal capacity of 380 MW.*

[38] *Throughout the guideline, we will refer to the electricity producer as the investor and the electricity consumer/reseller as the offtaker.*

[39] *The other alternative, to sell electricity to a third party, is not (yet) legal in Jordan.*

Though it is not regulated in Jordan, in theory, at the end of a PPA, there are three different options:

- Reconditioning: to sign a new PPA and update the entire power plant with the latest technology.
- Contract extension: to extend the contract duration for a fixed period of time.
- Decommissioning: to remove the installation.

In Jordan, if IPP companies have not acquired the site of the installation, another determining factor is the land lease contract.

Risks from the Perspective of the Investor

Within the PPA contract, there are a number of risks worth identifying in the interest of mitigating them.

Credit risk: Present especially when the offtaker has a high credit/default risk profile.

For Jordan, the preferred offtaker is the state-owned company NEPCO. The credit default risk for Jordan as a country, as rated by the American agency Standard & Poor's, is BB, while Moody's rated it as Ba2.[40] Hence, this risk exists and might make negotiations with international lenders more difficult and credits more costly. Nevertheless, a contract with the government is still more securely rated over 20 years than one with a privately-owned utility. Although in round 1 many systems were too small to be connected to the transmission grid, all companies were said to prefer to construct transformer stations at their own expense to gain access to the transmission grid than to connect to a private distribution grid operator (DSO).

Regulatory risk: PPAs with NEPCO are subject to the risk of changes in the legislative framework. International investors will therefore have to consider the regulatory risk before providing funding for projects. Nevertheless, Jordan has in the past provided a relatively stable legal and regulatory framework in the energy field for investors.

Technical risk: When PPAs are based on PV-generated electricity, it is relatively easy to have access to financing under good conditions. This is mainly due to the following factors:

- The stability of revenue enabled by a relatively fixed PPA price over a long period of time.

[40] *http://www.tradingeconomics.com/jordan/rating 10 July 2014*

- PV technology reliability: The output of a PV plant can be forecasted with a low margin of error.

b. Involved Stakeholders

The key characteristic of the PPA business model for PV projects is that the plant operator and the power offtaker are different legal entities. The PV plant is usually the only asset of a company that serves as a single purpose vehicle (SPV).

Through the SPV it is possible to include external equity investors as shareholders of the SPV. The equity investors require certain target returns and the SPV as an operator tries to achieve this while also ensuring the debt service in accordance with the loan contract. The engineering, procurement & construction company (EPC) builds the turnkey PV system and the EPC contract transfers certain construction risks to the EPC contractor. An operation and maintenance (O&M) service provider is usually contracted to ensure a reliable operation of the PV system and to take care of the accounting with the power consumer.

In Jordan, all electricity generated by the IPP is sold to the single offtaker NEPCO.

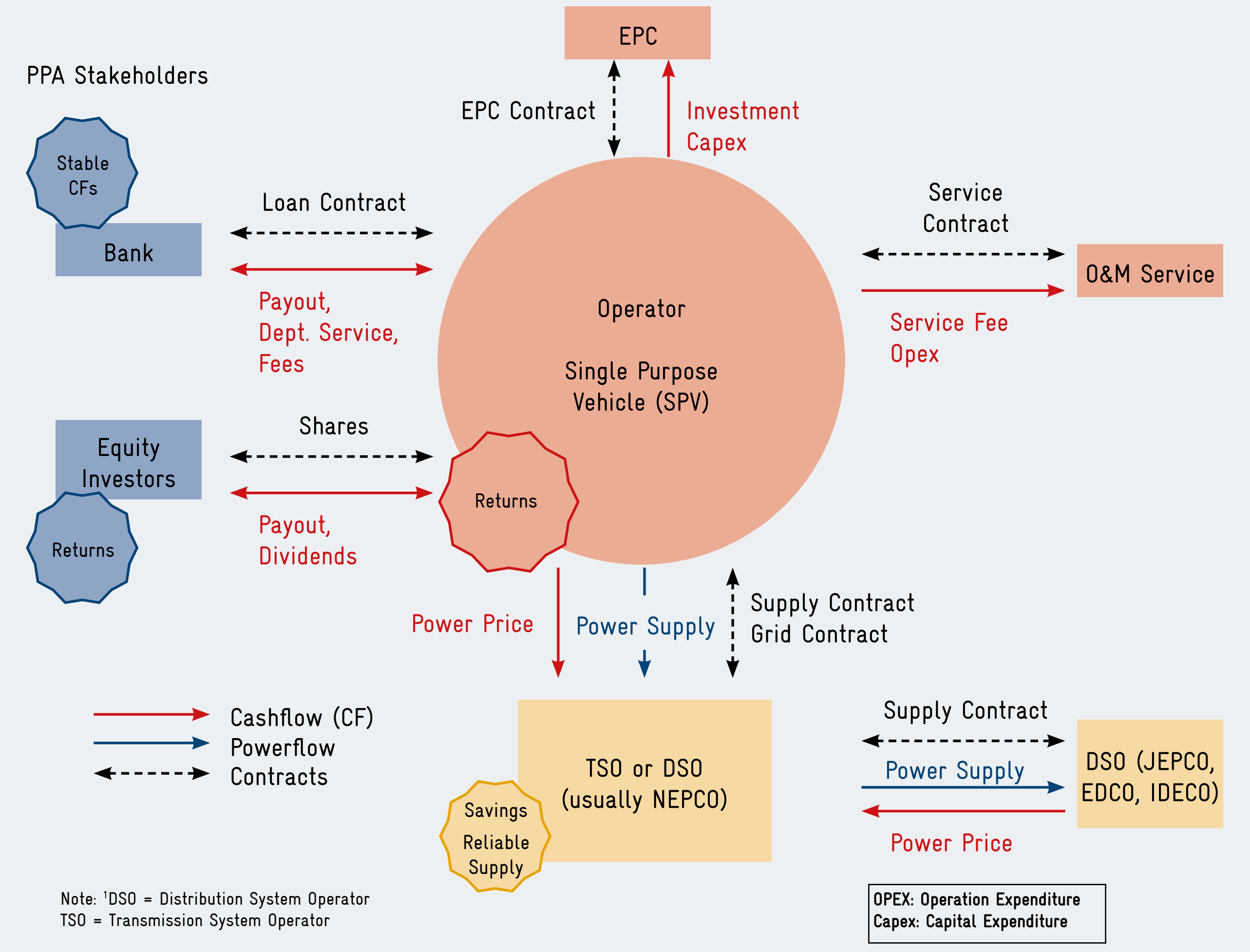
Preparation / negotiation process
In the negotiation process, up to the signing of a PPA, the MEMR and the ERC are also important.

MEMR: The Ministry not only sets the rules, but also designates areas for project development. In addition, it becomes an active part of negotiations as soon as a recommendation has been made by the Regulating Commission, and eventually pays for electricity produced through its liabilities with NEPCO.

ERC: The Energy Regulatory Commission sets the reference price and accepts and evaluates proposals and offers of third parties.

Applicant / potential IPP: Applicants can make tender offers or propose RE projects according to the rules of the law and Expression of Interest.

Figure 57: PPA stakeholders in Jordan



Offtaker (TSO/DSO): The utility either has to accept IPP electricity and feed it into the grid, provide the infrastructure for the connection or pay the distribution network operator for adaption made to the grid, if IPP electricity is directly feed into the distribution grid. Until today, this operator is NEPCO as the so-called "bulk supply licensee" that owns the transmission lines.

Distributor (DSO/TSO): The distributor has to accept IPP electricity from renewable energy sources and adapt the grid infrastructure accordingly for a charge, as defined by the ERC. To date the three DSOs JEPCO, IDECO, EDCO are the so-called Retail Supply Licensees in charge of the distribution network and providing large-scale power consumers with direct access to the transmission network.

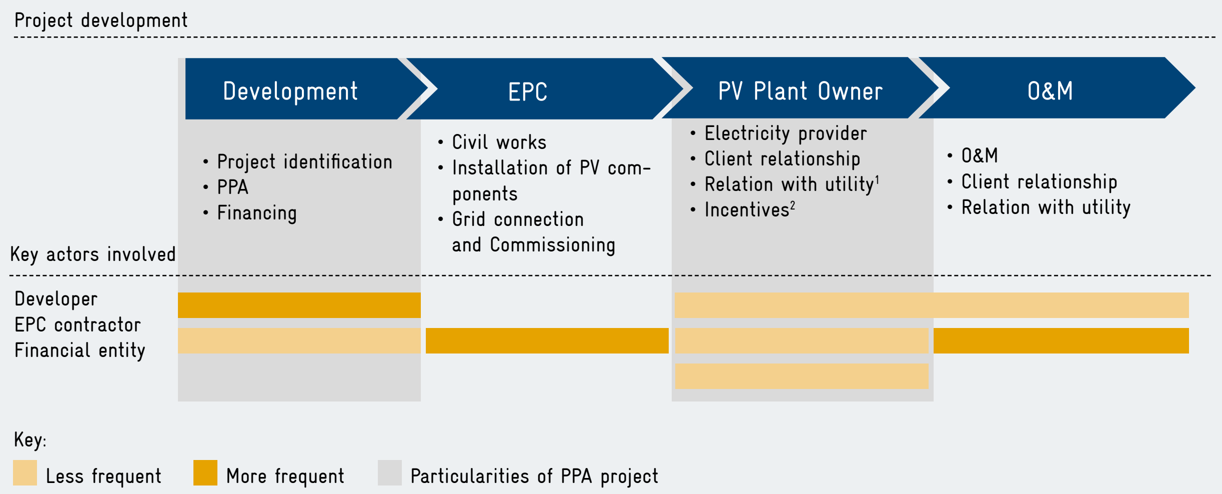
Further parties involved in the construction and operational process of the EPC are:

Developer: The developer is involved in all steps related to the preparation and planning of the project.

Engineering, procurement, construction contractor: The EPC contractor is involved in all steps related to the design, layout and construction of the PV plant.

Operation and maintenance contractor: Once the plant has been constructed, the O&M contractor services the plant to keep it running.

Figure 58: Value chain of a PPA project



Note: [1]If surpluses have to be managed; [2]Incentives can be shared between the plant owner and the electricity buyer
Source: ECLAREON interviews, ECLAREON analysis

c. Project Development Process

With the 3rd Round for expression of interest (EOI), one can note that a standard procedure exists, though none of the rounds have so far resulted in the construction of PV plants.

Figure 59: Simplified description of PPA process

Table 28: Detailed description of the PPA process

Process Steps PPA		
1. Call for expression of interest	Description	The MEMR publishes a call for expression of interest for renewable energy production. The Call for EOI usually provides information on: • Technologies that are eligible for participation • Designated geographical area, if any • Legal requirements for participation • Indications for interested companies such as technological specifications like system size, ceiling price, track record etc.
	Actor	MEMR, consultants
	Duration	A period of 1 to 2 months
2. Site selection / founding of consortia	Description	Companies interested in delivering their EOI are advised to: • select a suitable site close to a possible connection point or (medium voltage) electricity line, if the land is not provided by the government; • contact the relevant utility to gather insights on availability of capacities; • make pre-contracts with land owners to secure the site for buying / renting • form consortia with national / international partners and investors to have the right mix of qualifications, financial expertise, local knowledge and connections.
	Actor	Investors, EPC, relevant utilities, land owners
	Duration	Company-specific, but can take many months, so it is advisable to look for suitable partners and sites in advance
3. Express interest with letter of interest	Description	Any judicial person can submit an expression of interest containing • Letter of application • Executive summary • Applicant's organizational information • Project description • Technical capability of the applicant • BOO experience of the applicant • Financial information • Other information* The documents have to be submitted to the MEMR by a set deadline. In practice, it is useful to find relevant local / foreign partners and financial institutions before EOI rounds are published.** The reference price list of the ERC should also be considered since bids above the list will not be considered.
	Actors	Investor / project developer
	Duration	Company-specific, but requirements are extensive.

* *http://www.memr.gov.jo/LinkClick.aspx?fileticket=TQXs0UJD04g%3D&tabid=36 , 19 June 2014*

** *It is to be noted that technical qualifications and past experience in round 2 & 3 have been set very high. Experience in operation of a 20 MWp plant (round 2) and a 50 MWp plant (round 3) is a hurdle for many market actors.*

Process Steps PPA		
4. Waiting period & signing of memorandum of understanding	Description	After the submission of the EOI within the deadline given by the MEMR, proposals are evaluated by a commission in the Ministry to give feedback. **Memorandum of understanding (MOU)***** Project developers that are successful in passing the EOI stage receive a **MOU** from the government, which fixes the next steps and requirements. This enables the project developer to proceed with measurement campaigns, feasibility studies and other preparatory and due diligence work such as negotiating access to land and financing for the proposed project.
	Actors	Project developer, investor, owner, MEMR
	Duration	At least 6 months, in the past longer
5. Offer	Description	Upon completion of the MOU process, the applicant is required to submit a full and committed direct proposal to the MEMR fixing a price below a certain ceiling price, currently at JD 0.1 / kWh.
	Actors	Project Developer, IPP
	Duration	In the past (EOI 1) more than one year; for current processes a period of 8 to 10 months is expected after signing of MOU.
6. Power purchase agreement	Description	With support from NEPCO, MEMR evaluates the offer from a technical and financial standpoint and clarifies details. Upon recommendation of MEMR, the Council of Ministers consults and approves the offer and signs a PPA with the IPP. The Ministry of Finance provides a state guarantee for NEPCO's liabilities.
	Actors	Project developer, IPP, MEMR, NEPCO
	Duration	In the past (EOI 1), 6 to 8 months
7. Financial closure	Description	With the PPA, the IPP has 6 months to conclusively negotiate with financing institutions.
	Actors	IPP / financial institutions
	Duration	Max. 6 months
8. Construction of the plant	Description	Once financial funds have been secured and acknowledged by the MEMR, the EPC can start to construct the PV plant. Agreements have to be signed with NEPCO or other relevant utilities specifying the time of commissioning necessary substations or transformers
	Actors	IPP / MEMR / NEPCO
	Duration	Unknown

*** *Samples for MoU with the MEMR can be found here: http://www.memr.gov.jo/LinkClick.aspx?fileticket=01NTSqhsFpg=&tabid=93 , 18.July 2014*

Process Steps PPA		
9. Start operation	Description	Once the project has been build and connected, the PV plant may start operations; from then on it provides electricity to and receives funding from NEPCO.
	Actors	IPP, NEPCO
	Duration	20 Years

d. Project Economics of PPAs

Financial Overview

The financial model is a milestone in every project as it will determine if the project is profitable or not for both parties, the plant owners and the electricity buyers.

Financial model from the investor's point of view:
The general input for the investor's financial model can be divided into two categories:

- Costs
  - Capital expenditure (CAPEX): This includes, among other factors, permitting, engineering, procurement and construction (EPC) costs, connection costs, construction insurance.
  - Operational expenditure (OPEX): Operation and maintenance (O&M) costs (mostly maintenance, product replacement and repair) and other operating costs such as rental fees, insurance, etc.
  - Financing: Leverage, interest rate and tenor are the main parameters to consider.
- Revenues
  - Energy generation: This depends on several factors such as the solar resources available in the chosen location, the performance ratio and the degradation of modules.
  - PPA price: the price per kWh agreed upon in the contract.
  - Other revenues such as the salvage value of a PV system at the end of its useful life (if applicable).

Critical Success Factors for the PPA Business Model

The critical success factors for the development of a PPA model, which any investor should consider before pursuing a particular opportunity, are the following:

- Regulatory framework.
  - It should be legal to sign a PPA under reasonable conditions, as is guaranteed by the REEL and laws in Jordan.
- A cap on the maximum installed capacity by location might limit the investment opportunity; this is the case for EOI 2 & 3 in Jordan, for example.
- Economics of the project
  - Alternative electricity prices from other sources should be higher, which is the case in Jordan with its high fuel costs.
  - Dimensioning of the PV plant should be done according to demand or capacity, which is the case in EOI rounds 2 & 3.
  - The potential risk of the project resulting from the offtaker should be reasonable so as not to limit profitability; in Jordan such risk is based on regulatory, technical or financial issues.
  - The offtaker should be an entity with credibility and financial muscle.
  - Other involved parties, such as insurance companies and financial entities, should be sufficiently knowledgeable of the PV sector.

Examples

As an example a hypothetical EOI Round 2 project with 50 MWp is simulated. These projects will be the next ones to emerge, while EOI Round 1 project negotiations have been terminated. In addition, the latter differ massively in size and will be granted a feed-in tariff of JD 0.12 / kWh, while with EOI 2 only a ceiling price of JD 0.1 /kWh has been set.

Assumptions
For the following section, the parameters from the net-metering chapter have been used.

Please refer to the chapter on "Net-metering Assumptions" for more information.

In addition, for large plants the transformer typically increases losses by around 3% and therefore reduces the performance ratio to 0.79 and 0.74 for Amman and Aqaba respectively.

Table 29: Assumptions for a large PPA project

PV System		
System size	kWp	50,000
Specific investment cost	JD/kWh	1,000
Absolute investment cost	JD	50,000,000
Specific yield	kWh/kWp/a	1,800
Degradation	%	0.8%
Operation & maintenance	JD/kWp/a	15
Price Parameter		
PPA tariff	JD/kWh	0.1000
Electricity price escalation	% p.a.	0%
Inflation	% p.a.	5.70%
Investment		
Project duration	Years	20
Equity	%	30%
Debt tenor	Years	7
Interest rate	%	6.13%
Discount rate	%	10%
Net present value	JD	15,256,319
Equity IRR	%	18.32%
Amortization	Years	7.73

Example 7: Large PV System of 50 MWp for a PPA contract with the MEMR in Round 2 of Direct Proposals

Particularities:

- Equity share of the investment is 30%.
- Electricity is sold to NEPCO at a calculative tariff of 0.10 JD/kWh (ceiling price).
- Low system price, but not the lowest one named in the interviews.
- Turnkey installation, no transformer costs etc. included.
- No costs for land lease / purchase included.
- Tenor of 7 years.

Market segment:
Round 1-3 of direct proposals, here referring to system size of 50 MWp in Round 2

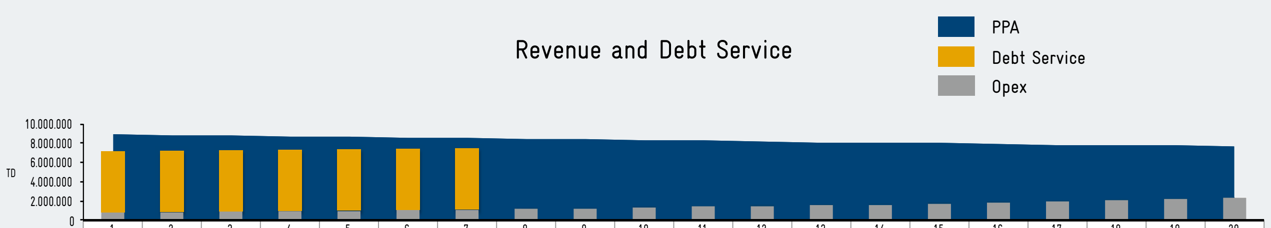
Attractiveness of PV for investors is medium, for the following reasons:

- The investment has a relatively long payback time.
- Highly competitive and long negotiation process.

Regulatory ways to increase attractiveness:

- Increase long-term visibility of the PPA market.
- Specify areas of preferential connection etc.

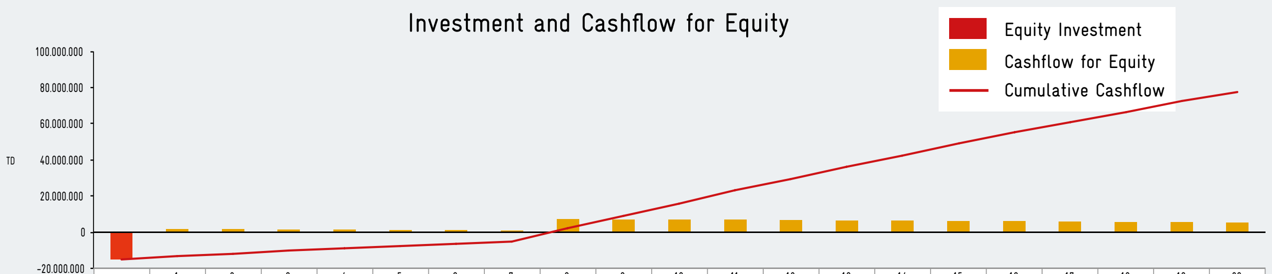
Figure 60: PPA revenue and dept service analysis



Operation Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
PPA	8.928.000	8.856.576	8.809.794	8.715.438	8.645.714	8.576.548	8.531.245	8.439.873	8.372.354	8.305.375	8.261.504	8.173.020	8.107.636	8.042.775	8.000.292	7.914.605	7.851.289	7.788.478	7.747.338	7.664.361
Debt Service	6.368.595	6.368.595	6.368.595	6.368.595	6.368.595	6.368.595	6.368.595	-	-	-	-	-	-	-	-	-	-	-	-	-
Opex	792.750	837.937	885.699	936.184	989.546	1.045.951	1.105.570	1.168.587	1.235.197	1.305.603	1.380.022	1.458.684	1.541.829	1.629.713	1.722.606	1.820.795	1.924.580	2.034.281	2.150.235	2.272.799

Operation Year

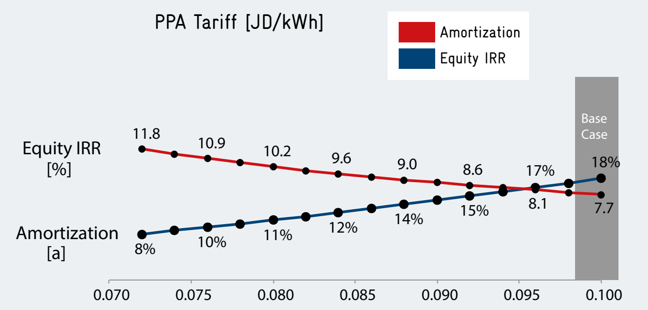
Figure 61: PPA Investment and cashflows analysis



Operation Year	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(15.225.000)																				
Cashflow for Equity	-	1.766.655	1.650.045	1.555.500	1.410.659	1.287.573	1.162.003	1.057.081	7.271.285	7.137.157	6.999.772	6.881.482	6.714.337	6.565.807	6.413.062	6.277.685	6.093.810	5.926.708	5.754.197	5.597.102	5.391.562
Cumulative Cashflow	(15.225.000)	(13.458.345)	(11.808.300)	(10.252.800)	(8.842.141)	(7.554.568)	(6.392.565)	(5.335.484)	1.935.801	9.072.958	16.072.729	22.954.211	29.668.548	36.234.355	42.647.417	48.925.103	55.018.913	60.945.621	66.699.818	72.296.920	77.688.482

Operation Year

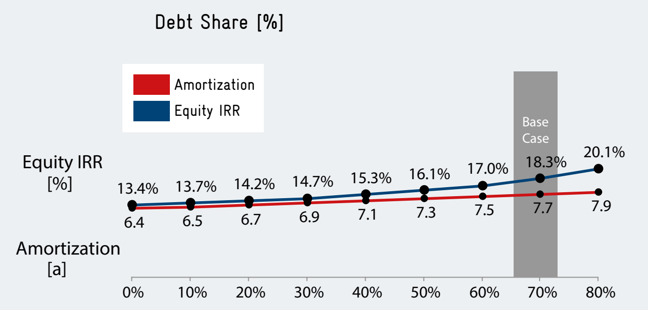
Figure 62: PPA tariff sensitivity analysis



Explanation:
The PPA tariff for EOI-Rounds 2&3 are ceiling tariffs. Only tariffs below will be accepted.

Evaluation:
A strong decrease in tariffs decreases the internal rate of return of the equity employed and the time of amortization to a considerable degree.

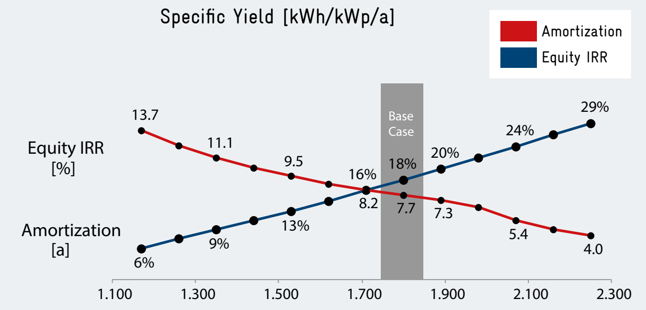
Figure 63: PPA Debt share sensitivity analysis



Explanation:
A change in the debt share of the PV system has moderate effects on the internal rate of return of equity employed.

Evaluation:
The best possible option would be to finance the entire PV system through a bank loan; 30% of equity is already considerable.

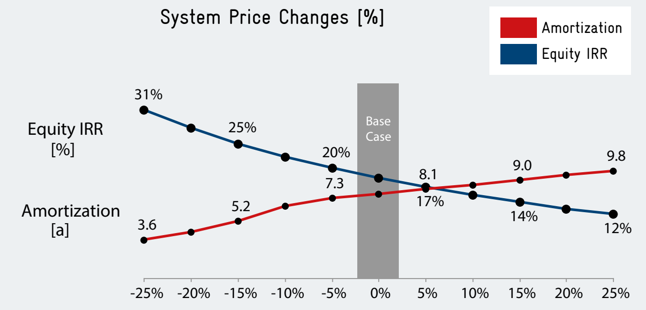
Figure 64: PPA energy yield sensitivity analysis



Explanation:
A strong increase in specific yield per kWp (e.g. high irradiation) will lead to a considerable improvement in the internal rate of return of equity employed.

Evaluation:
A strong increase in yield might be possible because PPAs allow the installation of systems at locations with high irradiation in unpopulated areas.

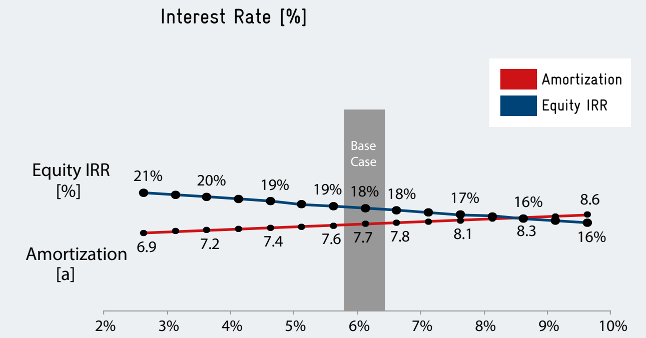
Figure 65: PPA equipment price sensitivity analysis



Explanation:
A strong decrease in specific system price per kWp will lead to a considerable improvement in the internal rate of return of the equity employed.

Evaluation:
A strong decrease in the prices is currently not very probable, since PV prices in Jordan are already relatively competitive at an international level. Once EPC companies are established and customers know the product, economies of scale might lead to price reductions.

Figure 66: PPA interest rate sensitivity analysis



Direct Consumption Shares [%]

Explanation:
A strong increase in the interest rate for the loan of the PV system has moderately negative effects on the internal rate of return of equity employed.

Evaluation:
Even if the interest rate would be considerably higher, the economic attractiveness of the investment would still be acceptable

e. Barriers & Recommendations, Next Steps –

Short-term Outlook

Direct proposals within the EOI procedure seem to work smoothly. Nevertheless, the fact that it has taken since late 2011 to achieve signing of PPAs in EOI Round 1 indicates an ongoing learning process, which will hopefully result in the construction of several 100 MWp of solar PV. As some of the barriers within the EOI Round 1 process have been cleared, the focus of the next section are those barriers that still exist or were mentioned by interviewees. The barriers vary according to the focus group, but might be addressed by policy-makers and interest groups.

Table 30: Regulative barrier communication

Regulative barrier: Communication & energy strategy outlook	
Barrier	So far, three EOI have been published; according to interviewees, EOI 2 & 3 came about rather unexpectedly. Expectations are high that there will be more EOI. Nevertheless, it was feared that delays or even cancellations of EOI rounds might negatively affect trust in governmental EOI processes and alter the timeframe for project development.*
Recommendation	An update of the National Energy Strategy should be developed that takes the short-term and mid-term capacity extension of different energy forms into account and provides a timetable to provide a reliable source of information. A national grid expansion strategy should be also developed and synchronized with the energy strategy. The different steps of further EOI processes should be communicated.
Next steps	Once initial experience with EOI 1 projects has been gathered, the assumptions on further renewable energy projects should be made and published.

Table 31: Regulative barrier grid capacity restrictions

Regulative barrier: Overall grid capacity restrictions:	
Barrier	Grid capacity: So far, 170 MWp for Solar have been licensed. In addition, wind projects from EOI round 1 still have to be realized. Doubts exist whether if EOI 2 + 3 can be realized in the market due to grid capacities.* A so-called "Green Corridor" for wind and solar energy sources was deemed to be necessary for the transfer of electricity and is planned accordingly. Nevertheless, financing and a timetable have not yet been established.
Recommendation	A strategic grid extension strategy should be published, which provides timelines for the realistic market development in order to prevent frustration among investors.
Next steps	Information on the electricity grid capacities should be provided and communicated, providing short-term, medium-term and long term outlooks.

* *By September 2014 EOI Round 3 was cancelled by the MEMR without further explanation.*
http://www.memr.gov.jo/LinkClick.aspx?fileticket=KvRV6fuTyC8%3d&tabid=36 7 October 2014

Table 32: Economic barrier land access

Economic barriers: Land lease & speculation:	
Barrier	Land has to be secured far ahead of any confirmation of a project by the MEMR. The entire process takes a considerable amount of time and is costly. Once a project is granted the land has to be secured. This could lead to land speculation by land owners, resulting in higher project costs.
Recommendation	Establish cost-efficient regulation to facilitate land acquisition and contracts to prevent such speculation and guarantee that contracts can be created; however, this seems to be difficult to put into practice.
Next steps	Evaluate the experience of EOI 1 and wheeling projects to draw conclusions, if the barrier persists.

Table 33: Economic barrier system size

Economic barriers: High barriers for market entry	
Barrier	EOI 2 & 3 continuously raises the market entrance barrier for IPP. According to the call for EOI, the size of the PV plants to be built are 50 MWp (round 2) and 100 MWp (round 3). In addition, sufficient experience has to be provided. IPP have to demonstrate experience with PV plants of at least 1 year with 20 MWp (50 MWp) system sizes and 2 years with 10 MWp (20 MWp) system sizes. The aim is to limit applications to companies with a proven track record and the necessary financial capacities, as well as to limit the number of applications. Apart from the land issue, sufficiently sized land has to be available at the site of the prospective plants. The result is that only very big companies will be able to realize the respective projects. Though economies of scale will enable them to provide lower prices on a per MWh level, strict screening of applications might have an opposite effect, leaving only a limited number of players to be able to participate. In addition, if the experience requirement is taken too strictly, even some of the successful bidders from round 1 would not be eligible to participate in round 3.
Recommendation	Applications should be considered based on corridor of sizes and not judged too strictly.*
Next steps	Evaluate the experience of EOI 1 and wheeling projects to draw conclusions, if the barrier persists.

* *By September 2014 EOI Round 3 was cancelled by the MEMR without further explanation.*
http://www.memr.gov.jo/LinkClick.aspx?fileticket=KvRV6fuTyC8%3d&tabid=36 7 October 2014

Table 34: Regulative barrier definitions

Regulative barriers: Unclear definitions / communication	
Barrier	Local content: Content of Jordanian origin can yield 15% bonus funding on the proposed tariff until a 500 MWp cap of renewables has been reached; however, no definition exists.
Recommendation	Specify the regulation.

Table 35: Regulative barrier government land availability

Regulative barriers: Database for government lands not available	
Barrier	For tenders and direct proposals, a database of available government lands, that would help to streamline processes, is not yet available.
Recommendation	Create database according to grid capacities and capacity development plan.

Long-term Outlook

As depicted, an attractive investment opportunity has been created for certain investor groups, especially international investors and well established EPC companies and consortia. Although EOI Round 1 has not been accomplished yet and will eventually take between 3 to 4 years, an outline for the subsequent processes has been created. Learning effects on the part of both MEMR and NEPCO and on the applicant's side will enable both parties to realize future negotiations quicker than in Round 1. PPA offers present a good possibility to reduce the fuel costs for NEPCO and to enable investors to generate appropriate profits. As examples in other countries show, IPPs could face the threat of retroactive legislative changes. At the moment, however, PPA with solar are mutually beneficial for the investors and the Jordan authorities. In the near to mid-range future in Jordan, at least from today's perspective, it seems improbable that energy generation costs can be considerably reduced for energy sources other than renewables.

Nevertheless, certain issues for the future have to be settled.

- What role should RES play in the mid-term energy mix in Jordan? Is the government willing to commit to a higher share of renewable energies?
- Closely connected to this question are the aspects of grid infrastructure and access to the grid. If the grid is not ready to transmit electricity from solar, wind and other sources, then this technical obstacle could hamper future renewable capacities in Jordan.

EOI Round 1 has provided a good example of how to improve and streamline the direct proposal process. In addition, the ERC has gathered experience that allows it to set a ceiling price for the following rounds. It remains to be seen if all Round 1 projects can be realized, and the process should be thoroughly monitored in case this is not possible.

For the time being, EOI 1 projects can contribute to lowering the generation fuel costs reimbursed by NEPCO and to matching the growing energy demand with domestic resources. Future rounds will provide NEPCO with electricity costs at an even lower price, though not necessarily at levels as low as the lowest subsidies for residential and public consumers. The use of the currently inexpensive renewable energy sources will be an important contribution to improve the country's trade balance.
Jordan is leading the way for other countries and is showing how to reduce energy costs, become more independent of imports, as well as how to create job opportunities, knowledge, capacities and domestic added value. In the coming years, Jordan could succeed in exporting knowledge to the region, positioning itself as service provider in the renewable energy sector.

In addition, as technical improvements in the infrastructure will become necessary to improve the grid capacities for fluctuating renewable energies, Jordan will once again lead the way for other countries.

6. Opportunities for Foreign Companies

Jordan presents interesting investment opportunities in PV. The overall framework is positive, and both the country and the residents of Jordan will benefit from the technology if high-quality and sustainable projects are realized.

Nevertheless, in order to be successful, investors who want to become active in Jordan will need to respect several aspects:

1. Secure local partners: These are important since the market for net-metering is very fragmented and only local companies have good access to clients, information and contacts. In the PPA segment it will certainly be useful to cultivate contacts to local partners, especially when it comes to negotiations with the MEMR as well as the construction of PV systems.
2. Build capacities and quality awareness: PV is not yet well-established in Jordan. To prevent bad experiences with poor quality installations, especially in the end consumer market, awareness for quality systems and installations has to be supported through capacity-building measures.
3. Lobby financial institutions: The market still has to be prepared in Jordan. For many projects, financing will be crucial for medium to large systems, even though profitability is excellent. If possible, PV financing must be facilitated by providing expertise on project economics as well as financing methods.

In addition, the following specific possibilities are seen:

- Equipment manufacturers can focus on exporting their products (e.g. PV modules, inverters, structures, etc.) to Jordan without import tax.
- Developers could first seek local collaborators in order to gain access to new business opportunities.
- EPC companies can take advantage of business opportunities arising from the competitiveness of the technology by offering their services and know-how to local investors. It is advisable to collaborate with local players or to buy licenses from developers.
- The growing popularity of PPAs is attracting a large number of investors and financial entities who see this contract as a financial product. It seems appropriate for investors to seek a partnership with local developers in the case of direct line PPAs, or with large international developers in the case of generation utility PPAs.
- As PPAs usually involve large PV plants, it seems an attractive niche for O&M companies. To enter into a new market, it is recommended that O&M companies partner with EPCs or with investors.

7. ANNEX 1: Wheeling

Guidelines for renewable energy systems' connection to distribution or transmission systems in a geographical location different from the geographical location point of consumption

(Unofficial translation of key regulations – no guarantee for the correctness of any content used.)

Procedures for connection of renewable energy systems to the distribution systems for users connected to the same licensed distribution company

Article 1

The net electricity at the site of renewable energy system is calculated as:

Equation:
Net electricity = (1 – losses * exported electricity from the renewable energy system) - all Imported electricity for the user's meter(s).

Article 3:

The applicant should guarantee that the renewable energy systems comply with ENA standard (ENA G83/1 for small renewable energy systems and ENA G59/1 for large renewable energy systems), and he should provide a certificate from a third party proving that the system complies with the international safety standard.

A small renewable energy system has been defined as a system that can be connected to the distributor grid and does not exceed 16 A for each phase (approximately 3.68 kW for each phase).

A large renewable energy system has been defined as a system that is not small and does not exceed 5 MW.

Small renewable energy systems:

Article 4:

The capacity of the installed system is determined as the electricity production not exceeding average monthly consumption in the previous year from the date of application for connecting the renewable energy systems.

Article 7 (Procedures for small renewable energy systems):

1- The applicant should apply for the system through a special form prepared by the distributor.
2- The applicant should provide all necessary information and documents regarding the geographical location where the system will be built.
3- The distributor should inform the applicant within 10 business days if the application is complete or not. If the application is not complete, the distributor should inform the applicant in writing about missing information.
4- If the application is not complete, the applicant should prepare all missing information within 10 business days. Based on the approval of the distributor, the applicant may ask for additional time to provide the missing information.
5- The distributor then should inform the applicant within 10 business days if the application is complete or not.
6- If the applicant fails to provide all missing information, the application is then considered to be cancelled.

Article 8 (Approval of small renewable energy systems):

1- The distributor should conduct a site visit within 20 business days from the application completion.
2- After the initial approval of the distributor, the distributor should specify to the applicant the cost of connecting the renewable energy system to distribution lines within 10 business days of the site visit.
3- The total installed capacity should not exceed 15% of the feeder peak load.
4- The total installed capacity should not exceed 20 kVA for each phase.
5- The installed capacity should not exceed the average monthly consumption of the previous year from the date of application for connecting the renewable energy system.

Article 9 (Agreement):

Upon the distributors initial approval, the applicant should pay the required cost of system connection within 20 business days; if it is not paid within this period, the system is considered to be cancelled.

Once the costs are paid, the distributor should send the signed agreement to the applicant within 10 business days.

Article 10 (Operation of small renewable energy systems):

1- The user should install the small renewable energy system within 3 months after signing the agreement.
2- The user should inform the distributor that the system is ready to operate and pay a fee of JD 20.
3- The distributor should inspect and conduct a site visit within 10 business days, and should inform the user of the inspection date.
4- Upon inspection, the distributor should inform the applicant whether his system complies with Article 3 or not.
5- If it does not comply, the user should correct the situation and apply for re-inspection within 20 business days. The user should pay a fee of JD 15 for the re-inspection.
6- The distributor should re-inspect the system within 10 business days of the re-inspection application.
7- If the system fails to comply with Article 3, the agreement is then considered to be cancelled.

Large renewable energy systems:

Article 11 (Procedures for large renewable energy systems):

1- The applicant should apply for the system through a special form prepared by the distributor.
2- The applicant should provide all necessary information and document regarding the geographical location where the system will be built in.
3- The distributor should inform the applicant within 15 business days if the application is complete or not. If the application is not complete, the distributor should inform the applicant in writing about the missing information.
4- If the application is not complete, the applicant should prepare all missing information within 15 business days. Contingent upon the approval of the distributor, the applicant may ask for additional time to provide the missing information.
5- The distributor then should inform the applicant within 10 business days if the application is complete or not.
6- If the applicant fails to provide all missing information, the application is then considered to be cancelled.

Article 12 (Completion of connection conditions):

1- The distributor should conduct a site visit within 30 business days of the application completion.
2- The distributor should specify to the applicant the cost of connecting the renewable energy system to the distribution lines and the costs of required studies within 30 business days of the site visit.

Article 13 (Technical studies):

1- It is the applicant's responsibility to pay all fees for all required studies.
2- Contingent upon the applicants approval, the distributor may conduct all required studies at the expense of the applicant at a cost of JD 5/kW and a minimum fee of JD 500 for the preliminary study and JD 10/kW and a minimum fee of JD 1000 for the impact study.
3- Upon the distributor's approval, the applicant may assign a third party to conduct the required studies, the results of these studies, however, should be reviewed and agreed by the distributor.

The required studies are:

Preliminary study:

The distributor should provide the applicant with the agreement form to conduct this study within 5 days of the preliminary meeting.

The agreement should specify the fees, the study period, the field and the objective of the study.

The applicant should approve the agreement within 30 business days; otherwise, it is considered to be cancelled.

The distributor should finish the preliminary study within 60 business days of the date of signing the agreement or payment of the fees, whichever is latest.

Contingent upon the approval of both the applicant and the distributor, the study period can be extended.

Based on the results of the preliminary study, the distributor may ask for an impact study.

Impact study:

The distributor should provide the applicant with the agreement regarding the impact study within 10 business days of the preliminary study's completion.

The agreement should specify the fees, the study period and comprehensive revision of protection devices to comply with the grid codes.

The applicant should approve the agreement within 30 business days; otherwise, it is considered to be cancelled.
The distributor should include the following in his study: flow current, fault current, protection devices, impacts on the grid system, stability of grid system and voltage drop.

The distributor should finish the impact study within 60 business days of the date of signing the agreement or payment of the fees, whichever is latest.

Contingent upon the approval of both the applicant and the distributor, the study period can be extended.

Article 14 (Connection agreement):

The distributor should provide the applicant with the connection agreement as well as the costs of connection within 10 days of the completion of the impact study.

The applicant should pay the required cost of system connection within 20 business days; if it is not paid within this period, the system is considered to be cancelled.

Once the costs are paid, the distributor should send the approval of the system connection to the distribution system.

The applicant should review and sign the agreement with 30 business days; otherwise, it is considered to be cancelled.

After signing the agreement, and for those systems larger than 1 MW, the applicant should obtain a license or approval from the electricity regulatory commissioning according to current electricity laws.

Article 15 (Operation of large renewable systems):

Upon distributor approval, the user should assign a third party to complete inspection and testing of the system within 30 business days of expected system operational date, at his own expense. The distributor may waive the requirement to assign a third party if the distributor inspects and tests the system at a cost of JD 1 /kW with minimum fee of JD 250.

If a third party is assigned, it is his responsibility to send to the distributor a checklist and timetables of all inspection and testing procedures that will be carried out, carry out all inspections and testing in the presence of the distributor, inform the distributor that the system is ready for operation and inform the distributor of date of commencing operations.

It is not allowed to postpone the operational date of the system for more than 6 months after the signing the agreement; if this period is exceeded, it is the distributor's right to cancel the agreement.

The applicant should present and provide the license obtained from electricity regulatory commission to the distributor within 30 business days.

Article 16 (Net-metering process for both small and large renewable energy systems):

1- The distributor should record the imported and exported energy at the generation site on a monthly basis.
2- The distributor should record all meter(s) readings on a monthly basis.
3- The distributor should issue a monthly bill to the user, which should include:
   a) Exported energy from the generation site
   b) Imported energy to the generation site
   c) Consumed energy for the user's meter(s)
   d) Energy losses due to electricity flow from renewable system to the grid, according to charges stipulated by the directive
   e) Net-metering between net energy exported from the generation site and the energy imported for the user's meter(s)

Article 17 (Electricity bill accounting):

1- If the electricity imported to the user's meter(s) is more than the net electricity exported from the renewable energy systems at the generation site, the user should pay the difference on a monthly basis.
2- If the electricity imported to the user's meter(s) is less than the net electricity exported from the renewable energy systems at the generation site, the excess electricity is rolled over to the subsequent month.
3- By the end of the year, if there is excess energy, it is sold to the distributor at prices in the reference price list issued by the electricity regulatory commission.
4- Procedures of connection of renewable energy systems to the transmission systems for users connected to the licensed distribution company.

Article 20

It is the responsibility of the licensed transmitter (NEPCO) to review and evaluate all applications.

Article 21

The licensed transmitter should prepare a list of technical requirements for the renewable energy systems connected to the transmission system.

The applicant is responsible for all costs required for connecting the renewable energy systems to the transmission system.

Article 22

The licensed transmitter has the right to carry out a yearly inspection to ensure that the renewable energy system connected to the transmission system complies with transmission system codes.

The user has the right to disconnect the renewable energy system, but he should inform the transmitter within 15 business days about the disconnection, except in emergency cases.

Article 23 (Application process):

1- The applicant should apply for the renewable energy system's connection to the licensed distributor for the purposes of determining the system capacity that can be installed.
2- The applicant should apply for the renewable energy connection with the licensed transmitter, indicating the allowable installed capacity approved by the distributor. The application should include the capacity and type of renewable energy system, the geographical location of the renewable energy system and the meter(s) that will benefit from the renewable energy system.
3- The transmitter should inform the applicant within 15 business days if the application is complete or not. If the application is not complete, the transmitter should inform the applicant in writing about the missing information.
4- If the application is not complete, the applicant should prepare all missing information within 15 business days. Contingent upon the approval of the transmitter, the applicant may ask for additional time to provide the missing information.
5- The transmitter then should inform the applicant if the application is complete or not within 14 business days.
6- If the applicant fails to provide all missing information within the stipulated period, the application is then considered to be cancelled.

Article 24 (Technical constraints):

1- The maximum allowable installed capacity is 10% of the transmission line to which the renewable energy system is connected.
2- The maximum allowable capacity is 20% of the transformer located between the point of generation and the consumer.

Article 25 (Technical studies):

1- The licensed transmitter should provide the applicant with the required technical studies to complete his application and the cost of such studies if it will be carried out by the transmitter, within 14 business days.
2- Contingent upon the applicant's approval, the transmitter may conduct all required studies at the expense of the applicant at a cost of JD 5/kW of peak load for the preliminary study and JD 10/kW of peak load for the impact study.
3- Contingent upon the distributor's approval, the applicant may assign a third party to conduct the required studies; however, the results of these studies should be reviewed and agreed by the transmitter.
4- The applicant should agree within 30 business days to conduct the studies; otherwise, the application is considered to be cancelled.

The required studies are:

Preliminary study:

1- If it is agreed that transmitter is to conduct the preliminary study, the transmitter should provide the applicant with the agreement within 5 business days.
2- The applicant should review and sign the agreement within 30 business days; otherwise, it is considered to be cancelled.
3- The transmitter or the third party should complete the preliminary study within 60 business days of the date of signing the agreement or payment of fees, whichever is latest.
4- Contingent upon the approval of both the applicant and the transmitter, the study period can be extended.

Impact study:

1- If it is agreed that the transmitter must conduct the impact study, the transmitter should provide the applicant with the agreement of impact study within 10 business days of the preliminary study's completion.
2- The applicant should approve the agreement within 30 business days; otherwise, it is considered to be cancelled.
3- The distributor should finish the impact study within 60 business days of the date of signing the agreement or payment of the fees, whichever is latest.
4- Contingent upon the approval of both the applicant and the transmitter, the study period can be extended.

Article 26 (Connection agreement):

1- The transmitter should provide the applicant with the connection agreement as well as the costs of connection within 10 days of the completion of the impact study.
2- The applicant should pay the required cost of system connection and review the agreement within 30 business days; if it is not paid within this period, the system is considered to be cancelled.
3- For those systems larger than 1 MW, after signing the agreement, the applicant should obtain a license or approval from electricity regulatory commission according to current electricity laws.

Article 27 (Operation of the renewable system):

1- Upon the transmitter's approval, the user should assign a third party to complete the inspection and testing of the system within 30 business days of the system's expected operational date, at his own expense. The transmitter may waive the requirement to assign a third party if that the transmitter inspects and tests the system at a cost of JD 1/kW of peak load.
2- If a third party is assigned, it is his responsibility to send to the transmitter a checklist and timetables of all inspection and testing procedures that will be carried out, carry out all inspections and testing in the presence of the transmitter, inform the distributor that the system is ready for operation and inform the distributor of the date of operation.
3- It is not allowed to postpone the operational date of the system for more than 6 months after the expected operational date.

4- The applicant should present and provide the license obtained from electricity regulatory commission to the transmitter within 30 business days of the expected date of operation.

Article 28 (Net-metering process for renewable energy systems):

1- The transmitter should record the imported and exported energy at the generation site on a monthly basis.
2- The transmitter should issue a monthly bill to the user, which should include:
   a) Net exported energy from the generation site, calculated as (exported energy – imported energy – losses)
   b) Charges of energy flow according to rules stipulated under the directive issued by electricity regulatory commission.
3- The transmitter should issue a bill to the licensed distributor that includes the net energy exported from the renewable energy system's generation site.
4- The distributor should issue a monthly bill to the user considering the net exported electricity from the renewable energy system's generation site as electricity imported from the licensed transmitter.

Article 29 (Electricity bill accounting):

1- If the electricity imported to the user's meter(s) is more than the net electricity exported from the renewable energy systems at the generation site, the user should pay the difference on a monthly basis.
2- If the electricity imported to the user's meter(s) is less than the net electricity exported from the renewable energy systems at the generation site, the excess electricity is rolled over to the subsequent month.
3- By the end of the year, if there is excess energy, it is sold to the distributor at prices in the reference price list issued by electricity regulatory commission.

Procedures for connection of renewable energy systems to the transmission systems for users connected to the licensed transmitter company

Article 32

It is the responsibility of the licensed transmitter (NEPCO) to review and evaluate all applications.

Article 33

The licensed transmitter should prepare a list of technical requirements for the renewable energy systems connected to the transmission system

The applicant is responsible for all costs required for the connection of renewable energy systems to the transmission system.

Article 34

The licensed transmitter has the right to carry out yearly inspections to ensure that the renewable energy system connected to the transmission system complies with transmission system codes.

The user has the right to disconnect the renewable energy system, but he must inform the transmitter within 15 business days of the disconnection, except in emergency cases.

Article 35 (Application process):

1- The applicant should apply for the renewable energy connection with the licensed transmitter, indicating the planned installed capacity and type of renewable energy system, the geographical location of the renewable energy system and the type of load at the point of consumption.
2- The transmitter should inform the applicant within 15 business days if the application is complete or not. If the application is not complete, the transmitter should inform the applicant in writing about the missing information.
3- If the application is not complete, the applicant should prepare all missing information within 15 business days. Contingent upon the approval of the transmitter, the applicant may ask for additional time to provide the missing information.
4- The transmitter then should inform the applicant if the application is complete or not within 14 business days.
5- If the applicant fails to provide all missing information within the allowable period, the application is then considered to be cancelled.

Article 36 (Technical constraints):

1- The maximum allowable installed capacity is 10% of the transmission line to which the renewable energy system is connected.
2- The maximum allowable capacity is 20% of the transformer located between the point of generation and the consumer.

Article 37 (Technical studies):

1- The licensed transmitter should provide the applicant with the required technical studies to complete his application and the cost of such studies if they will be carried out by the transmitter, within 14 business days.
2- Contingent upon the applicant's approval, the transmitter may conduct all required studies at the expense of the applicant at a cost of JD 5/kW of peak load for the preliminary study and JD 10/kW of peak load for the impact study .
3- Contingent upon the distributor's approval, the applicant may assign a third party to conduct the required studies; however, the results of these studies should be reviewed and agreed by the transmitter.
4- The applicant should agree within 30 business days to conduct the studies; otherwise, the application is considered to be cancelled.

The required studies are:

Preliminary study:

1- If it is agreed that transmitter is to conduct the preliminary study, the transmitter should provide the applicant with the agreement within 5 business days.
2- The applicant should review and sign the agreement within 30 business days; otherwise, it is considered to be cancelled.
3- The transmitter or the third party should complete the preliminary study within 60 business days of the date of signing the agreement or payment of fees, whichever is latest.
4- Contingent upon the approval of both the applicant and the transmitter, the study period can be extended.

Impact study:

1- If it is agreed that the transmitter must conduct the impact study, the transmitter should provide the applicant with the agreement of impact study within 10 business days of the preliminary study's completion.
2- The applicant should approve the agreement within 30 business days; otherwise, it is considered to be cancelled.
3- The distributor should finish the impact study within 60 business days of the date of signing the agreement or payment of the fees, whichever is latest.
4- Contingent upon the approval of both the applicant and the transmitter, the study period can be extended.

Article 38 (Connection agreement):

1- The transmitter should provide the applicant with the connection agreement as well as the costs of connection within 10 days of completion of the impact study.
2- The applicant should pay the required cost of system connection and review the agreement within 30 business days; if it is not paid within this period, the system is considered to be cancelled.
3- For those systems larger than 1 MW, after signing the agreement, the applicant should obtain a license or approval from electricity regulatory commission according to current electricity laws.

Article 39 (Operation of the renewable system):

1- Upon the transmitter's approval, the user should assign a third party to complete the inspection and testing of the system within 30 business days of the system's expected operational date, at his own expense. The transmitter may waive the requirement to assign a third party if that the transmitter inspects and tests the system at a cost of JD 1/kW of peak load.
2- If a third party is assigned, it is his responsibility to send to the transmitter a checklist and timetables of all inspection and testing procedures that will be carried out, carry out all inspections and testing in the presence of the transmitter, inform the distributor that the system is ready for operation and inform the distributor date of operation.

3- It is not allowed to postpone the operational date of the system for more than 6 months after the expected operational date.
4- The applicant should present and provide the license obtained from electricity regulatory commission to the transmitter before within 30 business days of the expected date of operation.

Article 40 (Net-metering process for renewable energy systems):

The transmitter should issue a monthly bill to the user indicating the imported and exported energy at the generation site, the imported energy at the location of consumption, as well as losses and charges associated with the energy flow.

Article 41 (Electricity bill accounting):

1- If the electricity imported to the user's meter(s) is more than the net electricity exported from the renewable energy systems at the generation site, the user should pay the difference on a monthly basis.
2- If the electricity imported to the user's meter(s) is less than the net electricity exported from the renewable energy systems at the generation site, the excess electricity is rolled over to the subsequent month.
3- By the end of the year, if there is excess energy, it is sold to the transmitter at prices in the reference price list issued by electricity regulatory commission.

8. ANNEX 2: Connection of a Wheeling System

Directive Governing the Electrical Energy Flow Generated from Renewable Energy Systems for Purposes of Self-Consumption issued by the Council of Commissioners of the Electricity Regulatory Commission pursuant to Article (17) of the Renewable Energy and Energy Efficiency Law No. (13) for the year 2012 and Articles (7/B/3) and (9/B) of Electricity Law No. (64) for the year 2002

(Unofficial translation of most important regulations - no guarantee for the correctness of any content used)

Article (3)

It is allowed for any consumer connected to the transmission system to build, own and connect a renewable energy system, and to transmit electricity energy through transmission lines for the purposes of own consumption in a geographical location different from the geographical location point of consumption.

It is allowed for any consumer connected to the distribution system through a licensed distributor to build, own and connect a renewable energy system to the distribution system for the purposes of own consumption in a geographical location different from the geographical location point of consumption within the area of the same licensed distributor.

It is allowed for any consumer connected to the distribution system through a licensed distributor to build, own and connect a renewable energy system to the transmission system for the purposes of own consumption in a geographical location different from the geographical location point of consumption within or outside the area of the same licensed distributor.

Article (4)

The user should pay all costs required to connect his system to the distribution or transmission systems.

The user should pay all charges and losses determined by the Council of Commissioners of the Electricity Regulatory Commission.

It is the responsibility of the user to carry out all necessary technical studies for the purposes of connection.

Article (5)

The offtakers (NEPCO, JEPCO, EDCO and IDECO) are required to conduct monthly balancing between the energy flows to the grid after subtracting the losses and the energy flows to the consumer.

If the energy flow to the consumer is greater than the energy flow to the grid from the renewable system, the user should pay the difference at his applied tariff on a monthly basis.

If the energy flow to the grid from the renewable energy system is greater than the energy flow from the grid to the user, the offtaker should roll over the excess electricity to the subsequent month.

9. ANNEX 3: Wheeling charges

Directive Governing Charges of the Electrical Energy Flow Generated from Renewable Energy Systems for the Purposes of Direct Consumption Issued by the Council of Commissioners of the Electricity Regulatory Commission pursuant to Articles (7/B/3) and (9/B) of Electricity Law No. (64) for the year 2002

(Unofficial translation of most important regulations – no guarantee for the correctness of any content used)

Article (4)

It is permitted for anyone to build, own and operate a renewable energy system connected to the transmission or distribution systems and to transmit the electricity generated through the distribution and transmission lines.

Article (5)

The following charges are applied for the system as described in Article (4).

Type of connection	Electricity losses (%)	Charge (Fils/kWh)
Connection to transmission system for a user connected to the transmission system	2.3	4.5
Connection to distribution system for a user connected to the distribution system	6	7
Connection to transmission system for a user connected to the distribution system	8.3	11.5

If the site location is chosen by the licensed transmitter or distributor, the above table does not apply.

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11. Interviews & Consultation

8 structured interviews were conducted with installation and EPC companies in Jordan concerning net-metering business models.

4 structured interviews were conducted with EPC companies in the field of PPAs, partially overlapping with the ones concerning net-metering.

4 partially structured telephone interviews were conducted with international EPC and technical companies with projects / activities in Jordan.

6 background interviews were conducted with representatives of MEMR, NEPCO, JEPCO, NERC, EDAMA, and JREC.

1 workshop was given on 16 June 2014 to present initial results.

Relevant institutions were solicited for feedback in the drafting of this study.

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH
Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
T +49 (0) 6196-79-0
F +49 (0) 6196-79-7291
E info@giz.de
I www.giz.de