On the Horizon

Up-scaling Solar PV for Self-Consumption in the Jordanian Market

RCREEE

Regional Center for Renewable Energy and Energy Efficiency

المركز الإقليمي للطاقة المتجددة وكفاءة الطاقة

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About RCREEE

The Regional Center for Renewable Energy and Energy Efficiency (RCREEE) is an independent not-for-profit regional organization which aims to enable and increase the adoption of renewable energy and energy efficiency practices in the Arab region. RCREEE teams with regional governments and global organizations to initiate and lead clean energy policy dialogues, strategies, technologies and capacity development in order to increase Arab states' share of tomorrow's energy.

Through its solid alliance with the League of Arab States, RCREEE is committed to tackle each country's specific needs and objectives through collaborating with Arab policy makers, businesses, international organizations and academic communities in key work areas: capacity development and learning, policies and regulations, research and statistics, and technical assistance. The center is also involved in various local and regional projects and initiatives that are tailored to specific objectives.

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Contents

Executive Summary

Solar PV has the potential to reshape Jordan's energy future and achieve a range of economic, social and environmental benefits. There are many opportunities that can be leveraged to reach this potential, as reflected by solid regulatory framework on renewable energy and attractive contextual factors supporting the case for increased solar PV deployment.

This report is an outcome of the market assessment study on up-scaling solar photovoltaic (PV) for self-consumption in Jordan conducted by the Regional Center for Renewable Energy and Energy Efficiency (RCREEE) in cooperation with the International Institute for Industrial Environmental Economics (IIIEE) at Lund University. The report presents the current status of distributed solar market development; identifies key barriers and drivers for up-scaling PV for self-consumption and discusses the impact of recent regulatory changes: the wheeling and net metering regulations.

This report mainly focuses on:

- Commercial and industrial sectors
- On-grid solar PV
- Generation of electricity for self-consumption

Based on the analysis of the contextual factors, a framework was constructed that guided the research investigation. During the research period, 18 interviews, 2 roundtable discussions, 1 seminar, and 2 public presentations were carried out. Key stakeholders included policy makers, associations, developers, utilities, financial institutions and end-users.

The report provides the following key recommendations on how to overcome barriers and capitalize on opportunities for up-scaling solar PV self-consumption in Jordan:

- Clear up confusion over policy and regulation: Meetings with stakeholders, particularly in the private sector, have revealed confusion about the interpretation of policies and regulations relating to distributed generations. If the confusion over interpretation of the current policies and regulations continues, particularly regarding the net metering scheme, stakeholders will find it difficult to commit to solar PV investments, while misinformed investments will continue.

- Adjust policy to account for large consumers: Policy makers should act to update existing supporting schemes – particularly the net-metering and energy wheeling regulations – in order to better meet the needs of large consumers. The 5MW capacity for net metering is problematic as most large industries; hotels, telecom etc. require facilities larger than 5MW to offset any significant amount of their consumption. The same limit seems to apply for energy wheeling. Although NEPCO said that they would consider buying surplus production from facilities larger than 5MW on a case-by-case basis, this is not sufficient. There needs to be a written guarantee made in the legal documents. Furthermore, the energy wheeling regulation must be updated in order to specify how alternative distribution and business models that arise from energy wheeling will be accounted for by the regulation

- Target Green Loans at SMEs: Access to capital is crucial to finance the high initial cost of solar PV systems. All in all, many banks consider loans to SME's too risky because of this segments' inability to provide appropriate financial guarantees. This is a challenge in many countries and the most common and direct way to solve this issue, and encourage commercial banks to lend out money to SME's, is through guarantee schemes that share the risk of default. This is usually done via guarantee funds or guarantee associations which exist in more than 70 countries.

- Address quality concerns by involving Policy makers, industry associations, current retailers and manufacturers in the establishment of a rating system for inverters, modules and installations to avoid a situation that many other infant solar PV markets have been through previously.

1 Introduction

1.1 Current Electricity Market

The total installed capacity of electrical energy generating plants in Jordan was 3312 MW in 2012 [1]. More than 99% of this energy was generated from natural gas and petroleum products see Figure 1 [1]. Unlike other countries in the region, Jordan does not have access to any significant fossil fuel reserves [2], and the country instead imports about 96% of its total energy consumption needs [3]. Prior to the political upheaval in the Arab region in 2011, Jordan's electricity generation was heavily reliant on preferentially-priced natural gas imports from Egypt via the Arab Gas Pipeline. A volatile situation in Egypt as well as other major oil trading partners has forced Jordan to operate its power plants on highly expensive imported petroleum products [2]. The total electricity consumption in Jordan reached 14274GWh in 2012 [1]. The main demand came from households followed by the industrial and commercial sectors see Figure 2. According to the Electrical Regulatory Commission the electricity demand is set to increase by 250% in 2025 based on the 2012 demand level [1,4].

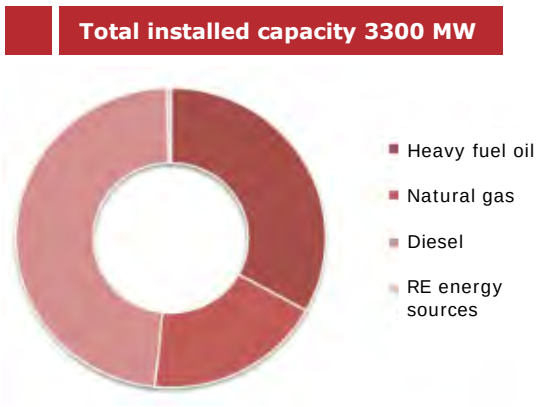


Figure 1: Electrical energy production by type of fuel in 2012. Source: Data from NEPCO

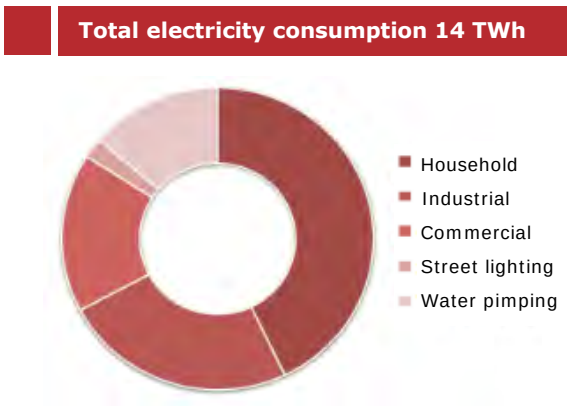


Figure 2: Electrical energy consumption by sector in 2012. Source: Data from NEPCO

Jordan's electricity market is partially liberalized. The Jordanian government decided to restructure the electricity sector in 1997, where the main objective was to increase the capacity and efficiency of Jordan's electricity sector [5]. Figure 3 illustrates the existing electricity market structure. Since the restructure, the Jordanian power sector is now regulated by the Electricity Regulatory Committee (ERC). The electricity sector is operating on a single buyer model, where there is a strong competition in the entry of new power generators. The generation companies include the privately-owned Central Electricity Generating Company and state-owned Samra Electric Power Generating Company. The electricity generated from generators is sold to the state-owned National Electric Power Company (NEPCO), the single buyer on the market, which operates the transmission systems. The electricity is then distributed to consumers through the three privately-owned distribution companies, the Jordanian Electric Power Company (JEPCO), the Irbid District Electricity Company (IDECO), and the Electricity Distribution Company (EDCO). Large electricity consumers, such as industries, are supplied through NEPCO directly [5].

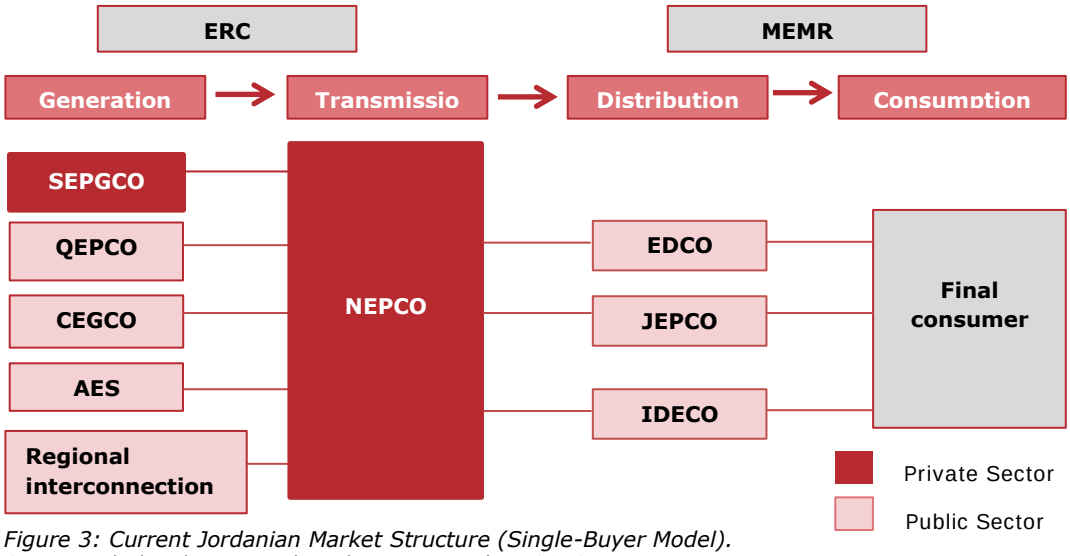


Figure 3: Current Jordanian Market Structure (Single-Buyer Model). Source: Abul Failat, Y. Jordan Electricity Market. 2013

1.2 Achievements for Solar PV

Although the installed capacity from solar PV is only roughly 8MW as of April 2014 [6], it should be noted that there are 210 MW worth of solar PV projects that have been approved with a signed power purchasing agreement (PPA) that will be brought into operation between the second half of 2014 and the end of 2015. This additional capacity amounts to roughly 10% of the current total generation capacity of 3312MW in 2012. This tremendous increase in installed capacity that will be seen over the next few years is the result of the solid supporting schemes recently set up and introduced by the policy makers, and an enthusiastic private sector. More specifically, it has been governmental supporting schemes in the form of 'direct proposal submission' and 'competitive tendering process' that have been the main drivers of this rapid deployment of solar PV [8,9].

The direct proposal submission scheme entails proposals from the private sector to the government for large-scale electricity generation projects (renewables). If successfully approved, a Power Purchase Agreement (PPA) is awarded and the generated electricity is sold to the utilities for a set period of time. The competitive tendering process is similar, but it is the government who secures the land for development and the PPA is awarded via a competitive bidding process.

Such large-scale projects with the objective of selling back to the utilities are well on track for greater diffusion, with applications for direct proposal schemes flooding in, and the 3rd round of competitive tendering process is open as of 2013. However, this report, as mentioned in the introduction, focuses on the self-consumption market, that is, those who produce electricity for the purpose of their own consumption, not for selling to utilities or third parties. Within this market, the focus will be on the non-residential segment (commercial and industrial). The solar-PV self-consumption market in Jordan has great potential that is currently not being met. The following chapter will outline the current opportunities present and existing successful cases in this nascent market.

Table 1: Description of main supporting schemes for Solar PV self-consumption

Supporting Schemes for PV Generated Electricity for Self-Consumption

Net Metering

A billing mechanism that credits costumers for excess self-generated electricity they feed back into the grid. Each month the costumers pay the utility the net difference, on kWh basis, between what they consumed and what they fed back into the grid. If what they produced exceeds what they consumed, the excess is rolled over to the next month on kWh basis.

Characteristics of Jordanian Scheme

- Projects larger than 5 MW are unable to make use of the scheme.
- The size of the solar system making use of the scheme cannot exceed the consumer's average monthly consumption.
- In the case of electrical energy surplus production, the financial settlement is made at the end of the year at a price of 120 Fills/KWh.energy wheeling.

Energy Wheeling

The transfer of electricity through transmission and distribution lines from off-site generation to area of use for self -consumption.

The Jordanian wheeling regulation is applicable for projects regardless of size. A wheeling charge is paid to the relevant utility

2 High Potential for the Solar PV Self-Consumption Market

A high level of enthusiasm regarding solar PV in general was observed throughout various stakeholder interviews, focus groups, and roundtable discussions. In particular, an increasing interest in solar PV for self-consumption purposes was evident, given the many attractive opportunities it presents. For example, several schools and hospitals have either implemented or are in the process of implementing mid-size solar PV systems ranging between 10kw and 2MW [10]. A fresh food storage facility operator that was interviewed is in the process of installing a 2MW system to offset its high electricity bill [11]. Abu Darwish mosque has installed a 10kW system that has reduced its electricity costs by 80% [12]. For more details, see the case studies about these two examples below. The main drivers in the solar PV self-consumption market are characterized by: the supporting policy schemes in place, high electricity tariffs and a high solar potential.

2.1 Supporting Policy Schemes in Place

Jordan is one of few countries in the Middle East and North Africa (MENA) region that has a relatively comprehensive renewable energy policy in place. The Ministry of Energy and Mineral Resources (MEMR) has set a renewable energy target of 7% of Jordan's energy mix by 2015 and 10% by 2020 [13]. For renewable energy self-consumption, the government introduced the Renewable Energy and Energy Efficiency Law in 2012, which forms the basis for supporting schemes and other incentives (see table 1). The two main supporting schemes 'net metering' and 'energy wheeling' are outlined in the table below (see table 1). The energy wheeling regulation was only added in January 2014, with some details still in need of clarification. Therefore, there are yet to be any projects that make use of this scheme. The net metering scheme has seen more but limited diffusion – mainly limited to the residential and tertiary sector. There are currently no projects from the industrial sector making use of the scheme. However, as the schemes are fine-tuned and more success stories emerge, projects making use of these schemes should increase rapidly – interviews with various stakeholders have confirmed the demand and interest.

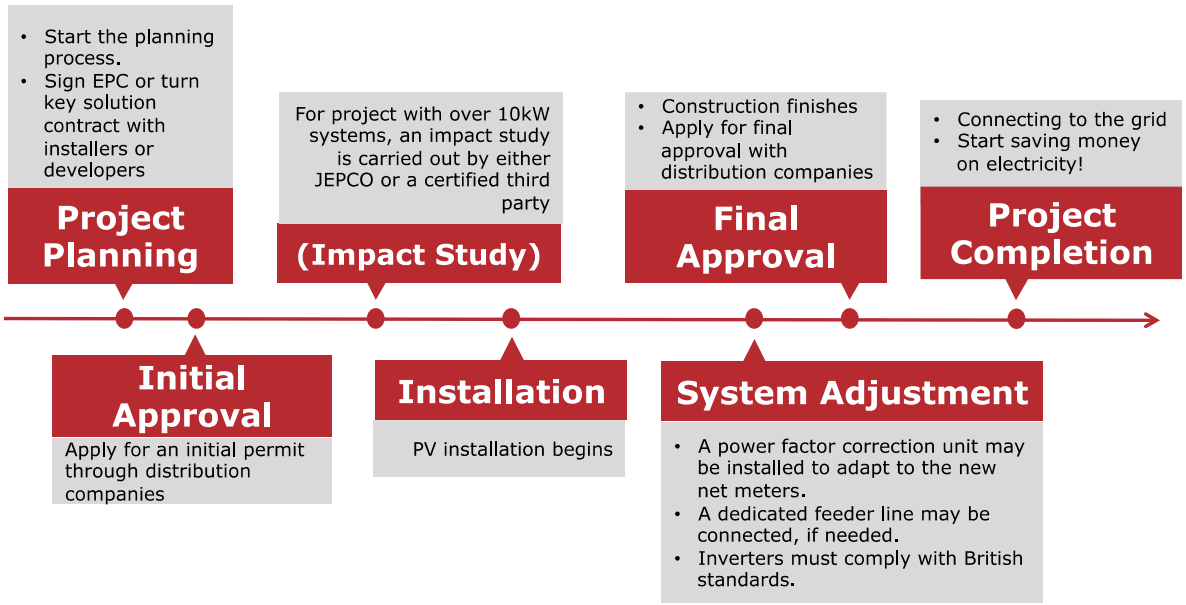
The following table includes a hypothetical example bill calculation to aid readers in understanding the main concepts of net metering implemented in Jordan. In order to calculate the net balance to be billed by the distribution companies, the electricity consumed is subtracted from the sum of the electricity generated and the electricity carried over from last month's surplus. If there is electricity surplus at the end of the calendar year, the customer can choose either to roll over the surplus or to get a refund for the surplus at the set rate of 0.12 Jordanian Dinar (JD)/kWh.

Table 2: Net Metering Bill Example

Month	Consumption	Generation	Last Month Carry-over	Net Balance	kWh Billed
January	1100 kWh	1000 kWh	0 kWh	-100 kWh	100
February	1000 kWh	1100 kWh	0 kWh	100 kWh	0
March	1200 kWh	1100 kWh	100 kWh	0 kWh	0
April	1100 kWh	1200 kWh	0 kWh	100 kWh	0
May	1200 kWh	1200 kWh	100 kWh	100 kWh	0
June	1300 kWh	1200 kWh	100 kWh	0 kWh	0
July	1400 kWh	1300 kWh	0 kWh	-100 kWh	100
August	1300 kWh	1400 kWh	0 kWh	100 kWh	0
September	1300 kWh	1300 kWh	100 kWh	100 kWh	0
October	1100 kWh	1200 kWh	100 kWh	200 kWh	0
November	1200 kWh	1200 kWh	200 kWh	200 kWh	0
December	1200 kWh	1100 kWh	200 kWh	100 kWh*	0

*The 100 kWh surplus at the end of the year can be ***either*** carried over to the next calendar year ***or*** paid back at 0.12 JD/kWh to customer as requested.

Finally, the following diagram showcases the various steps involved in which a consumer desires to make use of the net-metering scheme. Consumer first chooses an installer or developer that they desire to work with. An initial approval from the distribution companies is needed before installing the solar systems. An impact study is required for systems over 10kW. In order to get a final approval, system adjustment is needed to comply with regulatory standards, as illustrated in Figure 4. All inverters must comply with the British standards. A power factor correction unit may be needed to adapt the new meters. Some customers may require dedicated feeder lines, if they are installing systems that require higher voltage. After the final approval from distribution companies, the solar systems can then be connected to the grid.



It is important to note that on top of these two key supporting policy schemes, there are other incentives in place that can support Solar PV self-consumers. For example, systems and equipment of renewable energy sources are exempted from custom duties and sales tax, regardless of country of origin.

2.2 Case Studies

Fresh Fruits

Fresh Fruits signed an EPC contract with Trina Solar in February 2014, in which the Chinese solar company is responsible for the engineering, procurement, and construction of the 2 MW project for Fresh Fruits in Jordan. Construction is scheduled to begin in April 2014. The first mega-scale solar project in Jordan is expected to be completed and connected to the national grid by July 2014.

The project plans to install a 2.01 MW solar PV system on Fresh Fruits' warehouses. The system will cover two thirds of the company's overall electricity consumption. The total electricity consumption accounts for 6% of the total costs of the company. The project is estimated to produce 3.2 GWh per annum, preventing approximately 38,400 tons of carbon dioxide emissions.

Fresh Fruits had begun considering solar PV systems in 2011 as a solution to the company rising electric bills, even before the country's renewable energy regulation came in place in 2012. The payback period calculated at the time was not economically viable. With the net metering regulation, the payback period of the project is about 6 to 7 years. Fresh Fruits believes that this investment is beneficial to the company in the long run.

Fresh Fruits Company was established in 1997 and provides storage facilities and logistics services to the fresh fruit and vegetable industry in Jordan. The company provides a wide range of services including refrigerated and frozen storage, indoor and outdoor storage, packing and repackaging, e-Freight, transportation, and stock management.

Abu Darwish Mosque

The Abu Darwish mosque in central Amman installed a 10kW solar PV system on its rooftop in July 2013. The solar project was installed by the Shamsi Company, which started in June 2013. The 10kW system covers 80% of the electricity consumption of the mosque. The mosque is only paying 25 JD per month now instead of the annual 500 JD electric bill. The project is financed by the donation funds.

From the worshipers of the mosque, since the Abu Darwish mosque is not financially supported by the Jordanian Ministry of Awqaf and Islamic Affairs and Holy Places. Worshipers of the mosque are aware of the solar system which was widely publicized in the media. Currently there are about 7 mosques that have installed solar PV systems on their rooftops. Many stakeholders believe that the increasing flux of solar PV installations at mosques might influence other people to install PVs, which can be a positive indicator for the deployment of solar PVs in Jordan.

2.3 High Electricity Tariff Rates

Jordan has a relatively high electricity tariff rates, compared to other countries in the region. Even with government subsidies, Jordan's electricity prices for the residential sector are more than ten times higher than its oil-rich Arabian Gulf neighbors [14]. Moreover, the electricity tariff rates are especially high for the commercial sector, including banks, telecommunications, and retailers, with tariffs reaching EUR 0.28/kWh in 2013 [15].

Furthermore, all sectors except residential and agricultural are expected to experience annual increase between a 5.0% and 15% in electricity tariff rates from 2013 to 2017 [15]. Table 3 briefly outlines the lower and upper limits of selected sectors that are relevant to this report. A more detailed table for all Jordanian sectors and industries is attached in the Appendix with tiered electricity tariff rates.

Table 3: Electricity Tariffs Between 2013-2017 **(fils/kWh)**

Sector	2013	2014	2015	2016	2017
Residential Users					
1-160 kWh/month	33	33	33	33	33
501-600 kWh/month	114	114	114	114	114
>1000 kWh/month	235	259	271	285	296
Commercial Users					
> 2000 kWh/month	146	168	193	222	255
Banks	265	278	292	307	322
Telecommunication Companies					
> 2000 kWh/month	278	292	307	322	338
Small Industries Users (Uniform Tariff)					
> 2000 kWh/month	66	75	87	100	115
Hotels (Uniform Tariff)	146	168	193	222	255
Metallurgical Industries					
Peak Load (dinar/kW/month)	2.98	2.98	2.98	2.98	2.98
Day Supply	237	254	273	294	316
Night Supply	176	190	204	219	235

From the new electricity tariff rates announced by the Jordanian government, the commercial and extractive industrial sector will experience the highest increase in electricity prices, with almost 15% annual increase till 2017, on top of their existing high rates. Some industries have the capacity to move their operations overseas in order to keep their businesses competitive in the region [19]. However, for commercial sectors and extractive industries, increase in operating costs may have an adverse impact on their businesses [19]. Such dilemma makes it crucial for sectors with high electricity rates to seek new energy solutions such as solar PV.

2.4 High Solar Potential

Jordan is blessed with an abundant solar potential. 90% of Jordan has a desert climate with little precipitation and an average of 330 sunny days every year in Jordan [16]. The irradiation in the country ranges from 2200 kWh/m^2 – 2550 kWh/m^2, with the southern part of Jordan getting more direct sunlight on a regular basis. Many areas, including Ma'an, Irbid, Mafraq, and the Dead Sea valley, are suitable for solar plants, given that most of these areas are unoccupied desert habitats.

In comparison, Germany only receives a maximum direct sun irradiation of 1,200 kWh/m^2 [17], yet Germany is one of the highest users of solar PV in the world. A study by German Aerospace Centre suggests that the economic potential of PV in Jordan is 4.5 TWh/year that would constitute one third of current electricity demand [18]. This makes exploring solar energy options as a crucial element to Jordan's economic development.

3 General Barriers and Challenges

The following section addresses the identified general barriers that affect commercial and industrial scale self-consumers. These barriers may appear as discouraging but could be overcome relatively easily within the next few years with commitment and initiative from policy makers and key stakeholders.

3.1 Policy and Regulation

A solid, transparent and predictable policy framework is crucial for the diffusion of solar PV. From interviews and analysis, it became evident that there was confusion over policy interpretation and concerns over policy predictability amongst stakeholders. Furthermore, some consumer segments felt their needs were not adequately covered by existing policy.

3.1.1 Confusion over regulation interpretation

Not only was this prevalent in discussions involving various stakeholders, but also within the same organization. There is confusion over the net metering policy among different stakeholders. For example, many misunderstood the fact that the monthly surplus was rolled over on a kWh hour basis, not on a monetary basis [8, 19, 20]. There have been multiple cases in industry where confusion over the net metering policy lead to misinformed hesitation in investment [8,20]. In addition, some stakeholders had misunderstood other aspects such as the way in which the peak capacity charge was calculated for large industries [20].

3.1.2 Concerns over policy unpredictability

Various stakeholders voiced concerns over the unpredictability of the supporting schemes in place. Many brought up cases where a supporting scheme was suddenly changed – often having an adverse effect. For example, the fact that the purchasing price for the direct proposal scheme was lowered from the original promised price, and the fact that an additional impact study step was added to the net metering application process both added extra complications to the process [6, 8, 19, 20, 21, 22, and 23]. An executives of a large industrial company stated that he turned down a solar PV proposal, because he believed the supporting schemes were too volatile [19], bringing up the examples mentioned above. Large consumers who want to make use of the newly implemented energy wheeling policy also voiced their concerns over the possibility of a sudden increase in the wheeling charge in the future [22,23].

3.1.3 The policy 'grey-zone' for large consumers

Despite the increased interest from large-scale consumers for solar PV, current supporting policies do not adequately cover their needs and solar projects - which tend to be larger than 5MW.

Regarding the net metering scheme, the biggest issue is that projects over 5MW cannot make use of the scheme. In addition, it is quite unclear how the current net metering scheme will account for the day/night/peak capacity tariff structure that most large consumers pay [24]. This is not clearly indicated in any of the regulatory documents, and one utility company did not know how exactly they would adapt net metering to this tariff structure, as they had not had this case before [25].

The energy wheeling regulation is crucial for most large-scale consumers and projects. Energy wheeling allows for alternative distribution and business models, but the regulation does not adequately cover each of these specific circumstances [26]. For example, a large telecommunications company wanted to install a large centralized solar PV plant and distribute the electricity to thousands of telecom towers around the nation [23]. However, it was unclear to them how and if they would be covered by the energy wheeling regulation. Another example involved a hotel association which had everything in place: the motivation, the finance, permits, etc., to install a large solar PV plant and distribute electricity to the member hotels [22]. However, again it was unclear how the energy wheeling regulation would account for this 'collective model', and was the only bottleneck. Due to large consumers and projects being a policy grey-zone, a high impact (installed capacity, investment/job opportunity) and high potential segment is being excluded.

3.2 Financial and Economic

3.2.1 Difficulties in accessing financing

Even though the upfront cost per kW of installed solar panels in Jordan is low (EUR 1-1.5/W) [10], compared to international price levels, the cost is still significant for Jordanian consumers. This high initial investment requires access to substantial capital which has shown to be a challenge for all identified segments.

Financing options for deployment of solar PV for self-consumption within the private sector are limited to equity financing and/or bank loans while the public sector have access to public financing. Equity financing is an alternative or complement to a bank loan but most often less preferential for companies since equity holders require higher return on their investments. Public financing as an option is only available for the public sector and must usually be complemented with a bank loan. Since most upfront costs for solar PV projects for self-consumption are financed via debt, access to bank loans is crucial [19,27].

The first challenge related to bank loans for solar PV systems is the limited access to green loans. Two of the major commercial banks are offering preferential Green loans that have been made available through the French Agency for Development's Green credit line and Central Bank of Jordan's Green lending program. Via these lending programs, commercial banks are able to offer interest rates (4-5.5%) that are substantially lower than the average interest rates and tenures (10-13 years) that are longer than usual [27].
However, there are some limitations. The French Agency for Development requires that a minimum of 700,000 USD (0.5 million EUR) be withdrawn each time a commercial bank wants to make use of their Green credit line program [28]. If a bank client wants to borrow less than the minimum amount they have to be grouped together with other projects before the commercial bank can apply for the money at the French Development Agency. According to interviewed financial stakeholders, this requirement forms a barrier to providing green loans to small and medium size enterprises (SME's) [27]. The lending program provided by the Central bank is also more suitable for larger investments and has up until today mainly financed solar PV projects under the direct proposal scheme [27].

The second challenge relates to the inability of customers to meet the requirements for bank loans. Banks require in general that the payments are secured via a power purchase agreement (PPA) or inward letter of credit for large companies and collateral for SME's. They also require that a feasibility study has been conducted, that the qualification of the management of the company meet certain standards and that the company's balance sheets meet certain requirements [27]. The past year's downturn followed by the Arab spring has affected much of the industrial and commercial sectors that serve on the regional market, resulting in inadequate balance sheets to meet loan requirements. According to interviewed stakeholders, the overall requirements to obtain a bank loan in Jordan today are the hardest to meet for SME's [28].

Figure 6: Solar PV installation Sehatty resort. Dead Sea, Jordan. Photo: Emma Åberg, IIIEE.

The third challenge is associated with the limited knowledge on feasibility of renewable energy projects among banks. Limited knowledge about a certain technology or industry tends to create a more conservative approach in the evaluation of loan applications [27, 28].

3.2.2 Economic attractiveness

For certain sectors, solar PV is still not economically feasible, simply due to the fact that the cost of generating electricity through solar PV is higher or comparable to that of retail electricity. Since the cost of generation is relatively homogeneous across all sectors [15], it is the retail electricity prices that are the biggest determinant of feasibility. Certain sectors such as the metallurgical industry and agriculture still pay relatively low electricity tariffs [15], and find it more difficult to justify investing in solar PV from an economic standpoint. Even when electricity tariff rates are sufficiently high to render solar PV profitable, it can be overlooked due to relatively long payback periods [10]. From our interviews, payback periods range from 4 – 8 years for commercial and industrial projects depending on factors such as electricity tariff rates and facility size [8, 10, 11, 19]. The upper end of this range has proven to be too long for some potential consumers, particularly those who are vulnerable to changing contextual factors that may force them to move operations abroad [19].

Furthermore, solar PV investments are often compared to other electricity generating options, or even other general investments. In this case, the solar PV option may be overlooked due to longer payback periods or lower net-present value/returns when compared to other options. For example, a large industrial company was considering installing a large-scale solar PV plant for self-consumption, but dropped the proposal in favor of a co-generation plant that was more attractive in terms of payback period, net present value, and practical applicability (the excess steam could be used for one of the manufacturing steps) [19].

3.3 Technical and Physical

Technical and physical barriers exist in Jordan in the form of current grid capacity, building stock space issues, structural integrity of buildings and ownership structure of buildings.

3.3.1 Grid capacity

Grid capacity is crucial to the smooth deployment of solar PV particularly for larger scale projects such as those being proposed by commercial and industry sectors in Jordan. Stakeholders have stated that current grid capacity is insufficient for the load that is required for future self-consumption projects – particularly large wheeling projects [8, 22, 29]. Therefore, without grid capacity upgrades, projects will stall and investment in future projects is unlikely.

NEPCO is currently upgrading the grid capacity under the "Green Corridor" upgrade, scheduled to finish in 2017, which should adequately handle the additional load once completed. There is however skepticism from private sector stakeholders as to whether this deadline will be met. Uncertainty hinders the ability of companies to safely invest in solar PV projects [22,30].

Distribution companies such as JEPCO place the emphasis of the bottleneck on consumers. Projects connected to distribution lines may require new dedicated feeder line to be installed in order to support the larger electrical loads. Since the cost is borne by the consumer, the consumer may downgrade the project size to avoid bearing these extra costs. This often stalls projects, lessens the project size or can terminate projects completely [25].

3.3.2 Space and structural issues

Solar PV requires adequate space on roof or ground as well as structural integrity of buildings to be able to mount panels. Many sites lack space and structural integrity to support panel installation. Therefore, off site panel installation is often required, resulting in increased transaction costs of the projects and also installation costs, adding to already high upfront costs [10].

3.3.3 Quality control

The quality of modules, bracketing, inverters and installs is a key concern for Jordan's self-consumption solar PV market. Infant solar PV industries are susceptible to new market entrants offering inferior, low quality products to unaware consumers. This has an adverse impact on the trust and reputation of the industry and can hinder the growth of the industry if not controlled adequately, as people lose confidence in the technology.

Currently Jordan lacks any standards or guidelines for quality control of solar PV products and services [8, 20, 21, 31]. Even though the Jordanian PV market is relatively new, there are over 300 solar PV companies already registered due to the underlying potential of the market [6]. The infancy of the market makes it difficult to rate/rank current companies, and a lack of knowledge of consumers about differences in quality and efficiency makes it difficult to ascertain quality before installation is complete [8, 20, 21, and 31]. While some discussion has taken place about quality control issues, it still remains an underestimated issue within the industry. For example, some major Jordanian suppliers and manufacturers still do not see this as a potential problem [32].

3.4 Administrative

Internal administrative procedures such as bureaucracy and decision-making processes, and external administrative procedures within both regulation and financing add to the project install timeline. Within regulation, the net metering process requires an impact study to be carried out by a third party [10, 11, and 21]. This makes up the largest proportion of the pre-install phase of a project and can take up to five months. Within the financing process, feasibility studies are generally outsourced to third parties and are therefore time-consuming. The time lag between engaging with the client and the start of the installation makes it very difficult for retailers and installers to maintain client interest [21]. This also adds extra risk to the project if modules and parts are ordered from overseas to shorten the time line prior to final approval from a client [21].

Long internal decision making processes for sectors, such as schools, hospitals, and some large industries, delays project starts and adds risk to developers who must order stock ahead of time with no guarantee of an install timeframe [21, 27].

4 Segment Specific Barriers

In parallel to the identification of barriers, an analysis was conducted to determine which segment of consumers each barrier most significantly affected. Through this analysis, three distinct segments were identified: Large Private Consumers (medium/large industry, large hotels, telecommunication), Small Private Consumers (SME's, retail, restaurants etc.), and Social Sector Consumers (Schools and Hospitals). The table below gives a general overview of how each segment is affected by different barrier groups, and of key stakeholders who can help overcome these barriers.

Some key observations include:

- Technical and Physical barriers seem to affect all three segments uniformly.
- Large private consumers face comparatively higher regulatory and administrative barriers, while facing comparatively lower financial barriers.
- Small private consumers face comparatively lower regulatory and administrative barriers but face comparatively higher financial barriers.
- Social sector consumers face comparatively low regulatory and financial barriers, with only administrative barriers being a bottleneck. This sector has seen the most activity out of the three.

Table 4, Summary matrix of segment specific barriers

▲ Comparatively high barrier ● Comparatively low barrier

	Policy + Regulatory	Financial + Economic	Technical + Physical	Administrative
Large Private Consumers	**Grey- Zone** - 1> 5MW+Not Covered -structure of Tariffs -Energy wheeling unclear	**Easier access to capital** -Easier to meet requirements - Targeted green loans	Uniform	Relatively long internal decision making
Small private consumers	**Most needs covered** - < 5 MW covered - Energy wheeling not needed	**Difficulties accessing capital** -More difficult to meet requirements -Green loans not targeted		Relatively quick internal decision making
Social sector Consumers	Most needs covered - < 5 MW covered - Energy wheeling not needed	Easier accessing capital -Access to public financing -less stringent payback period requirements - Higher Tariffs		Internal decision making can be bottleneck
Uniform Barriers (Across Segments)	-Confusion over interpretation -Unpredictability		-Quality Control -Grid capacity -Structural/Space	Time consuming initial project setup
Key stakeholders	-Policy makers - Associations	- Financial sector - Policy Makers	- Utilities - Policy makers - Installers	- Utilities - Policy makers -Financial institutions

5 Key Recommendations

5.1 Clear up Confusion over Policy and Regulation

If the confusion over interpretation of the current policies and regulations continue, particularly regarding the net metering scheme, stakeholders will find it difficult to commit to solar PV investments, while misinformed investments will continue. Policy makers and utilities must make an effort to make supporting schemes as clear as possible. For example, with the most commonly misunderstood net metering scheme, the ERC and utilities could include specific examples of calculations or electricity bills on their website. Industry associations could also contribute – for example, by creating brochures that better explains policies and point out common misconceptions. They should also act as the interface for better communication between policy makers and the private consumers.

5.2 Adjust Policy to Account for Large Consumers

The policy grey zone for large consumers and projects is leading to the exclusion of a high impact potential segment – one that has a significant and increasing interest. Policy makers should act to update existing supporting schemes – particularly the net-metering and energy wheeling regulations – in order to better meet their needs. The 5MW capacity for net metering is problematic as most large industries; hotels, telecom etc. require facilities larger than 5MW to offset any significant amount of their consumption. The same limit applies for energy wheeling. Although NEPCO said that they would consider buying surplus production from facilities larger than 5MW on a case-by-case basis, this is not sufficient. There needs to be a written guarantee made in the legal documents. Furthermore, the energy wheeling regulation must be updated in order to specify how alternative distribution and business models that arise from energy wheeling will be accounted for by the regulation. Industry associations can play a crucial role by conveying the needs of the large consumers to the policy makers. For example, an industry association successfully lobbied for changing the maximum allowed installed capacity for net metering from 25% to 100% of average demand.

5.3 Target Green Loans at SME's

Access to capital is crucial to finance the high initial cost of solar PV systems. In our interviews with financial institutions it has been confirmed that SME's have significant difficulties in accessing bank loans in general and green loans in particular. Collateral requirements are usually the number one constrain followed by transaction costs, lack of familiarity with loan procedures, socio-cultural barriers and low profit margins [33]. All in all, many banks consider loans to SME's too risky because of this segments' inability to provide appropriate financial guarantees. This is a challenge in many countries and the most common and direct way to solve this issue, and encourage commercial banks to lend out money to SME's, is through guarantee schemes that share the risk of default. This is usually done via guarantee funds or guarantee associations which exist in more than 70 countries.

An available risk mechanism in Jordan is the majority state-owned Jordanian Loan Guarantee [34]. It is to the authors of this report unclear how this mechanism supports commercial banks in providing green loans to SME's. It is nevertheless considered necessary that this is being investigated and that a strategy for future credit guarantee schemes is being developed by concerned stakeholders such as banks, other financial institutions and policy makers.

In addition to this, both existing green lending programs under the Central Bank of Jordan and AFD, must be adapted to better account for SME's by imposing less stringent requirements.

5.4 Address Quality Concerns

Without adequate quality control, the solar PV market in Jordan is at risk of becoming flooded with unreliable products and installations. This has the potential to set the growth of the industry back years if consumers lose confidence in the technology. Policy makers, industry associations, current retailers and manufacturers need to be involved in the establishment of a rating system for inverters, modules and installations to avoid a situation that many other infant solar PV markets have been through previously.

The example below gives a brief outline of quality control rating system introduced in Australia as a way for consumers to identify and differentiate between solar module products.

Quality control example – Australia

While Australia's solar PV market is now relatively well developed it encountered quality issues that Jordan must avoid. The market was flooded with poor quality products which adversely affected the trust and growth of the industry. Australia now has a well-developed ranking system for suppliers based on 3 tiers shown below

[37]. This gives consumers knowledge and confidence in products they purchase. Consequently, they are able to avoid inferior products and low tier manufacturers are forced out of the market.

This system does not automatically control the product range within the country and it is still crucial for customers to be educated about how systems should operate so they are able to determine if their system is sub-standard. Tier 3 panels often suffer from accelerated degradation and may not last the expected life-span of a solar panel of 25 years. Within Australia the current market still suffers from many tier 3 products entering market at low prices. While tier 1 and tier 2 panel based systems are initially slightly more expensive, they will continue to operate at higher output capacity's for the entire life span more than making up for the initial difference.

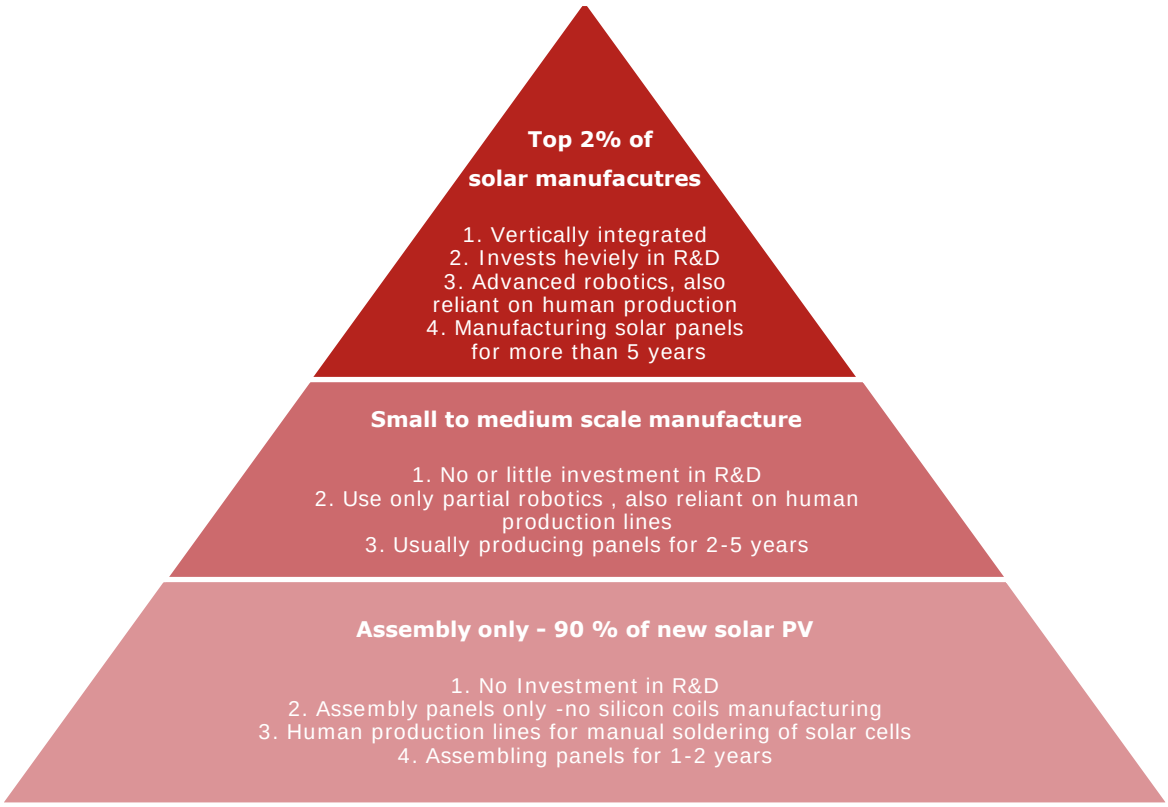


Figure 7 Australian Quality Tier Systems Source: Information from Pike Research

5.5 Promote Third Party Ownership

One way to address several of the barriers identified in this report would be to allow for and promote third party ownership business models. Such models have shown to be successful in overcoming many of the key barriers to deployment of solar PV in countries such as the United States and Singapore [33,34].

There are two types of third party business models operating on the PV market in other countries today. These are the Leasing model and the Power Purchase Agreement model (PPA).

5.5.1 Leasing model

Under the leasing model, customers pay a monthly fee to the retailer for leasing of a solar PV system. The leased system can be used in whatever way desired by the customer. If the system can be connected to a grid and make use of a feed-in-tariff or net-metering scheme, this benefits the customer directly.

This model has a number of advantages that have made it viable and popular in other countries particularly for larger industrial and commercial users:

- High upfront costs are born by the retailer, therefore beneficial for businesses that may have difficulty in accessing credit to pay for a system upfront. This also benefits suppliers of high quality modules

and installations as they are able to overcome the higher upfront cost of their systems which addresses the quality concerns discussed above.

- The maintenance and risk of the system not operating is created by the retailer. If the system does not operate correctly, the customer is able to stop making their lease payments under a performance contract which also addresses quality concerns.
- The retailer realizes a regular cash flow over the lifetime of the panels.
- Hassle factor, which refers to the unwillingness and/or lack of competence to handle planning, installation etc. is covered by the installation company.

A leasing model would be possible in Jordan under current regulation. Leasing as a type of business model is in fact very well established for other type of products and most banks in Jordan have close cooperation's with leasing companies.

5.5.2 Power Purchase Agreement (PPA) model

This type of third party business model is similar to the leasing model in the way that a third party owns the solar PV system that the end-customer is making use of. The difference is that the customer is buying their electricity generated by the solar PV systems from the company owning the panels, instead of buying electricity via the utility. The tariff is usually fixed and the total electricity bill ends up being lower than if the customer would buy their electricity from the grid. The customer usually "hosts" the panels on his rooftop but does not have to take care of maintenance or faults. Whatever feed-in-tariffs or net-metering schemes the system can make use of benefits the company and not the customer.

The model has a number of advantages. Additional to benefits mentioned for the leasing model the PPA model with its fixed electricity cost, also provides price security and cost predictability for the customer.

The PPA model is not possible in Jordan today since third party sale of electricity is not allowed under current legal framework [24].

Stakeholders in Jordan have indicated a high demand for both type of third party business models, especially among large-scale industries and certain commercial branch associations. Many larger electricity consumers are reluctant to become power producers and want to focus on their core business instead [6,31]. Others, such as the hotel association, want to invest in centralized solar PV systems that support multiple legal identities within the same branch [22].

Stakeholders such as policy makers, associations, solar businesses and potential consumers must come together and 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.

6 Final Remarks

Jordan's potential to be a regional leader in the PV market should not be understated. In a short period of time, the market has been enabled through effective regulations and increased industry knowledge and passion. This enabled the market transformation from being non-existent to being on the edge of a significant growth. The above findings, analysis and recommendations show that the barriers currently hindering market transformation can be overcome relatively easily, which can enable a significant, sustainable development for the industry.

7 References

[1] NEPCO. (2012). Annual report 2012. Retrieved on 2014-03-28 from: www.nepco.com.jo/store/docs/web/2012_en.pdf

[2] Enerdata. (2013). Jordan Energy Report.

[3] Clean Energy Pipeline. (2013). An analysis of investment opportunities in Jordan's renewable energy sector. Retrieved on 2014-03-28 from http://images.cleanenergypipeline.com/Documents/2013/11/1_febbcbbd-672e-4aa5-a73d-01229a44764c.pdf

[4] ERC. (2009). Energy sector in Jordan. Retrieved on 2014-03-28 from: http://www.naruc.org/International/Documents/TheEnergySectorInJordan.pdf

[5] Energypedia. (2014). Jordan energy situation. Retrieved on 2014-03-28 from: energypedia.info/wiki/Jordan_Energy_Situation

[6] Interview with CEO, an industry association, 2014-04-06

[7] RCREEE. (2013). Arab Future Energy Index AFEX 2013 Renewable Energy. Retrieved on 2014-03-28 from http://www.rcreee.org/sites/default/files/reportsstudies_afex_re_report_2012_en.pdf

[8] Workshop with MANSUR students at Jordan University. 2014-04-07

[9] Stevens, S. & Norman, M. (2013). Jordan Annouces Round 3 of Direct Proposals Process for Renewable Energy. Project Finance News. Retrieved on 2014-04-06 from http://www.pfnewswire.com/2013/11/jordan-announces-round-3-of-direct.html

[10] Interview with COO, a solar PV developer, 2014-04-06

[11] Interview with general manager, a retailer, 2014-04-09

[12] Study visit to Mosque Abu Darwish. 2014-04-13

[13] Ministry of Environment. (2013). The National Climate Change Policy of the Hashemite Kingdom of Jordan 2013-2020. Retrieved on 2014-03-28 from: http://arabstates.undp.org/content/rbas/en/home/library/Env_Energy/publication_12/

[14] Bassam Fattouh. (2010). Energy Subsidies in the Middle East. Conference presentation, Geneva, Switizerland. Retrieved on 2014-03-28 from http://www.iisd.org/gsi/sites/default/files/ffs_gsiunepconf_sess3_bafattouh.pdf

[15] RCREEE. (2014). Electricity tariffs. Internal data. Retrieved 2014-04-08

[16] Climate Parliament. (n.d.). Renewable Energy in Jordan. Retrieved on 2014-03-28 from http://www.climateparl.net/cpcontent/Publications/130502%20Climate%20Parliament%20Renewable%20Energy%20Jordan%20Overview.pdf

[17] Solar World Innovation. (n.d.). Germany a country full of sun. Retrieved on 2014-03-28 from http://www.sw-innovations.de/en/solar-power/solar-radiation-map/

[18] DLR. (2005). MED CSP - Concentrating Solar Power for the Mediterranean Region. German Aerospace Centre, Germany.

[19] Interview with CEO, a large industrial company 2014-04-08

[20] Roundtable hosted by RCREEE andThe Network for Jordanian Industrial sustainability. 2014-04-09.

[21] Interview with a partner of a solar PV developer, 2014-04-09

[22] Interview with chairman, an hotel association, 2014-04-09

[23] Interview with a project manager, a telecommunications company, 2014-04-09

[24] Law No. (13) Of 2012 Renewable Energy & Energy Efficiency Law. Ministry of Energy and Mineral Resources. Retrieved on 2014-03-28 from http://www.memr.gov.jo/LinkClick.aspx?fileticket=vblQv7AybK8%3D&tabid=253

[25] Interview with a manager of a distribution company, 2014-04-10

[26] ERC. (2014). Energy Wheeling Regulation. Orally translated from legal text by RCREEE.

[27] Interview with head of investment division, a commercial bank, 2014-04-09

[28] Interview with an officer, a foreign development agency, 2014-04-10

[29] Interview with the head of a government agency, 2014-04-07

[30] Interview with a manager of an industry association, 2014-04-10

[31] Final presentation and roundtable discussion hosted by RCREEE and NEPCO. 2014-04-14.

[32] Interview with Business Development Manager, a solar PV developer, 2014-04-06

[33] Barhenhol, B. (2006). Access to Finance: The Place of Risk Sharing Mechanisms. Retrieved on 2014-05-23 from http://info.worldbank.org/etools/docs/library/235440/Balkenhol_RiskSharingMechanisms-final_8-10-06.pdf

[34] Saadani, Y., Arvai, Z,. & Rocha, R. (2010). A Review of Credit Guarantee Schemes in the Middle East and North Africa Region. Retrieved on 2014-05-23 from http://blogs.worldbank.org/files/allaboutfinance/MENA%20Flagship%20Credit%20Guarantee%20Schemes%20Final.pdf

[35] Drury, E., Miller, M., Macal, C. M., Graziano, D. J., Heimiller, D., Ozik, J., & Perry IV, T. D. (2012). The transformation of southern California's residential photovoltaics market through third-party ownership. Energy Policy , 42 , 681–690.

[36] Coughlin, J., & Cory, K. (2009). Solar Photovoltaic Financing : Residential Sector Deployment Solar Photovoltaic Financing : Residential Sector Deployment, (March).

[37] Pike Research (Navigate Research). (2012). Building Integrated Photovoltaics. Retrieved on 2014-04-14 from http://www.navigantresearch.com/research/building-integrated-photovoltaics

8 Appendix: Detailed Jordanian Electricity Tariff Rates

Electricity Tariffs Between 2013-2017

Sector	2013	2014	2015	2016	2017
	(fils/kWh)	(fils/kWh)	(fils/kWh)	(fils/kWh)	(fils/kWh)
1. Residential Users					
1-160 kWh/month	33	33	33	33	33
161-300 kWh/month	72	72	72	72	72
301-500 kWh/month	86	86	86	86	86
501-600 kWh/month	114	114	114	114	114
601-750 kWh/month	141	152	163	175	188
751-1000 kWh/month	168	181	194	209	224
>1000 kWh/month	235	259	271	285	296
2. Conventional Users					
1-160 kWh/month	36	40	44	48	53
161-300 kWh/month	79	87	96	105	116
301-500 kWh/month	95	104	114	126	139
501-600 kWh/month	125	138	152	167	184
601-750 kWh/month	152	163	175	188	202
751-1000 kWh/month	176	185	194	204	214
> 1000 kWh/month	247	259	272	286	300
3. Radio and Television (Uniform Tariff)	140	161	186	213	245
4. Commercial Users					
1-2000 kWh/month	105	120	138	159	183
> 2000 kWh/month	146	168	193	222	255
5. Banks					
1-2000 kWh/month	265	278	292	307	322
> 2000 kWh/month	265	278	292	307	322
6.Telecommunication Companies					
1-2000 kWh/month	238	250	263	276	290
> 2000 kWh/month	278	292	307	322	338
7. Small Industries Users (Uniform Tariff)					
1-2000 kWh/month	57	66	75	87	100
> 2000 kWh/month	66	75	87	100	115
8. Medium Industries Users					
Peak Load (dinar/kW/month)	3.79	3.79	3.79	3.79	3.79
Day Supply	72	83	96	110	127
Night Supply	61	70	81	93	107

9. Agricultural Users (Uniform Tariff)	60	60	60	60	60
10. Agricultural Users (ToU Tariff)					
Peak Load (dinar/kW/month)	3.79	3.79	3.79	3.79	3.79
Day Supply	59	59	59	59	59
Night Supply	49	49	49	49	49
11. Water Pumping (Uniform Tariff)	76	87	100	115	133
12. Hotels (Uniform Tariff)	146	168	193	222	255
13. Hotels (ToU Tariff)					
Peak Load (dinar/kW/month)	3.79	3.79	3.79	3.79	3.79
Day Supply	133	153	176	203	233
Night Supply	117	135	155	178	205
14. Street Lighting (Uniform Tariff)	92	106	122	140	161
15. Jordanian Armed Forces (Uniform Tariff)	118	136	157	180	207
16. Ports Sector (Uniform Tariff)	129	148	170	196	225
17. Large Industrial Users					
A. Metallurgical Industries					
Peak Load (dinar/kW/month)	2.98	2.98	2.98	2.98	2.98
Day Supply	237	254	273	294	316
Night Supply	176	190	204	219	235
B. Other Industries					
Peak Load (dinar/kW/month)	2.98	2.98	2.98	2.98	2.98
Day Supply	108	124	143	164	189
Night Supply	87	101	116	133	153
18. Agricultural/ Commercial Mixed Tariff	90	100	112	126	142