IIIEE Theses 2014:14

Solar Power in the MENA Region

الطاقة الشمسية في منطقة الشرق الأوسط وشمال أفريقيا

A review and evaluation of policy instruments for distributed solar photovoltaic in Egypt, Palestine and Tunisia

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Thesis for the fulfilment of the
Master of Science in Environmental Management and Policy
Lund, Sweden, September 2014

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Published in 2014 by IIIEE, Lund University, P.O. Box 196, S-221 00 LUND, Sweden,
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ISSN 1401-9191

Acknowledgements

I would like to express my warmest gratitude to my main supervisor Lena Neij and my co-supervisors Alvar Palm and Tareq Emtairah. Your professional support and encouragement have made this period of thesis writing an instructive and very exciting time. I am impressed and inspired by your expertise on the topic and I highly appreciate the priority that you have given to this project.

I would like to thank RCREEE for suggesting the overall topic and giving me the opportunity to write this thesis in collaboration with you. A special thanks to Hind Il Idrissi for making my interview travel in the MENA region an amazing and unforgettable time. I am also very greatful to all interviewees that have shared their important and interesting knowledge with me.

Last but certainly not least, Batch 19 at IIIEE. We have shared so many memorable experiences during the year in Lund and I will miss you all deeply. A special thanks to the persons that made the summer of thesis writing to such a nice and joyful time. To Lele for the time you have spent reviewing and commenting on my work - you are great! To Nathalie, Steinar and Erika for bringing humour and sunshine to the IIIEE library and Study room 1. To Matt for being a great travel mate and surf teacher.

Thank you all!

Emma

Abstract

The MENA (Middle East and North Africa) region enjoys a high availability of clean renewable energy sources, especially solar. In recent years, several countries within the region have introduced policy instruments to encourage the deployment of distributed solar photovoltaic (PV). This thesis reviews and evaluates policy instruments adopted in Egypt, Palestine and Tunisia. The experiences from these three countries suggest that policies, in order to be successful, have to be carefully chosen and designed according to each country's institutional capacity and contextual background. Tunisia stands out as the lead country based on its successful Prosol Elec program, which combines a net metering scheme with a financial mechanism. The program is both the most effective in terms of installed capacity as well as highly suitable in its institutional context. Palestine, on the other hand, introduced a feed-in tariff that was effective but highly inappropriate based on the country's economic constraints. Egypt has adopted a net metering scheme and, in contrast to the situation in Palestine, its effectiveness is projected to be low while its institutional feasibility is deemed moderate.

The project is conducted under the supervision of RCREEE (Regional Center for Renewable Energy and Energy Efficiency), who is involved in setting the objectives of the study and facilitating stakeholder contacts in the MENA region.

Keywords: Solar Photovoltaic, MENA, Policy instrument, Feed-in tariff, Net metering, Subsidy.

Executive Summary

This thesis reviews and evaluates policies for distributed solar photovoltaic (PV) deployment in the Middle East and North Africa (MENA). The focus is on a group of countries that have seen a relatively advanced policy development within this area; namely Egypt, Palestine and Tunisia. The problem addressed in this study concerns the limited amount of information that exists on distributed solar PV policies in the MENA region. Secondly, it relates to the challenging task of designing policies that effectively encourage solar PV deployment in specific contexts. Consequently, key objectives of the study are to provide a better understanding of adopted policies, evaluate their performances and discuss their suitability for specific contexts.

In order to deliver these objectives the author undertook three in-depth case studies based on thorough literature review and twenty-five interviews with stakeholders in the region, including energy ministries, electricity regulatory commissions, electricity producers and distribution companies, solar PV installers and financial institutions. For the evaluation of policy instruments a simplified multi-criteria analysis has been conducted. After an extensive literature review and in accordance with the objectives of the paper, data availability, resources, and stakeholder perspective, the following two criteria have been selected for the analysis: *Effectiveness* and *Institutional feasibility*.

Presented below are the main results from the three case studies:

- **Egypt** has adopted a *net metering* scheme that targets residential customers with high-level electricity consumption. The policy has not yet been implemented but its potential effectiveness in terms of installed capacity is predicted to be low. In order for the net metering scheme to be successful, it would need to be combined with either a significant increase of electricity tariffs (which is not likely in the short term), or a subsidy in form of a grant or rebate. The institutional feasibility of a net metering scheme in Egypt looks promising given that distribution companies are open for capacity building.

- **Palestine** adopted a *feed-in tariff* scheme that was running for a short period before it was interrupted in the end of 2013. The scheme targeted the residential sector and was effective in reaching a fast deployment rate. Nevertheless, the FiT was highly unfeasible from an institutional perspective in which economic resources to finance the scheme were missing. Palestine has the highest electricity retail prices in the MENA region and is likely to reach PV grid-parity soon, this contextual factor should make the country suitable for a net metering scheme, which is less costly than a FiT.

- **Tunisia** is running a *net metering* scheme combined with a *rebate*. These two policy instruments in combination with a preferential bank loan have shown to be very successful in reaching a high deployment within the residential sector. Both effectiveness and institutional feasibility are high. However, the combination of policy instruments appears to be insufficient to stimulate deployment within the industrial and commercial sector. Lower electricity prices and the unavailability of the preferential bank loan are likely to be the reasons for the lower deployment rate within this sector.

In addition to the specific results from the case studies, a number of general insights were drawn from the overall study. First of all, policies, in order to be successful, have to be carefully chosen and designed according to a country's *institutional capacity* and *contextual background*. As concerns *institutional capacity,* in the countries under examination, the result

shows that the administrative capacity to handle adopted policy instruments is rather good. However, increased consideration must be taken in relation to a country's economic ability to finance a specific policy instruments. Regarding the importance of the *contextual background*, a number of factors seem particularly influential on the deployment rate and the effectiveness of policy instruments in the three countries. These factors are listed below:

- **Electricity retail tariffs:** countries (and sectors) with the highest tariffs have seen the highest levels of solar PV deployment. According to simplified estimations, Palestine and Tunisia are both close to rooftop PV grid-parity.

- **Availability of financing:** in situations in which policies have been combined with "green" loans to support the high upfront cost of a solar PV system, deployment has been higher. Such loans are available for the residential sector in Tunisia and for all sectors in Palestine.

- **Availability of (rooftop) space:** is a physical challenge that constitutes a barrier for deployment of distributed solar PV in all countries. Tunisia has addressed the problem by adopting a *Wheeling* decree; it is yet unclear how this decree can be combined with policy instruments for distributed solar PV.

- **Attitude of distribution companies:** is seen as one of the barriers for large-scale deployment of distributed solar PV. Distribution companies seem to be concerned over a potential loss of revenues.

The aim of the study was to provide a better understanding of the solar PV policy situation in the MENA region. It is however questionable whether the results from the different case studies and the overall research can be generalised to the whole region. Nevertheless, findings and conclusions should be of great interest for countries with similar institutional characteristics and contextual backgrounds. To validate the findings in this thesis, it is necessary to compare the results with those of other studies using similar approaches. However, to the knowledge of the author, few other studies have been published on this topic.

Based on the results in this study the main recommendation to policy makers in the MENA region is *not to underestimate the importance of choosing and designing policies that meet the country-specific institutional constraints*. A policy that has been adopted and implemented successfully in one country might as well fail in another context.

Since this is an initial study of an unexplored subject, many ideas for further research have developed during the course of the thesis. One suggestion is to evaluate whether it would be possible to replicate the Tunisian scheme (Prosol Elec) in other countries in the region. Another topic that requires additional research relates to grid-connected solar PV systems in countries with frequent power outages. A third suggestion concerns the risk of overcompensation through excessive subsidies. Country-specific LCOE-estimates are essential to avoid such scenario.

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Abbreviations

ANME	Agence Nationale pour la Maîtrise de l'Energie/National Agency for Energy Conservation
AFEX	Arab Future Energy Index
CDM	Clean Development Mechanism
CO2	Carbon Dioxide
CSNER	Chambre Syndicale National des Energies Renouvelables
CSP	Centralised Solar Power
EGP	Egyptian Pound
EEHC	Egyptian Electric Holding Company
EgyptERA	Egyptian Electric Utility and Consumer Protection Regulatory Agency
EUR	Euro
FIT	Feed-in Tariff
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GW	Giga Watt
IEA	International Energy Agency
ILS	Israeli Shekel
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
JEDCO	Jerusalem District Electricity Company
kW	Kilo Watt
kWh	Kilo Watt Hour
kWp	Kilo Watt Peak
LCOE	Levelised Cost of Electricity
MAD	Moroccan Dirham
MASEN	Moroccan Agency for Solar Energy
MENA	Middle East and North Africa
MoEE	Egyptian Ministry of Electricity and Energy
MW	Mega Watt
NREA	New Renewable Energy Agency
ONEE	Office National de l'Electricité et de l'Eau Potable/National Office for Electricity and Water Supply
PEA	Palestinian Energy Authority
PEC	Palestinian Energy and Environmental Research Centre
PERC	Palestinian Electricity Regulatory Council
PV	Photovoltaic
RE	Renewable Energy
REN21	Renewable Energy Policy Network for the 21st Century
RCREEE	Regional Center for Renewable Energy and Energy Efficiency

SEDA	Solar Energy Development Association
STEG	Société Tunisienne de l'Electricité et du Gaz/Tunisian Company of Electricity and Gas
STEG RE	STEG Renewable Energy
SWH	Solar Water Heater
TGC	Tradable Green Certificate
TND	Tunisian Dinar
TOU	Time of Use
WTO	World Trade Organization

1 Introduction

This Chapter begins by presenting background and significance of this thesis. It focuses on the need for an energy transition in the MENA region, solar PV technology as a suitable option in such transition, and the importance of public policy to encourage deployment. To justify the choice of topic and specify the aim of the thesis, the background is followed by a problem definition, description of objective and defined research questions. Last but not least, this introduction includes a description of the scope and limitations as well as the audience that this study targets.

1.1 Background

1.1.1 The need for an energy transition in the MENA region

The global dependency on fossil fuel is associated with many challenges and the need for a transition to alternative and sustainable sources of energy has been on the international agenda since the first oil crises in the 1970s (Yamba et al., 2011; Sarzynski, Larrieu, & Shrimali, 2012). Since energy and climate security are two of the most powerful motives for the transition to alternative sources of energy, the energy debate has focused on what energy alternatives that can be considered reliable, reasonably priced and environmental friendly. While the opinions on suitable alternatives vary, major international actors such as the Intergovernmental Panel on Climate Change (IPCC), the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA), argue that renewable energy (RE) sources, such as solar, wind, biomass, and small-scale hydro, play a critical role for energy security and for the mitigation of greenhouse gas emissions and climate change (Moomaw et al., 2011).

As a consequence of the oil crises, most countries in the world started RE research and development programs which involved industry and universities (Balaya et al., 2011). In addition, a handful of pioneering countries, such as Germany, Denmark, Spain and the US, managed to create early markets that have been crucial for the last decades expansion of RE (REN21, 2014). The Middle East and North Africa, which is the geographical region of focus for this study, has historically seen a very low grade of investment and uptake of RE technologies (Griffiths, 2013). However, a dramatically changed energy situation have contributed to an increased interest in alternatives to domestic oil and gas consumption, and RE markets, in the MENA, have evolved rapidly in recent years.

The objectives for an energy transition to RE sources in the MENA region are related to a number of key factors such as: a major energy demand growth (power demand growth by between 3% and 8% annually) due to population increases, urbanisation and economic progress; and energy security enhancement (REN21, 2013). Energy security has gained increased attention in the aftermath of the Arab spring and the political instability prevailing in the region. Although a lot of the world's crude oil and natural gas reserves are located in this region, most countries do not have any possession of such resources. Of the three countries (Egypt, Palestine and Tunisia) that are included in this study, each is more or less dependent on fuel imports and have seen continuous disruptions and increased energy prices during the last years (IRENA, n.d.). Reducing this dependency and creating a diversity of energy supply is therefore one of the most important factors behind an energy transition. The objective to secure the countries internal energy supply has lately taken focus from cooperation projects such as Desertec and the Mediterranean Solar Plan, which aim to connect the electricity markets between EU and parts of the MENA region in order to enable renewable electricity export from MENA to the European Union (MASEN, personal communication, May 29, 2014).

Climate change as an objective for an energy transition in the MENA region is mainly related to the fact that developed countries that are parties of the Kyoto protocol have the possibility to reach part of their binding climate targets through investments within the framework of the so called Clean Developing Mechanism (CDM). CDM projects allows for developed countries to implement emission-reduction projects, such as solar PV installations, in developing countries and account for these reductions to meet their own emission targets. The countries in the MENA region are considered developing countries and have for this reason no binding targets under the Kyoto protocol, instead they have attracted some RE investments in order to reduced emissions for other countries (UNFCCC, n.d.).

Other objectives for the energy transition to RE sources in the MENA region are associated with job creation and the fostering of local and regional innovation and industrial development. From this point of view solar PV remains one of the most dynamic RE technologies and accounted for 2.3 million jobs globally in 2013 (IRENA, 2014a). While manufacturing remains on a fairly stable level, installation jobs all over the world are increasing. Most of the manufacturing jobs were, in 2013, concentrated to China (IRENA, 2014a). To the knowledge of the author, no evaluations on job creation in the MENA region have been done up to date.

1.1.2 The solar PV technology

Solar photovoltaic (PV) is a RE technology that has seen a dramatic development during the last decades. Globally, it is by far the fastest growing energy technology thanks to a rapid increase in efficiency as well as reduced module cost (Boyle, 2012; IPCC, 2011; REN21, 2014). According to Renewable Energy Policy Network for the 21st Century (REN21) (2014), the annual average growth rate of solar PV installation in the MENA region, was at least 112%, between 2008 and 2011. Although the share of solar PV represents a relatively modest share of the overall electricity generation, all countries in the region use solar PV to meet part of the electricity demand (REN21, 2013) and solar PV has played a particularly important role in the electrification of rural areas in the region. Nevertheless, the total installed capacity of solar PV is still negligible compared to other regions. According to IEA (2014), the installed capacity of solar PV grew by an estimate of 37 GW in 2013 and the total installed capacity is now exceeding 100 GW globally. Large portions of this amount are concentrated to a handful of countries, namely Germany, China, Japan and the US. However, with its high solar irradiation and large areas of unfertile land, the MENA region is particularly suitable for Solar PV electricity generation.

The solar PV technology generates power through the direct conversion of solar energy into electricity (Boyle, 2012) and the potential efficiency of this process depends on, among other things, the absorber material of the PV panel and the amount of sunlight that reaches it. The most common absorber today is a crystalline solar cell followed by thin film solar cell. Crystalline solar cells are generally more efficient than thin film solar cells, but are also more expensive (Boyle, 2012). Both technologies are used in different types of applications. These applications are commonly classified in two categories; grid connected applications and off-grid applications. The grid-connected applications are, just like it sounds, connected to the electricity grid, while the off-grid applications work as stand-alone systems. Off-grid systems have usually been applied in remote areas far from the grid. Such systems are suitable for e.g., telecommunication towers, rural health care centres, recreational cottages, rural households and villages – everywhere where grid connection or other power generation alternatives are considered too expensive. Moreover, because of the price drop of solar panels and its ability to compete economically with traditional energy sources, the last years have seen a rapid deployment of solar PV on residential, commercial and industrial buildings also in urban areas (Arvizu et al., 2011).

Solar PV can further be divided into distributed and centralised solar PV. Distributed solar PV consists of smaller PV systems that are mounted on rooftops or on ground. They are connected to a specific user that either uses the electricity itself or feeds it into the grid. A distributed system for a household is usually between 1-10 kW and for a commercial or industrial user, from 10kW up to one or several MW. The other category of grid-connected solar PV is centralised systems, usually over 1 MW in capacity, which have the same function as any other power plants. Such systems provide electricity to be fed into the grid or to be sold to a third party (Balaya et al., 2011). A number of large PV plants are now in operation in countries like Germany, Italy, US and Canada. The learning curve is steep and costs are thus rapidly decreasing, allowing large-scale PV technology to become cost-competitive. As a result of that, the world's first unsubsidised solar PV plant was built in Chile during 2013 (IEA, 2014). A number of PV plants are also under construction in the MENA region.

The cost of energy from solar PV consists of a combination of the capital cost including interest for repayment and the maintenance and operational costs. The capital cost in turn comprise both the cost of the PV panels themselves and the balance of system cost. The latter includes all costs connected to the installation such as mounting, cables, inverters, land and foundation costs. Compared to other energy sources, both renewable and traditional, the maintenance and operational cost for a solar PV system is very low (Balaya et al., 2011; Schleicher-Tappeser, 2012). The capital cost on the other hand is relatively high even though it has gone down significantly during the last decades. Between 2008 and 2012 the global average price of solar PV modules per kW decreased by 80 per cent, from 3.08 EUR[1] (3.98 USD) per W to 0.61 EUR (0.79 USD) per W. In 2013, the prices remained fairly stable (IEA, 2014). Solar PV is said to be cost-competitive when it reaches the so-called "grid-parity". Grid-parity is when the cost per generated kWh from a solar PV system is in parity or cheaper than the end-users kWh-price from the conventional utility supplier (Balaya et al., 2011; Eclareon, 2014). This will be furthered discussed in section 5.1.2.

In addition to what has been mentioned above, solar PV is one of the most fast growing RE technologies thanks to its many benefits. First of all the abundance of its energy source and the fact that it is more or less pollution free, at least in the operation phase. The panels require low and simple maintenance and have an effective lifetime of 25 to 30 years (Christoforidis, Chrysochos, & Hatzipanayi, 2013). Solar PV can be used for everything from small-scale, stand-alone electricity supply in remote areas, to back-up systems, to large-scale utility generation integrated with the overall electricity system. The factor that limits the use of solar PV is that it depends on a cyclical time-dependent energy source. For this reason, solar PV systems require some sort of backup, either via a battery system or through a supplementary power source (Singh, 2013).

1.1.3 The relevance of solar PV policy instruments

Even though the economic feasibility and competitive advantages of solar PV systems look better than ever before, there are still a number of barriers that hold back the deployment rate. Such barriers include the comparably high up-front cost, technical complexity, financial viability (Coughlin & Cory, 2009), as well as a lack of electricity regulatory structures, complex grid access laws and permitting procedure (Arvizu et al., 2011).

Nevertheless, through appropriate policy design, many governments have shown that they can help overcome barriers, that could not be addressed by private organisations, and move the solar PV deployment forward (Arvizu et al., 2011). Some groups might argue that

[1] Currencies have been converted to EUR through XE.com during september 2014 (if nothing else has been specified).

governmental intervention is unnecessary and that any innovation that is good enough should manage to penetrate the market alone, for example through new innovative business models or technological development to make the innovation more competitive. This statement, however, does not hold true since many successful innovations in modern time have been identified and fast-tracked by government support ranging from R&D support to subsidies (Mallon, 2006). Experience from renewable energy technology in general, and solar PV in particular, shows that considerable public interventions in the energy market is needed to introduce any significant amounts of RE (Sawin, 2006).

Solar PV policy is composed of all actions that are undertaken by a public organisation in order to influence the deployment of solar PV. Such actions usually consist of a combination of regulatory, economic and informative policy instruments. The regulatory framework sets the contextual conditions for solar PV, which is fundamental since the existing electricity markets were not designed with RE in mind. The existing grid and its regulatory support was designed in conjunction with large-scale traditional power plants, which makes it particularly challenging for small-scale distributed solar PV to operate within the current context. Economic incentives are important to move a specific technology towards quick market-competitiveness and large-scale deployment. When this point is reached, the support can be gradually decreased. Informative or so-called "soft" policy instrument are important to overcome social barriers and misconceptions about a certain technology (Mallon, 2006). According to Balaya et al (2011), the most successful policies are those that send clear and consistent market signals tailored to meet the specific barriers of a certain application. A detailed description of policy support instruments for solar PV can be found in Chapter 3.

Solar PV policy receives significant attention from policymakers around the world and support schemes are being developed, evaluated and revised. According to REN21(2014), RE support policies were in place in 138 countries in 2014. It is yet unclear how many of these countries include support policies for solar PV. Both REN21 and the Regional Center for Renewable Energy and Energy Efficiency (RCREEE) have recently published reports to demonstrate, among other things, the progress of RE policy in the MENA region. These reports show that several of the countries in the region have some kind of support policies in place for solar PV deployment. The REN21 (2014) report, also argues that RE policy targets existed in all MENA countries by early 2013 and the majority of these targets place a priority focus on solar PV and/or CSP (REN21, 2014; Rcreee, 2013). However, none of the reports give any information about the characteristics of the policies or how they perform.

1.2 Problem definition

The MENA region holds great potential for solar power generation as a mean to meet its rising energy security challenge. Despite the many benefits and the recent price drop of solar PV modules, there are several barriers for the deployment that need to be overcome with the help of governmental intervention. Nevertheless, designing policies that effectively meet the barriers for solar PV deployment in a specific context is challenging and studies argue that many policy instruments are developed with poor consideration of their suitability and expected effect, and are rather the result of ad-hoc decisions (Edquist, 2011). In order to avoid such situation in the MENA countries, which are in the process of establishing or implementing solar PV policies, it is important to better understand and evaluate existing policy instruments. This can provide important insights for policy development in other countries as well as to improving existing policies.

1.3 Objective and research question

The aim of this master study is to develop a better understanding of policy instruments adopted for distributed grid-connected solar PV in the MENA region. Three countries with adopted policy instruments have been selected and the ambition is to evaluate the performance of the policies and discuss their suitability in certain contexts. The following research questions have been formulated with the objective to fulfil the aim stated above:

I: What are the characteristics of the policy instruments for distributed solar PV in Egypt, Palestine and Tunisia?

II: Within the context in which they operate, what is the level of effectiveness and institutional feasibility of the adopted policy instruments?

The first research question is descriptive and seeks to identify what kind of solar PV policy instruments have been introduced in the three countries and what characterise these instruments in terms of design details. A comprehensive answer to the first question is crucial to answer the following research question that aims to evaluate the performance of the policy instrument in their specific contexts. A qualitative approach based on extensive literature review and semi-structured interviews conducted in the three concerned countries, has been taken in order to answer the two research questions. The overall research is performed as separate case studies followed by a simplified comparative analysis. The methodological approach will be further presented in Chapter 2.

1.4 Scope

The study is focusing on three countries in the region, namely the ones that have been identified as among forerunners when it comes to policies for distributed solar PV and are therefore of interest for RCREEE. These are Egypt, Tunisia and Palestine.

Only public policies for the deployment of solar PV are covered by this study, excluding other types of solar power or solar heating. The focus is on *distributed solar PV*, which consists of smaller PV systems (1kW-1MW) that are mounted on rooftops or on ground. They are connected to a specific user that either uses the electricity itself or feeds it into the grid. The opposite of distributed systems is centralised systems, which operate as any other centralised power plants. Distributed solar PV systems are used within the residential, commercial or industrial sector. All sectors are covered within this scope. However, most policies that have been implemented are targeting rooftop installations for residential customer and for this reason a lot of attention will be given to this type of installations. Since most of the policy instruments that have been adopted concern grid-connected solar PV, the scope has been limited to such systems and will not include off-grid installations or rural electrification programs.

The main limitation of this study concerns the accessibility of detailed data. This is due both to the lack of transparency of public documents but also because of poor monitoring and evaluation of the implemented policies. Another limitation has been the language barrier. This is an issue worth mentioning since many recently established laws and decrees have not yet been translated from Arabic to English, or in the case of Tunisia, from Arabic to French. An additional limitation is the limited amount of interviews conducted for the study. Between 5-8 interviews have been conducted in each country and this means that only a few stakeholder's opinions and interpretations are being reflected in this study.

1.5 Audience

The main audience for this study consists of policy makers and stakeholders interested in the deployment of RE in general and solar PV in particular. Policy makers should be interested in taking part of the results of this study since it will give them an idea about the suitability of a particular policy in a certain context and also a better understanding of policy design options and their implications for the performance of the policy. Other stakeholders are specifically identified to be installers, developers and distribution companies. Distribution companies are highly affected by the policy development within the solar field since they in many countries are requested to provide access to their grids. This thesis will give them a better insight in what role they can play under different policy schemes. Installers and developers will get a better picture of the policy frameworks and their strength and weaknesses; this should be interesting information in their process of developing offers and new innovative business models. This study of solar PV policies in the MENA region will give a broad overview of the situation and within what areas it could be interesting to conduct more in-depth research. The study should for that reason be of interest also for the research community who are, or wants to work within this field.

1.6 Disposition

Chapter 1 presents the background and significance of this thesis. It focuses on the need for an energy transition in the MENA region, solar PV technology as a suitable option in such transition, and the importance of public policy to encourage deployment. To justify the choice of topic and specify the aim of the thesis, the background is followed by a clear problem definition, description of objective and research question. Last but not least can be found a description of the scope and limitations as well as the audience that this study targets.

Chapter 2 has been dedicated to the methodology. It contains an overview of the policy evaluation literature, the choice of methodological approach and a description of the selected evaluation model. The latter explains the choice of multi-criteria analysis and the reasoning behind the selected criteria effectiveness and institutional feasibility.

Chapter 3 is based on a literature review and gives an overview of policy instruments to support solar PV deployment. It examines the most commonly used regulatory instruments, fiscal incentives and public financing, aiming to describe their advantages and disadvantages as well as the most common design options.

Chapter 4 contains both findings and analysis in the form of case studies of the three countries and their adopted policies. A sub-chapter follows the case studies and aims to compare the case studies based, partly, on the evaluation criteria but also based on contextual factors that have been identified as of significance for deployment in the MENA region.

Chapter 5 is a discussion which takes a step back from the topic of the study and focuses on the methodological and analytical choices, and how they have affected the results of the study. It discusses to what extent the research questions have been answered and how generalisable the results are for the MENA region and other parts of the world.

Chapter 6 is the concluding chapter that discusses the main findings of the study and explains whether and how the thesis contributes with anything new. The chapter provides several recommendations for the audience and for future research.

1.7 Ethical considerations

This study has been commissioned by the Regional Center for Renewable Energy and Energy Efficiency (RCREEE) based in Cairo, Egypt. RCREEE has had requests concerning the topic of the thesis (policy for distributed solar PV) and the scope of the study in terms of which countries to analyse. The remaining parts of the study including: problem definition, research questions, further scoping, research methodology, and analysis, have been developed and conducted independently by the author. Regarding the data collection, RCREEE has provided the author with valuable contacts within public agencies in the MENA countries and some of the interviews have been officially booked via the organisation. However, the author has collected all primary data independently.

2 Methodology

The purpose of this Chapter is to present the research approach taken in order to fulfil the aim of the study and answer the research questions. It contains an overview of the policy evaluation literature, the choice of multi-criteria analysis and the reasoning behind the two selected criteria: *effectiveness* and *institutional feasibility*. Finally, it describes the methodological approach for data collection and the literature sources that have been used.

2.1 Policy evaluation

Governmental commitment and the use of public policy to reach climate and energy targets have resulted in an increased emphasis on policy evaluation (Neij & Åstrand, 2006). Public policies engage considerable resources, often in the form of significant financial support, thus careful monitoring and evaluation are needed to verify their functioning and results (IRENA, 2012a). Policy evaluation is further essential to better understand the policy process and policy programmes (Neij & Åstrand, 2006), as well as identify opportunities to adapt and improve policies (IRENA, 2012a).

The term "evaluation" is used in various ways in the policy evaluation literature and different definitions are related to its timing. While some theorists limit the definition of policy evaluation to retrospective assessments, others include a much broader perspective. Mickwitz (2003), claims that Michael Scriven (1991) provides the most general definition of the concept, and refers to the following citation: *The key essence of the term "evaluation" refers to the process of determining the merit, worth, or value of something, or the product of that process* (Mickwitz, 2003, p. 420). This definition embraces all types of policy evaluations that are described in the following sections.

2.1.1 Policy evaluation models

Evaluation can address various stages of the policy cycle and the most common distinction in the literature is made between *ex-ante*, *ex-post* and *on-going* evaluation. An ex-ante evaluation precedes the decision-making process and is meant to hypothetically pre-assess potential effects and implications of planned policies. The ex-ante evaluation can include a comparison of different policies and serves as a mean to improve the upcoming or on-going decision-making process (Wollmann, 2006). The European Union recognises this form of evaluation as particularly important within the field of environmental policy (Mickwitz, 2003). An ex-post evaluation is carried out once policies and measures have been terminated. This type of evaluation has often been referred to as program evaluation and has traditionally served to assess the degree of goal-achievement and the extent to which these achievements can be related to the policy in question (that is, the causality relationship) (Wollmann, 2006). However, nowadays it is common that ex-post evaluations examine other issues than goal-achievements, for example side effects or pre-defined values. An on-going evaluation is performed while the policy and its measures are in the process of being realised. On-going evaluations aim to assess and feed back important knowledge that can serve to adapt, adjust or redirect the implementation process (Wollmann, 2006). Mickwitz (2003) also refers to RIPI evaluations (recently introduced policy instruments), which seem to be closely related to on-going evaluations. He claims that such evaluations have become more common and are particularly important since it is easier to change a policy instrument with a short implementation period (Mickwitz, 2003).

There are a number of different evaluation models that can be used in order to conduct an ex-ante, ex-post or on-going evaluation. Most frequently used and discussed in the literature and previous studies are among others the Goal-achievement model, Cost-benefit analysis and Multi-criteria analysis. It should, however, be mentioned that there seems to be a lack of common definition and understanding of these models and the following descriptions are general.

Goal-achievement model

A commonly used model for public policy evaluation is the goal-achievement model that was mentioned above. The model is mainly used for ex-post evaluations and has the overall purpose to assess whether policy results are in accordance with policy goals, and whether these results are the product of the policy intervention (Vedung, 2008). The model is recognised for being simple, especially in relation to the first step, which includes: an identification of policy goals; their conversion to measurable objectives; and determination of realisation. However, the second step includes an examination of the causality between policy and goal-achievements, and this is considerably more complex to determine (Vedung, 2008). According to Mickwitz (2003), the disadvantage of the goal-achievement model is that it is deemed to overlook potential interesting side effects, furthermore, it does not consider the relevance of the goals or the cost of the policy.

Cost-benefit analysis

Different economic evaluation models have gained ground since the 1980s, among which the cost-benefit analysis. Most economists look upon evaluations that use economic criteria as a special type of evaluation model (Mickwitz, 2003). A cost-benefit analysis seeks to determine the efficiency of an instrument, i.e. whether the benefits (results) that derive from a specific policy program are worth the cost of the policy. Both benefits and costs are valued in monetary terms and this has proved to be complicated. The main problem relates to the valuation of benefits. First of all, what should be included as benefits, and secondly how these can be valued. Some of the methods used to valuate climate and environmental related benefits are willingness to pay (WTP) and willingness to accept (WTP) (Mickwitz, 2003). A cost-benefit evaluation can take place in any stage of the policy cycle (Wollmann, 2006) but is commonly used to examine different policy alternatives and motivate policy decisions. A cost-benefit analysis can further be included in a multi-criteria analysis or used as a criterion in a goal-achievement model (Mickwitz, 2003). A cost-benefit analysis is highly facilitated by very good availability of financial data.

Multi-criteria analysis

All evaluation models are based on some sort of value criteria analysis. However, criteria do not necessarily have to be based on policy goals. One approach that is commonly used to evaluate energy policies is called multi-criteria analysis. This approach is characterised by a mix of criteria and evaluation models that can be designed according to the purpose and context of the evaluation. If the efficiency criterion is included, and examined as a cost-benefit analysis, a multi-criteria analysis is sometimes called a partial cost-benefit analysis (Mickwitz, 2003). Depending on the issues of investigation, multi-criteria analysis can be applied to any stage of the policy cycle and a great number of policy evaluation criteria are suggested in the literature on public policy and evaluation. Mickwitz (2003) divides these criteria into three groups: general criteria, economic criteria and criteria linked to the functioning of democracy (Mickwitz, 2003). According to Vedung (2008), some of the most commonly employed criteria are effectiveness and efficiency. The former have to a large extent been the focus of energy policy evaluations (Neij & Åstrand, 2006). What criteria are suitable for certain evaluations depends on the characteristic of the policy, type of evaluation (ex-ante, ex-post, on-going), the issue under evaluation (objective, outcome, impact), knowledge gap, data availability, et cetera. Many multi-criteria analysis include somekind of trade-off analysis placing two criteria against each other: efficiency vs. equity, effectiveness vs. relevance, et cetera.

2.2 Choice of evaluation model

For the purpose of this study, the author has looked into different models applicable for an evaluation of adopted policy instruments for solar PV in the MENA region. In the early phase of the study it was confirmed that the policies under investigation reached very different stages in the policy cycle but that all of them were on-going or recently interrupted. Considering the fact that the MENA region has limited experience in policy instruments for solar PV deployment and that some of the policies have not yet been implemented, it has been deemed important to focus on the outputs (choice of instruments) and the administration, and limit the evaluation of impacts (emission reduction, job creation etc). This approach is, to a certain extent, supported in an article published by Neij & Åstrand (2006). The authors draw attention to the need to evaluate how policy instruments affect the socio-technical system (including actors, institutions, the economic and political framework, and the technological system) and thereby question the usefulness to only evaluate the impact of a policy in terms of aggregated isolated effects on the environment, installed capacity and emission reductions.

It has been crucial to select a flexible evaluation model that can be designed according to the specific conditions and needs in this region. The goal-achievement model was first considered, but then deselected because of unclear policy goals and the fact that it is most suitable for ex-post evaluations and that it has a strong focus on outcomes and impacts. The cost-benefit model was deselected partly because of the same reasons, in addition to a concern over the potential unavailability of financial data. From an examination of the different models, and also of previous studies within this field, it seems like a simplified version of a multi-criteria approach is most suitable to address the aim and the research problem stated in the pervious chapter.

2.2.1 Multi-criteria analysis

There is a limited amount of literature that provides guidance regarding criteria and indicator selection for evaluation of energy policies. However, IRENA (2012) published a policy brief with criteria recommended to evaluated RE support instruments. A reviewed version of this policy brief, with a stronger focus on lower income countries, was published in 2014. The criteria and indicators recommended by IRENA (2012) have been developed to evaluate the policies for deployment of RE technology and not to assess the implications of a policy for the environment, economy or energy security (IRENA, 2012). Considering the discussion in the previous section, on the importance to focus on the system and not only the impacts, such criteria are particularly interesting for the purpose of this thesis.

The criteria specified by IRENA (2012) are: *effectiveness, efficiency, equity, institutional feasibility and replicability* (IRENA, 2012). An evaluation can be done against one or several of these criteria with accompanying indicators of success. The following section describes which criteria have been selected and how the analysis has been performed.

Depending on the level of details, a criteria analysis is time-consuming and good data availability is required to assess most of the mentioned criteria (IRENA, 2012a). As a result of that, it is often necessary to scope down a study and carefully select a limited amount of criteria. Out of the five commonly assessed criteria identified by IRENA (2012), two have been selected for the evaluation of policy instruments for distributed solar PV: *Effectiveness* and *Institutional feasibility*. The selection has been based on the relevance of the criteria for the purpose of the paper, data availability, resources (time) and stakeholder perspective. One of the overall objectives of the thesis is to examine the suitability of adopted policy instruments in a certain context. Both selected criteria are considered highly relevant as a base for such discussion. The *Efficiency* criterion is also highly relevant for this purpose. Efficiency takes the measure of effectiveness one step further and considers whether the impact of a certain policy instrument could have been achieved with fewer resources (Mickwitz, 2003). This type of measure would give additional value to the research, but has been deselected because it requires a particularly good availability of fiscal data, something that has proved to be problematic to access in many of the countries in the MENA region. *Replicability* could have been of interest if this thesis aimed to assess the suitability of replicating and implementing a particular policy instrument from one country to another. This criterion is closely related to the selected *Institutional feasibility* and the concept of replicability will be kept in mind when discussing the suitability of a policy instruments in a certain context. Nevertheless, replicability as a criterion for analysis has been deselected. *Equity* looks at who has access to the support policy and who bears the costs. This is another important and interesting aspect to take into account when assessing the suitability of a policy in a certain context. It has however been deselected because of resource constraints and a need to scope down the extent of this study.

Table 2-1. Criteria and indicators for policy evaluation.

Criterion	Indicators	Methodology
Institutional feasibility	Policy complexity Existence and capacity of required institutions Appropriateness of responsibility delegation	Detailed qualitative case studies based on literature review and semi-structured interviews.
Effectiveness	Growth in capacity Appropriateness in overcoming barriers to deployment	Detailed qualitative case studies based on literature review and semi-structured interviews. Partly quantitative when measuring growth, in kWp installed capacity, against targets.

Source: Own elaboration of analytical framework developed by IRENA (2012).

Institutional feasibility

Institutional feasibility is one of the broader evaluation criterion identified by IRENA (2012) and illustrates the extent to which a policy instrument is likely to be seen as legitimate, able to gain acceptance and to be successfully implemented (IRENA, 2012). Especially in lower income countries, institutional feasibility has been found to highly determine the success of a policy (IRENA, 2014). The criterion does not say anything on how the policy performs but serves instead to describe how well the policy is suited to its institutional environment (IRENA, 2014b). According to Sawin et al. (2011), institutional feasibility can be considered high when policies are well adapted to existing institutional constraints. Assessing institutional feasibility can facilitate the understanding of why a policy performs in a certain way and help inform and revise policy choices.

It should be noted that the task to evaluate institutional feasibility is very complex and a qualitative approach needs to be taken to capture both tangible and intangible characteristics within the institutional environment. IRENA has identified a number of indicators that can be used to give a better idea about the feasibility of a policy instrument in a certain institutional environment, see Table 2-1. These indicators focus on the presence or absence of institutions and resources needed for implementation of a specific policy instrument. This is a simplified way to evaluate institutional feasibility and it can be questioned whether it is possible to determine feasibility based on these indicators. IRENA (2014) argues that a simplified evaluation using these indicators is more likely to determine the *unfeasibility*. If institutions and resources are absent, the institutional feasibility is most likely to be low. If they on the other and are present, it does not necessarily mean that the institutional feasibility is high.

Before moving on to discuss the different indicators, it is considered necessary to provide a definition of the word *Institution* since the concept is used differently throughout the literature. In the Systems of Innovation literature, a clear distinction is for example made between organisations and institutions. While organisations comprise actors, institutions comprise rules in the form of laws, regulations and norms (Edquist, 2011). Nevertheless, in this study, the term institution comprises both organisations and rules. This is also how the concept is used in the IRENA guide on policy evaluation. However, while IRENA (2012) mainly includes public institutions in the institutions concept, this thesis, does to a small extent, include private organisations, such as distribution companies and PV installers, in the definition.

The indicators used for assessing the institutional feasibility criterion are the following:

Policy complexity: while some policy instruments are easy and straightforward to implement, others require complex administrative arrangements and long-term commitments. Policy choice and design details are therefore particularly important for the suitability of the policy in a certain institutional context. The literature background on support instruments in Chapter 3 is used to discuss the level of complexity of the different policy instruments.

Existence of required institutions: the main focus is public institutions in the form of both organisations and rules. Important organisations for the implementation of policy instruments for distributed solar PV are: RE ministries and to what extent they have adopted laws and regulations; designated agencies to formulate solar PV strategies and administrate identified support instruments; electricity regulators to oversee the power market and set electricity tariffs and FiT. Other actors and rules that could be considered institutions are PV installers, quality requirements and commercial financing options. These are all mentioned but not analysed in-depth in this study.

Capacity of required institutions: the capacity of the required institutions relates to the economic feasibility, administrative capacity and also the political feasibility. The latter examines whether the policy instrument has been able to gain acceptance or if there is any potential barrier and opposition that might surround the adoption and implementation phase.

Appropriateness of responsibility delegation: this indicator is included to assess whether responsibilities of the policy instrument and its implementation have been assigned to appropriate organisations and if they have the right capacity and status to handle these responsibilities and are committed to do so.

Effectiveness

Effectiveness illustrates the extent to which intended objectives are met. In the case of policies for solar PV deployment, this criterion refers to the actual increase in installed capacity of solar PV. There are different approaches for how to measure or discuss effectiveness and one is to measure whether the national target has been achieved. According to IRENA (2012), this is useful and straightforward for individual countries. It is less valuable for cross-country comparisons since it does not say much about the ambition level or country specific context.

Studies on effectiveness of a policy can be done on different levels. Since some of the policy instruments in this study have not yet reached the implementation stage, the effectiveness is discussed on a theoretical level based on earlier studies on the effectiveness of particular policy instruments and their design details. Such discussion is related to the extent to which the adopted policy instrument is (or will be) effective in meeting the main barriers for deployment of solar PV: this is what determines the level of effectiveness of a policy instrument. The main barriers for deployment of solar PV relate to economic feasibility and the risk of investment (Drury, Jenkin, Jordan, & Margolis, 2014).

According to IRENA (2014), effectiveness offers a useful but limited insight about a policy instrument. Especially the indicator growth in capacity does not say anything about why the deployment was successful or not. Therefore, this criterion has to be used alongside other measures (IRENA, 2014).

The indicators used for assessing the effectiveness criterion are the following:

Growth in capacity: this indicator is used to investigate the effectiveness of the policy instruments. The growth in capacity is compared to national targets if such have been determined. It should be noted, however, that some of the policy instruments examined in this paper have not been implemented yet, and thereby this indicator cannot be used.

Appropriateness in overcoming barriers: based on the literature review in Chapter 3 and the contextual situation in the country, a theoretical discussion determines whether the adopted policy instrument and its design details is (or can be expected to be) suitable to overcome barriers to deployment and thereby increase the capacity.

2.3 Methodological approach

In order to identify the characteristics of existing policy support instruments and better understand their suitability in different contexts, this thesis uses a qualitative approach based on extensive literature review and semi-structured interviews conducted in the three concerned countries. The overall research is performed as separate case studies of the three countries, followed by a simplified comparative analysis. Each case study begins with a description of the country's power market situation and its strategy for distributed solar PV deployment. This part contains a detailed examination of the main policy instruments and their design details. The descriptive part is followed by the criteria evaluation of the policy instruments. The choice of analytical approach and selection of criteria are justified in section 2.2. The three case studies, together with the literature review on policy support instruments for solar PV, are the basis for a discussion on suitability of policy instruments in a specific context.

The gathering of data through literature review consists primarily of an examination of both official and non-published policy documents such as strategies, action plans, implementation guidelines, laws and regulations and other supporting documents. It also includes a review of reports published by international policy organisations as well as consultancy groups. Personal meetings have been fundamental to get access to relevant material that is not always easily accessible in the concerned countries. Peer-reviewed papers have mainly been used for the review of policy instrument theory in Chapter 3 describing the most common support policies for solar PV deployment in general.

Interviews have been conducted with stakeholders including ministries, electricity regulatory commissions, electricity producers and distribution companies, solar PV installers and suppliers, financial institutions and to some extent also end-customers. The interviews have not only served to collect new data on the latest development within this dynamic policy field but also to confirm secondary information collected through a primary literature review. A total of 24 interviews have been conducted and have been an invaluable source of information for this thesis.

3 Overview of solar PV policy instruments

This Chapter provides a literature review of policy instruments that support the deployment of distributed solar PV. It examines the most commonly used regulatory instruments, fiscal incentives and public financing, aiming to describe their advantages and disadvantages as well as their most common design options. The information gathered in this chapter will be used to understand the design of support policies that have been introduced in the three MENA countries.

Governments can employ a number of instruments to support the diffusion of distributed solar PV for self-consumption. Such policy instruments are often categorised as regulatory instruments, financial incentives and informative instruments. Nevertheless, different policy supports are relevant in different stages of a technology development phase and since this thesis focuses on the deployment phase of solar PV, this section primarily describes policy mechanisms relevant for that purpose. Deployment policies for renewable electricity technology are generally categorised as regulations, fiscal incentives and public finance (Sawin et al., 2011; IRENA, 2012). The most commonly used instruments will be described more in detail, including effectiveness, transaction costs, pros and cons as well as different design options. It should be mentioned that the classification of policies has different approaches in literature and the categorisation used here is just one way to structure the policy instruments. A Feed-in tariff (FiT) policy could for example be considered a subsidy, and should in that case be categorised under fiscal incentives. However, in this paper it is categorised according to the IRENA classification approach, namely as a regulatory instrument. The term policy instrument has many synonyms in the literature and will be alternated with the following terms in this paper: support instrument, deployment policy, and policy support instrument.

A lot of research has been done within the field of deployment policies for renewable energy in general and solar PV in particular. A geographical area of interest has been the US market in which many states have introduced net metering, fiscal incentives and in some cases tradable certificate schemes (Burns & Kang, 2012; Darghouth, Barbose, & Wiser, 2011). On the European level, a lot of peer-reviewed studies about the commonly deployed FiT mechanism have been published (del Río & Mir-Artigues, 2012; Jenner, Groba, & Indvik, 2013; del Río & Gual, 2007). In addition to the many studies on Japan's FiT schemes, more and more studies have been conducted on the policy development in China and other parts of Asia. Studies from all these regions cover a broad range of aspects such as effectiveness, efficiency, design options and social welfare aspects etc. Nevertheless, few peer-reviewed studies about the support policies for distributed solar PV in the MENA region have been published. The studies that have been conducted on the solar PV topic in the MENA concern: strategic considerations; assessments of future cooperation models between MENA and the EU; and future potential for solar PV. For this reason, most of the information (and analysis) in this chapter is based on universal studies of solar PV support policies, or alternatively studies that evaluate or describe a specific scheme in another region than the MENA.

3.1 Regulatory instruments

The regulatory instruments relate to national legal frameworks that govern the access to the market and the electricity grid through net metering policies, price-driven mechanisms such as FiT, quantity-driven mechanism such as quota obligations, and quality-driven instruments through certification or labelling requirements (Michell et al., 2011). Regulatory instruments can be established in laws, regulations or decrees. Laws are juridically binding rules that have been formulated by the government and passed by a legislative body. Regulations are often formulated by administrative agencies and specify how the law should be interpreted, implemented, monitored and enforced. Regulations are the rules of law and have the same legal status but are easier to change. A Decree can have different meanings according to the country it operates in. In general, it has the same characteristics of a regulation, but it is not based on a law and is issued directly by someone in authority. Accordingly, a Decree does not have the same legal status as a Law or a Regulation.

3.1.1 Net metering

Net metering has become a widespread regulatory mechanism to support deployment of distributed solar PV installations. It is commonly used in many US States, some countries in Europe (Michell et al., 2011) and is now getting more and more common in the MENA region (RCREEE, 2013). The latter is shown in the case of Tunisia and Egypt. It is essentially a mechanism to encourage residential or small-scale businesses to install RE and particularly solar PV.

The net metering mechanism allows for prosumers[2] to feed their excess PV generated electricity into the grid and use it to offset electricity consumption from the utility. A net metering scheme requires only one bidirectional electricity meter that keeps track of the direct net balance of the electricity to and from the grid (Poullikkas, Kourtis, & Hadjipaschalis, 2013). If the prosumer's net balance is negative in the end of the billing period, meaning that more has been consumed than produced, the difference in kWh is billed to the prosumer. If the prosumer, on the other hand, has an excess of kWh in the end of the billing period, this can be handled in a few different ways (Michell et al., 2011). The design details of the net metering mechanism look different from country to country and particularly when it comes to how the potential net excess generation is handled in the end of a settlement period. Some systems allow for customers to credit the excess kWh to the next year; others have been regulated so that any excess kWh in the end of the year is granted to the utility, or alternatively that any surplus has to be purchased by the utility. Another design detail that varies between different net metering schemes is the eligible installed capacity (Poullikkas et al., 2013). The allowed capacity varies, although net metering is commonly used for smaller systems for self-consumption (Ackermann, Andersson, & Söder, 2001). In order to minimise the level of excess supply, some countries have regulated this so that prosumers are not allowed to install higher capacity of solar PV than the average consumption level in the previous year. Without going too much into depth in the numerous design options, it is worth mentioning that the most basic net metering scheme is based on a one-to-one credit design. This means that one kWh, no matter when it was produced, can be credited against another kWh. However, a more complex alternative is the time-of-use (TOU) net metering. TOU takes into account the time of usage and production. This method is widely used in countries that apply a time-based electricity tariff structure. The procedure is rather simple and can be handled through a specialised reversible meter (Poullikkas, Kourtis, & Hadjipaschalis, 2013).

A well-designed net metering policy is a low-cost and easy-to-administer tool to motivate small actors to install solar PV (Sawin et al. 2011; Poullikkas, Kourtis, & Hadjipaschalis, 2013). It has several benefits both for prosumers, the utility and society. First of all, it provides the prosumer with a long-term guarantee of low electricity bills. This motivates the deployment of solar PV and the savings can be used to finance the relatively high upfront cost of the systems. Another benefit occurs through the possibility to "store" generated electricity on the grid and credit it over to the next billing period. According to Yamamoto (2012), the latter provides an incentive to reduce electricity consumption and increase the share of RE used in the system. A

[2] The term "Prosumer" is used in the literature to indicate actors with the double role of producer and consumer, e.g., an actor that installs a distributed solar PV system for self-consumption (Schleicher-Tappeser, 2012, p. 69).

net metering scheme also generates some benefits for the utilities, particularly when prosumers produce electricity during peak-hours (Campoccia, Dusonchet, Telaretti, & Zizzo, 2009) which means that utilities do not have to generate that, often expensive, electricity themselves nor purchase it on the market (Poullikkas et al., 2013). It is also beneficial for the utility since grid-connected solar PV systems decrease distribution losses. According to a review of design details in Sawin et al. (2011), the best result of a net metering scheme can be obtained if the mechanism does not limit system size or capacity and allows for excess generation to be credited to the next settlement period.

The problems associated with net metering lay within the lost revenues for the distribution company. However, according to Poullikkas et al. (2013), the share of installations is low compared to other types of electricity generation and do not represent a bigger threat than any energy efficiency measure. A study from the US market highlights that challenges related to the bill-saving value in some states have been identified. The potential to reduce the electricity bill is crucial for the net metering scheme to be effective, and this potential depends heavily on the structure of the retail electricity rate (Darghouth et al., 2011). The bill-saving value is for example much higher if the electricity tariff structure is divided in tariff-brackets and prosumers that use the net metering are able to cut their top consumption and avoid the most expensive brackets. However, if the overall retail electricity tariffs are lower than the generation cost for solar PV, it can be hard to motivate substantial growth of the market with only a net metering scheme. This would instead require for example a Feed-in tariff scheme, as described in the next chapter.

3.1.2 Feed-in tariff

A Feed-in tariff is a regulatory mechanism that is widely used primarily in Europe, Japan and China (Michell et al., 2011). Nowadays, American policymakers increasingly consider FiT as a policy option (del Río, 2012) and some countries in the MENA region have used it to support the deployment of small-scale solar PV as is described in the case of Palestine. Many studies claim that FiT is the most effective way to promote grid-connected RE technology (Sawin et al., 2011; del Río, 2012; Couture & Gagnon, 2010; Lesser & Su, 2008).

A FiT is a policy instrument that allows for prosumers to sell their self-generated RE electricity to the local distribution company. A regulatory body sets a price for electricity and lets the market determine the level of deployment. In many cases, the utilities are obliged to pay for RE generated electricity that are being fed into the local grid (Ackermann et al., 2001). Practically, the FiT works with two meters: one that keeps track of electricity fed into the grid; and another that keeps track of electricity consumed from the grid. Compared to net metering, when only the net amount of electricity that the prosumer produce beyond its own consumption is being "sold" back to the grid, the FiT allows for all electricity that is fed into the grid to be sold from the first kWh (Yamamoto, 2012). There are different types of FiT instruments, mostly depending on the tariff characteristics. The instrument can offer a fixed tariff that is independent of the electricity market, or a variable tariff depending on the fluctuating electricity market price (Michell et al., 2011). The latter involves the use of a premium price, which is a fixed premium on top of the electricity market price; this option entails a higher administrative burden (Toby Couture & Gagnon, 2010). Other design details that can differ between various FiT schemes are: conditions and costs for grid connection; whether the prosumer is guaranteed purchase or not; cap on deployment eligible for support; duration of support (long contract duration lasts 15-20 years, short contract duration lasts 5-10 years); reduction of support/tariff levels over time; and support financed via electricity consumers or taxpayers (del Río, 2012).

The fixed-price alternative of a FiT is typically combined with a guarantee of purchase of all generation and a pre-agreed price for connection to the grid (Michell et al., 2011). Such FiT design represents an almost risk-free deal from the point of view of the prosumers. The disadvantage with such system is that there is a risk for overcompensation through a price that is too high compared to the market price. It is therefore very important to set the right price from the beginning in order to avoid this situation and an overstimulation of the market. The premium payment alternative is getting more popular since it provides less risk for overcompensation and encourages generators to adjust generation in response to market price signals. Nevertheless, it also provides less certainty for the prosumers since they are exposed to electricity price fluctuations (Sawin et al., 2011; del Río, 2012; Couture & Gagnon, 2010). Such risk is particularly problematic for immature technologies such as solar PV, which is capital intense. Encouragement of small prosumers seems for this reason more likely under a fixed-tariff scheme (del Río, 2012).

Even though the administrative burden of FiT instruments is relatively low, the actual cost of the tariffs is a major issue. This cost can be financed either via the government or the electricity consumers. The latter is the most frequently used model and implies that an extra kWh charge is spread across electricity consumers. A model where the tariff is supported by governmental subsidies can be financed via a green tax or an auction of carbon allowance, where revenues are allocated to the FiT purpose (Sawin et al., 2011). A government-financed FiT scheme is often associated with greater risk since allocation of money becomes a subject of political debate in times of economic downturns or a change of government (del Río, 2012). A degression of tariff level over time can reduce the financial burden and thereby also increase the acceptability and feasibility of long-term support. Degression has also shown to give an incentive to improve technology and decrease the cost, particularly for expensive technologies with high learning rates such as solar PV (del Río, 2012). Another challenge is associated with the establishment of an appropriate tariff level (IRENA, 2012a). This requires skilled experts with good knowledge about the latest market development of solar PV. An appropriate FiT is determined as closely as possible to the specific generation cost of solar power (Toby Couture & Gagnon, 2010). There are different methodologies to calculate a FiT and the most common is based on the levelised cost of solar power generation (LCOE). LCOE is a measure of the cost per unit of PV electricity generated by the system (Pérez et al., 2014). A study performed by RCREEE in 2010 found that many countries in the MENA region were concerned about their capability to determine appropriate tariffs and this was a strong obstacle to implementing FiT schemes (IRENA, 2012a).

3.1.3 Other regulatory support policies

A number of different support policies for the deployment of solar PV exist. Nevertheless, not all of them have shown to be particularly suitable for the promotion of distributed solar PV systems. A quota obligation is one example of support policy that seems to be used more frequently to promote large scale RE plants but in some cases also for distributed RE technology.

A quota obligation is a quantity-driven policy that ensures a minimum share of electricity capacity, generation, consumption or sales coming from RE sources. Such instrument exists in various forms and under various names such as Renewable Portfolio Standards, Renewable Electricity Standards, and Renewable Obligations. Quota systems are often linked to certificate trading schemes such as the Tradable Green Certificate (TGC) scheme and have shown to encourage mainly already mature technologies (del Río & Mir-Artigues, 2012). A TGC system implies that there are quota-obliged buyers that have to procure a certain amount of RE electricity certificates. Certificates are received by producers or distributers of RE, who can then sell them to quota-obliged buyers on an artificial but open market. The reason that makes this instrument benefit already mature RE technology, such as biomass and wind energy, is that producers in many cases receive the same amount of certificates no matter what RE technology is used to generate a certain amount of electricity. This design gives a clear incentive to use the least expensive technology on the market and this has been the case in countries like Sweden, Japan, Australia, UK (del Río & Mir-Artigues, 2012). However, there are some examples of technology specific quota obligations on a state level in the US. Solar renewable energy credits can be traded in nine states in the US and credits are created for every 1MWh of electricity produced in a given year. The scheme is open for distributed solar PV systems whose generation can be taken into account by the utility, no matter if prosumers of solar PV electricity consume the electricity themselves or feed it into the grid (Burns & Kang, 2012).

3.2 Fiscal incentives

Fiscal incentives are meant to compensate for various market failures that make solar PV less competitive compared to electricity market prices. Fiscal incentives can lower the relatively high upfront cost that are associated with solar PV and thereby lower the investment risk for the potential prosumer. There are two types of commonly used fiscal incentives: tax policies and subsidies in the form of grants or rebates. Both are commonly used as a supplement to one of the regulatory policies described above (Michell et al., 2011).

3.2.1 Subsidies

Both grants and rebates are used to subsidise the high investment cost of solar PV. The difference between the two is that grants are provided ex-ante to help finance the investment, whereas rebates are reimbursements that are being provided after an investment is made. (Michell et al., 2011). Such subsidies are often designed either as a fixed amount of money per kW or as a percentage of the investment cost or based on expected system performance. The reliance on grants based on capacity installed has lately come under criticism because it is said to incentivise size as opposed to efficiency and performance (Timilsina, Kurdgelashvili, & Narbel, 2012).

Grants are in general more direct and imply a lower risk for the investor who does not have to worry about future policy changes. On the other hand, a grant that is paid out on beforehand does not guarantee that the system will operate efficiently and therefore it requires a certain amount of supervision to make sure that preconditions are met. Rebates require less supervision since the prosumer has to meet certain requirements to be eligible to get the refund after the installation has been made. This, on the other hand, constitutes a higher risk for the prosumer and is for that reason not as effective as a grant in stimulating investments (Michell et al., 2011).

In general, subsides as described above can play a significant role in increasing the deployment of solar PV. A study done on the US market shows for example that States that are offering cash incentives have seen a more extensive deployment of distributed grid-connected solar PV (Sarzynski et al., 2012). Subsidies are relatively easy to implement and do not require any long-term commitment by the governments. The overall challenge associated with this type of policy is naturally the availability of financing, which can be provided either through government funds or in the case of developing countries by donor funds (Michell et al., 2011).

3.2.2 Tax policies

Tax policies come in different forms but have in common that they are flexible tools that can target specific aspects of the market and be gradually increased or decreased as the market evolves. Tax reductions and exemptions act directly on the total payable tax amount and thereby indirectly reduce the total cost associated with the installation of solar PV. Reductions and exemptions can be put on VAT, property, sales, energy or the carbon tax, and are then allowed to be removed from the taxable income. The effectiveness depends on the applicable tax rate, which determines the allowed savings resulting form such policies. Sawin et al. (2011) take the Nordic countries as an example where energy taxes are high and where a tax exemption can be enough to stimulate the use of RE electricity. This illustrates how tax incentives must be adapted to the country-specific tax situation.

Tax credit is another type of tax policy that has shown to be effective in stimulating the solar PV market, particularly in the US (Timilsina et al., 2012) where a 30% federal investment tax credit is given to anyone who installs a solar PV system. The investment tax credit allows for prosumers to get reimbursed with 30% of the investment cost. This money is not refundable but is given in tax credits that can be used for income tax payments during the coming five years. Some studies show that cash payments could be preferable to tax credits since a cash payment would be equal for all people. A tax credit, on the other hand, might not be as beneficial for someone with tax liabilities that are minor than the tax credit. A study by Sarzynski et al. (2012) shows that states in the US that have complemented the Federal tax credit scheme with grants or subsidies have been more successful in deploying solar PV than states that have complemented that scheme with additional tax credit schemes or other tax policies. Another criticism towards this policy is as always related to its negative impacts on government revenues (Timilsina et al., 2012; Sawin et al. 2011).

3.3 Public finance

Commercial financing is still limited for solar PV systems in many countries. This is related to traditional lending institutions being unfamiliar with such projects which results in overestimated risks and lending requirements that are hard to meet for most clients. Public financing mechanisms are important to support the creation of financial products where the private sector is unwilling to act on its own. Such mechanism can include one or several of the instruments described below.

3.3.1 Loans and guarantees

Public finance instruments can be used to provide financing directly to end-customers for solar PV investments or indirectly through credit lines to local commercial banks or other financial institutes. The latter has shown to be effective not only to distribute money to small-scale solar PV projects, but also to build local capacity and encourage commercial banks to provide loans that otherwise would be associated with an elevated risk profile. These credit lines to commercial banks are offered at concessional rates that are meant to be passed on to the end-customer loan. A number of developing banks are offering such credit lines to commercial banks in developing countries, but there are also national banks offering "green" credit lines to their local commercial banks (Michell et al., 2011).

Another way to encourage commercial banks to finance RE projects in general and solar PV systems in particular is to offer a public guarantee scheme. Such schemes work as risk sharing mechanisms, which reduce the perceived credit risk that the local commercial banks associate with solar PV and other RE projects.

3.3.2 Investments and public procurements

In order to stimulate and develop the local market for a specific RE technology, public funds are sometimes used for direct investments in private projects or companies, so-called private equity. Such money is usually distributed through a public RE fund that is managed either by the government or by the private sector. Such investments can be useful in many parts of the development process but also in the actual deployment stage.

Other ways to encourage solar PV deployment consist on the public sector to invest in the technology for its own facilities. The potential is significant since electricity consumption within the public sector can be one of the largest shares of public expenditures (Michell et al., 2011).

4 Case studies – policy instruments in the MENA

This Chapter contains both findings and analysis in the form of case studies of the three countries and their adopted policies.

4.1 Egypt

4.1.1 Power market overview

During the last decade the power market in Egypt has been characterised by a growing electricity demand of about 7% per year. As a consequence, the total installed generation capacity has rapidly increased and reached approximately 29 GW in 2012 (RCREEE/IRENA, unpublished report, 2014). Most of the capacity relies on thermal power generation through the burning of natural gas and other fossil fuels. Hydropower used to constitute a more significant share of installed power generation but, since the rapid increase of total installed capacity, its share has been reduced to about 9% (MoEE, 2013). Since 2008, the country experiences frequent power cuts. According to interviewees, Cairo is now exposed to several power outages per day, particularly during peak hours. The power outages are officially explained as sabotage on transmission lines and other infrastructure in the country. However, the unofficial explanation relates to growing electricity demand, inadequate installed capacity, and the fact that Egypt since 2008 is a net importer of fossil fuel.

Steps towards a more liberalised power market have been taking place since the mid-1990s when the sector was opened for local and foreign investors to construct, operate and maintain electricity generation plants (EgyptERA, n.d.-a). However, the power market in Egypt is still characterised by a high level of government control in which state-owned Egyptian Electricity Holding Company (EEHC) coordinates six generation companies, nine distribution companies and one transmission company. The transmission company is the single buyer on the market and purchases the electricity from the generation companies and from the existing IPPs (MoEE, 2013). The electricity is then sold at a preferential price to the distribution companies and subsequently to the end-consumers.

Table 4-1. Electricity retail tariffs and structure for the residential sector in Egypt.

<table>
<tr><td rowspan="2">Category</td><td colspan="7">Tariff brackets and prices in EGP per kWh</td></tr>
<tr><td>1-50</td><td>51-100</td><td>1-200</td><td>201-350</td><td>351-650</td><td>651-1000</td><td>1000-</td></tr>
<tr><td>Residential consuming less than 100 kWh per month</td><td>0.075</td><td>0.145</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Residential consuming more than 100 kWh per month</td><td colspan="3">0.16</td><td>0.24</td><td>0.34</td><td>0.60</td><td>0.74</td></tr>
</table>

Source: EgyptERA (personal communication, June 17, 2014).

Egyptian electricity prices are characterised by a comprehensive subsidy system, which gives the country among the lowest electricity prices in the region, see Table 4-1. The system consists of indirect subsidies to the power sector, direct electricity subsidies and cross-subsidies. These supports constitute a significant share of the government budget and amounted to as much as 20% in 2011/2012 (RCREEE/IRENA, unpublished report, 2014). A number of efforts have been initiated to deal with this challenge and tariffs were reviewed and raised most recently in July 2014 (EgyptERA, personal communication, June 17, 2014). The electricity tariff structure for the residential customers consists of seven tariff brackets, whereof the first two are for customers consuming less than 100 kWh per month (EgyptERA, personal communication, June 17, 2014).

The main public actors involved in the electricity sector development and the RE policy in Egypt are: MoEE, the Ministry of Electricity and Energy; NREA, which is the New Renewable Energy Authority; EgyptERA, Egyptian Electric Utility and Consumer Protection and Regulatory Agency; and EEHC.

4.1.2 Policy instruments for distributed solar PV

Based on the power market situation in Egypt, the main objectives to increase the share of RE are to meet the growing electricity demand and become more independent of fossil fuel imports (RCREEE/IRENA, unpublished report, 2014). However, from the end-users point of view, one additional objective for the installation of distributed solar PV is to avoid the consequences of the increasingly frequent power outages (EgyptERA, personal communication, June 17, 2014).

The RE strategy that was adopted in 2008 specifies a target of reaching 20% of RE electricity generation by 2020. Out of this 20%, about 12% will be wind-generated, 6% will be from hydro and 2% will be from solar (whereof the largest part from CSP). 20% of the total installed capacity in 2020 will amount to approximately 7.2 GW (NREA, 2013). The RE strategy specifies that about one third of the target will be reached through public investments (NREA, personal communication, June 15, 2014). The strategy is focusing on large-scale projects and has not defined any specific target for distributed small-scale solar PV. However, according to personal communication with NREA (June 15, 2014), more attention will be given to distributed solar PV, due to the substantially lower technology prices since the strategy was introduced in 2008, but also because of the power outage challenges (NREA, personal communication, June 15, 2014). A Solar Plan was approved by the cabinet in 2012 and specifies a much more ambitious target than the RE strategy from 2008. The plan targets to install about 3.5 GW of solar power by 2027(NREA, 2013). Of this amount, it is stated that 2.8 GW should come from CSP and 700 MW from solar PV. In addition to that, a public PV rooftop program was declared in a resolution from the Cabinet in December 2013. The program targets to install 1000 PV rooftop systems on government building rooftops (NREA, personal communication, June 15, 2014).

In the context of encouraging distributed solar PV installations, the board of directors of EgyptERA, which is the electricity regulatory body, adopted a net metering decree in the beginning of 2013. This decree opens up for solar PV connection to the low-voltage grid for both the residential and the industrial/commercial sector (EgyptERA, personal communication, June 17, 2014; NREA, personal communication, June 15, 2014).

In addition to the net metering scheme, it is worth mentioning that the Cabinet has decided that a certain quota of electricity consumption from large industries must be generated by RE sources (NREA, 2013). This was decided in the end of 2013 and will come into force in January 2015 through a Guarantee of Origin scheme. The scheme will work as a Tradable Green Certificate scheme in which industries can choose to install a RE generating system themselves, or alternatively to buy green certificates on the market (EgyptERA, personal communication, June 17, 2014). Such scheme could encourage the installation of distributed solar PV, but since design details are yet to be developed, this instrument will not be analysed in this thesis.

Net metering

The main regulatory instrument to enable the deployment of distributed solar PV in Egypt is the newly formulated net metering decree. It allows for small-scale PV installations within the domestic and commercial sector to be connected to the low-voltage grid.

The net metering scheme has been designed so that any surplus electricity, produced by a solar PV system (in kWh), can be credited against kWh consumed from the grid. Characteristic for the Egyptian scheme is that the surplus is being credited only against electricity consumed in the prosumers' highest tariff bracket for each month (which should not be confused with *the* highest existing tariff bracket). If the prosumer manages to produce more electricity than the one consumed in the highest tariff bracket, the excess amount is credited to the next month. The excess transferred to the following month can be used again only to credit electricity consumed in the highest tariff bracket (EgyptERA, 2013). If the prosumer produces less kWh than has been consumed in the highest bracket, the prosumer is billed according to that difference. This means that, regardless of how much surplus electricity the prosumer feed into the grid through a solar PV system each month, he/she will always pay the monthly electricity bill according to what has been consumed from the grid in the lower tariff brackets. To illustrate this rather complex method, a calculation example is provided in Table 4-2. A final settlement is done in the end of each year for the residential sector and in the end of each month for certain sectors such as street lighting (EgyptERA, 2013). Any surplus electricity in the end of the settlement period will be granted to the distribution company (EgyptERA, personal communication, June 17, 2014).

Table 4-2. Example of electricity bill calculation.

<table>
<tr><td colspan="2">Hypothetical consumption/production</td><td colspan="4">Accounting method</td></tr>
<tr><td>Produced electricity from solar PV fed into the grid</td><td>Total electricity consumption from the grid</td><td colspan="2">Amount of kWh consumed from the different tariff brackets</td><td>EGP/kWh in the different tariff brackets</td><td>Electricity bill</td></tr>
<tr><td rowspan="5">600 kWh</td><td rowspan="5">1500 kWh (whereof 500 kWh in the highest tariff bracket)</td><td rowspan="4">Electricity consumed in the lowest tariff brackets</td><td>200</td><td>0.16</td><td>32</td></tr>
<tr><td>150</td><td>0.24</td><td>36</td></tr>
<tr><td>300</td><td>0.34</td><td>102</td></tr>
<tr><td>350</td><td>0.60</td><td>210</td></tr>
<tr><td>(Electricity consumed in the highest tariff brackets) - (Electricity produced from solar PV system)</td><td>500 – 600
= (-) 100
100 kWh will be rolled over to the next billing period to be credited from consumption made <u>only</u> in the highest tariff bracket.</td><td>0.74</td><td>0</td></tr>
<tr><td colspan="5">Bill savings month x</td><td>370 EGP</td></tr>
<tr><td colspan="5">kWh rolled over to next billing period</td><td>100 kWh</td></tr>
<tr><td colspan="5">Total electricity bill month x.</td><td>380 EGP</td></tr>
</table>

Source: EgyptERA (2013)*, Egyptian regulation on the connection of Solar PV to the low and medium voltage grid. Own translation from Arabic to English and modification according to the latest electricity tariffs.*

No installation limit has been specified, meaning that customers can connect a system that produces more electricity than they consume (EgyptERA, 2013). This is however unlikely because of a number of reasons. Most importantly, the fact that surplus electricity can only be credited in the highest tariff bracket encourages customers to install PV systems that meet a small portion of their overall load. This behaviour is reinforced through a policy design, which cancels potential excess electricity in the end of the year. Moreover, solar PV panels require roof space, which is a particular challenge in Egypt and especially in Cairo. It is considered unlikely that larger consumers targeted by this net metering scheme will have space to install systems that manage to cover their whole electricity need. The only capacity limit that has been specified can be found in the grid code for small-scale PV. This code specifies a capacity limit of 100 kW for systems connected to the low-voltage grid (EgyptERA, 2014a).

The application process includes to following steps: the customer contacts an installer who needs to have a license issued by NREA; the installer prepares the technical file required and sends it to the distribution company; the distribution company examines the technical file and approves it if conditions are met; a contract between the distribution company and customer is written; the installer proceeds with the installation (EgyptERA, 2014b)

No PV systems have yet been connected to the grid under a net metering contract. NREA is still in the process of developing license requirements for installers (EgyptERA, personal communication, June 17, 2014; NREA, personal communication, June 15, 2014). As soon as a list of licensed installers is published by NREA, EgyptERA will open the application process for grid connection. Through the public rooftop program, NREA expects public actors to be the first to connect PV systems to the grid (NREA, personal communication, June 15, 2014).

4.1.3 Institutional feasibility

Policy complexity

As previously mentioned, net metering schemes are in general associated with low administrative burden compared to both FiT and other instruments such as quota systems. The administrative arrangement that needs to be in place depends on the design details of the scheme. The Egyptian net metering design is more complex than a regular net metering scheme in which prosumers connecting a PV system receive a one-for-one credit for any electricity they operate. A basic net metering design requires a single bidirectional electricity meter, which is considered an administrative advantage of the net metering scheme. However, the rather complex calculation method that is used in the Egyptian case requires two installed meters, just like in a FiT system (EgyptERA, personal communication, June 17, 2014). Nevertheless, according to EgyptERA (personal communication, June 17, 2014), the selected calculation design does not cause any additional administrative arrangements, bidirectional meters are still an uncommon technology for the country and two meters would have been used in any design case. The calculation method that has been adopted will most likely require rather complex billing procedures for the distribution companies, especially if the prosumer produces more electricity than is used in its highest tariff bracket. However, this fact has not been confirmed by any distribution companies.

Existence and capacity of required institutions

NREA's main focus is on the development of large-scale RE project through cooperation and agreements with the private sector and bilateral agents. Its main responsibility when it comes to distributed solar PV is to set targets and develop strategies. NREA was established in 1986, but so far it has little experience in small-scale solar PV other than from rural electrification programs (NREA, personal communication, June 15, 2014). Their main involvement in the new regulatory scheme is through the issuing of licenses for PV installers. At this moment, NREA is in the process of developing requirements for the PV installer license and is struggling with the design of an enforcement mechanism to control the licensed installers. NREA expresses great concerns over the quality of installers and PV products on the market. The agency refers to the situation that occurred with solar water heaters around 20 years ago, when poor quality products entered the market and destroyed the consumer confidence for 15 years (NREA, personal communication, June 15, 2014). For this reason, NREA has decided to put in place a solid qualification program and works together with the industry to achieve this purpose (NREA, personal communication, June 15, 2014). While EgyptERA has put all regulations in place, NREA is taking time to finish the qualification program. NREA is usually setting targets for RE in Egypt, but this has not been done for distributed solar PV (NREA, personal communication, June 15, 2014). The absence of a target could constitute a challenge, since it signalise lower commitment than clear and ambitious targets.

EgyptERA is the electricity regulator in Egypt. It was established in 1997 and apart from regulating the electricity market and issuing new electricity tariffs and licenses for operators; it is responsible for designing and issuing the net metering regulation (EgyptERA, personal communication, June 17, 2014). This net metering scheme has been adopted as a Decree/Regulation by EgyptERA's board of directors. EgyptERA has also formulated and adopted a grid code for small-scale solar PV that is in line with the net metering scheme (EgyptERA, 2014b). EgyptERA has developed clear guidelines, including examples of billing calculations, see Table 4-2, for how the net metering scheme should be interpreted. EgyptERA is being financed by state budget and revenues generated from licenses issuance and renewal (EgyptERA, n.d.-b). The internal capacity on solar PV policy seems rather high, based on interviews and the work performed, but further investigation of this aspect would be needed to draw any assumptions.

As described above, distribution companies play an important role in the application process of the net metering scheme. The communication between them and the prosumers can become a challenge according to NREA (personal communication, June 15, 2014). Distribution companies have no previous experience in connecting distributed solar PV to their grids, but according to NREA, training sessions will be organised. It is yet unclear the extent to which the distribution companies will become an obstacle in this process.

A major challenge for the feasibility to deploy solar PV in Egypt is the lack of financial institutions that can provide loans or other investments to cover the upfront cost of a solar PV system. No public or private incentives are in place at the moment (NREA, personal communication, June 15, 2014; SEDA, personal communication, June 16, 2014; AFD, personal communication, June 16, 2014).

Appropriateness of responsibility delegation

Current division of administrative responsibility seems appropriate. However, the fact that the two separate boards of directors controlling NREA and EgyptERA are formed under the same Chairmanship of the Minister of Electricity and Energy could constitute a problem (EgyptERA, 2014d; NREA, 2013). The level of independency of the regulator EgyptERA can, for this reason, be questioned.

4.1.4 Effectiveness

The Egyptian net metering scheme has not yet been implemented, thus no evaluation based on empirical measurements has been done. However, it is possible to discuss the potential effectiveness of the Egyptian scheme based on its design details, the context it will operate in and a literature review of the effectiveness of different net metering schemes and other policy instruments.

Net metering schemes alone are, in general, less effective than other policy instruments such as FiT (Sawin et al., 2011). Their effectiveness relates to a large extent to the electricity retail prices applied in the country and the savings they allow the prosumers to make (Darghouth, Barbose, & Wiser, 2011). These savings, in turn, will determine the prosumers' rate of return on the solar PV investment. As mentioned earlier, even with the newly increased tariffs, Egypt has extremely low retail prices for electricity. It makes no economic sense, for anyone that consumes electricity on an average level, to install a solar PV system under current net metering scheme.

However, the Egyptian net metering scheme tries to ensure that bill savings become as high as possible by crediting surplus electricity only in the consumers' highest tariff bracket. This gives an additional economic incentive to install solar PV. Other the potential financial savings, a major non-economic incentive for large-scale consumers to install solar PV is the regular power outages in the country. Without having performed any deeper analysis on this issue, a net metering scheme, compared to a FiT scheme, allows the installer of a PV system to self-consume electricity before any surplus is fed into the grid. This aspect should be of crucial importance if there is a power outage. A FiT scheme, conversely, obliges the installer of a solar PV system to feed all electricity directly to the grid and then buy it back for consumption. However, this is a technical reflection that needs further investigation.

The Solar Energy Development Association (SEDA) claims (personal communication, June 16) that there is a demand from large-scale consumers and that 150 000 electricity low-voltage grid subscribers consume more than 1000 kWh per month without ever swinging below 1000kW.

4.1.5 Suitability of adopted policy instrument

The electricity sector is a huge economic burden for the Egyptian government, with subsidies constituting more than 20% of the state budget (RCREEE/IRENA, unpublished report, 2014). The formulated net metering scheme is an inexpensive alternative for an already burdened economy. The main barrier for the net metering scheme to work effectively in Egypt is the country's extremely low electricity retail prices. Electricity generated from solar PV is much more expensive than all kinds of electricity bought from the grid, even within the highest tariff brackets, see *Table 5-2*. The design details of the net metering scheme make sure that as large bill savings as possible will be allowed for the prosumers. However, these will not be enough to make a solar PV system economically viable even for large-scale consumers. Customers that install solar PV under the net metering scheme will not be driven by economic reasons, but rather by an energy security perspective, and considering the many power outages in Egypt, a net metering scheme is actually more suitable than a FiT scheme, which would need to be specifically adjusted to take power outages into account. However, this aspect has to be investigated more in detail.

In order for the net metering scheme to work effectively, it would probably need to be combined with either a significant increase of electricity tariffs (which is not likely in the short term), or a subsidy in form of a grant or rebate.

4.2 Palestine

4.2.1 Power market overview

One of Palestine's main objectives for increasing the share of RE in general, and solar PV in particular, is to enhance the level of energy security and become as energy independent as possible (PEC, communication, June 9, 2014). The power market situation in Palestine is characterised by the absence of large-scale electricity generation, which has resulted in a great dependency on the Israeli state-owned Electricity Company - IEC. Most of the electricity demand is now imported from IEC (PERC, personal communication, June 9, 2014) and this seems to be a constant source of conflict between the two countries.

The internal market is fully liberalised and consists of a handful of Palestinian distribution companies operating in the West bank and Gaza (PERC, personal communication, June 9, 2014). Electricity prices in the country are the highest in the MENA region and often used as a source of market comparison (RCREEE, 2013). In accordance with higher electricity prices from IEC, there have been two tariff rate increases of 8% each between 2010 and 2014. Traditionally, there have been no or few electricity subsidies in Palestine. However, according to PERC (Palestinian Energy Regulatory Council), the Palestinian Authority has now promised to subsidise the second increase by 25% (PERC, personal communication, June 9, 2014).

The electricity tariff structure for the residential sector consists of two options: either pre-paid bills according to a fixed tariff regardless of the consumption level, or a post-paid bill according to six tariff brackets.

Table 4-3. Electricity retail tariffs and structure for the residential sector in Palestine.

Category	Tariff brackets and prices in ILS per kWh					
	1-160 kWh	161-250	251-400	401-600	601-	-
Pre-paid residential	0.5650					
Post-paid residential	0.4900	0.5283	0.6350	0.6650	0.7350	1.0

Source: PERC (personal communication, June 9, 2014).

There are a low- and a medium-voltage grid in Palestine and over 240 connection lines over to Israel and IEC. Without access to the electricity meters, Palestine has no possibility to verify that the issued electricity bills from Israel are correct, and this is a big concern. This is the main reason for the issuing of the new electricity law that is supposed to regulate the electricity market and oblige everyone to connect to the distribution lines. The law also introduced a new agency with the mission to establish a high-voltage transmission grid that should serve as the only connection to the IEC in the future (PERC, personal communication, June 9, 2014).

Despite a subsidised power market and few direct subsidies of electricity tariffs, there is a substantial amount of public funds spent to secure electricity supply. While the electrification rate has reached over 99% in Palestine, only about 50% of the population is connected to one of the distribution companies (PERC, personal communication, June 9, 2014). The rest is connected to municipal grids, which are a remaining from the time when municipalities handled all electricity distribution and import. This disjointed system causes many regulatory problems and is a great burden for the state budget. One problem is; that several Palestinian municipalities direct-import electricity, in order to resell it to their residents. These municipalities have repeatedly ignored to pay their electricity bills to Israeli IEC. Nevertheless, since the sale of electricity is one of few sources of income for the Palestinian municipalities, the Palestinian Authorities have been indulgent with this behaviour and negotiated an agreement with Israel. According to this agreement, Israel should not cut electricity supply to the Palestinian municipalities and villages, but instead deduct their collected debts from tax revenues that are paid out from Israel to Palestine (PERC, personal communication, June 9, 2014). For the Palestinian Authorities, the scope of this problem accumulated about 1.5 billion EUR (7 billion ILS) of lost tax revenues between 2002 and 2014.

The main public actors involved in the electricity sector development and the RE policy process are: PEA, which is the Palestinian Energy Authority (Ministry of Energy); PEC, the Palestinian Energy and Environmental Research Centre; and PERC. These public actors will be looked upon more closely in relation to their importance for distributed solar PV to be deployed in the country.

4.2.2 Policy instruments for distributed solar PV

Palestine's RE strategy for 2012-2020 was developed by PEA, the Palestinian Energy Authority, and is based on a RE assessment that was done in 2009. The assessment was financed by the World Bank and conducted by a Spanish consultancy firm and an international board of experts (PEC, personal communication, June 9, 2014).

The RE strategy specifies an overall target of 10% electricity production from RE sources by 2020. This equals an installed capacity of approximately 130 MW. Out of that, it is foreseen that 50% should come from solar energy sources whereof 25 MW from small-scale rooftop solar systems (PEC, personal communication, June 9, 2014). In order to reach the target of installed rooftop systems, a program called Palestinian Solar Initiative (PSI), was introduced in 2012 and is officially still running even though it was interrupted recently because of financial constraints. The target of the PSI is to install 1000 PV systems on household rooftops between 2013 and 2015 (PEC, personal communication, June 9, 2014;PENRA, 2012). PSI focuses on single houses and the main support instrument is a FiT scheme, which is being described more in detail below.

There are no other programs or support mechanisms for distributed solar PV on a public level. A subsidy to cover part of the upfront cost of residential solar PV systems was discussed in the formulation phase of the PSI program, but the incentive was left out because of economic limitations and a willingness to increase the FiT level (PEC, personal communication, June 9, 2014). No public incentives have yet been introduced to encourage the industrial or commercial sector to install solar PV for self-consumption. Nevertheless, a private initiative was introduced in January 2014 when one of the distribution companies (JEDCO) launched their own net metering scheme (JEDCO, personal communication, June 10, 2014). This is an interesting scheme but it has been excluded from this thesis since it is not a public policy and therefore it falls outside the scope of this thesis.

According to personal communication with PERC and PEC (personal communication, June 9, 2014), a revision of the PSI program is taking place at the moment, and PERC is in parallel working to open up for net metering at the low-voltage grid. It is however unclear what the policy details in such scheme will look like.

Feed-in Tariff

Under the PSI program a FiT for solar PV rooftop installations up to 5kW is offered. The scheme has been designed so that residential customers sign a Power Purchase Agreement

(PPA) with their distribution company. The plan was to launch the PSI program and the FiT scheme in three phases with minor differences of conditions. The first phase would include 100 households; the second 300 households and the third 600 households. A total amount of 250 households had signed a PPA with their distribution companies before the PSI was put on hold in the end of 2013 (PEC, personal communication, June 9, 2014).

The PPAs that have been signed up until today are 20-year agreements with a market-independent tariff that is designed as a front-end loaded model. Such model offers higher payments in the early years than in the later years. In Palestine, the tariff is reduced by 7% per year and the prosumer is guaranteed purchase from a 5 kW system. In order to boost the program in the beginning, a higher Feed-in tariff was offered in the first phase. The first 100 houses got 0.234 EUR per kWh (1.07 ILS/kWh) fed into the grid. The following 150 houses in the second phase got 0.175 EUR per kWh (0.8 ILS/kWh) (PERC, personal communication, June 9, 2014). The calculation of the FiT has been done by the electricity regulatory council, PERC, and is based on the following parameters: the cost of installed kWp; the desired payback period; the total output of the system, see Figure 4-1 (PERC, personal communication, June 9, 2014). The latest FiT issued in 2013 amounted to 0.175 EUR per kWh (0.8 ILS/kWh) and was based on the following data: the cost of the installed PV was 2500 USD/kWp in 2013; the desired payback period was set to be 8 years; and the total output of the system was assumed to be around 1500 kWh per installed kWp during one year. However, according to PEC (personal communication, June 9, 2014) the cost of installed PV has decrease to around 2000 USD/kWp in only one year. This means that a new FiT has been calculated, but since the PSI program is put on hold it has not yet been issued. Nevertheless, the new FiT based on the lower price of installed PV would amount to 0.14 EUR per kWh (0.64 ILS/kWh) (PERC, personal communication, June 9, 2014).

$$\frac{\textit{Cost of installed panels (EUR/kW)}}{\textit{Output (kWh/year)} \times \textit{Desired payback period (year)}} = \textit{FiT (EUR/kWh)}$$

Figure 4-1. Calculation method for the Palestinian Feed-in tariff scheme.

Source: PERC (personal communication, June 9, 2014).

The financing of the FiT is being shared between the distribution companies and the government. The distribution companies contribute with an amount that equals the electricity tariff for residential customers with a pre-pay contract. Before the electricity tariff rise in the beginning of this year, the pre-paid tariff was 0.114 EUR per kWh (0.52 ILS/kWh). The rest of the FiT, that is the difference between the FiT level and the residential electricity tariff, is financed with a government subsidy (PERC, personal communication, June 9, 2014).

In order to be eligible for the FiT scheme several conditions have to be met: to be in an area where one of the five distribution companies operates; to have no debts to the distribution company; to be the owner of the house or have the approval of the owner; to sign the PPA through the client's own subscription with the distribution company; and to install a system not exceeding 5kW. In addition to this, a set of physical and technical requirements has to be met, such as to have enough space on the rooftop (5 kW is about 15m2) and meet the technical standards of that specific distribution company (PEC, personal communication, June 9, 2014).

The application process looks as follows: the owner applies for a PPA agreement to a distribution company; the distribution company visits the house and makes an audit; if the audit is approved, the distribution company sends an application to PERC for final approval of FiT; PERC approves and the distribution company can sign a PPA with the client. The distribution company then provides the client with a list of approved installers that the client can use to install a system (PEC, personal communication, June 9, 2014; PERC, personal communication, June 9, 2014).).

4.2.3 Institutional feasibility

Policy complexity

Once implemented, a FiT is fairly easy to administrate compared to other support instruments such as quotas. Its various design options determine the complexity and the administrative arrangements needed. The Palestinian FiT remuneration model is based on one of the most basic design options, a market-independent model, which should result in comparably low transaction costs since it does not require to actively market the system's electricity on the spot market (Toby Couture & Gagnon, 2010).

The main challenge associated with the implementation of a FiT is an appropriate calculation of the tariff level and its financing method. Appropriate calculation of tariff level means that the FiT payment has to be sufficient to recover the project cost over its lifetime. In addition, it has to entail a reasonable rate of return to make the scheme attractive for the customers (TD Couture, Cory, Kreycik, & Williams, 2010). The most successful FiT schemes offer tariffs that are determined as closely as possible to the specific generation cost, which can be determined through LCOE calculations (Toby Couture & Gagnon, 2010). LCOE is a measure of the cost per unit of PV electricity generated by the system (Pérez et al., 2014). Due to changed market conditions, the LCOE and the FiT have to be revised over time. The method requires detailed market research and is commonly used in the EU and other parts of the world where the FiT have been adopted (TD Couture et al., 2010). The calculation method used in Palestine does not incorporate the levelised cost of PV-generated electricity. However, it still uses the idea to base the tariff on the generation cost of solar power, but instead of incorporating the LCOE the method uses the investment cost of solar PV. It is a complex issue to determine whether this basic FiT scheme and its calculation method are the best design options for Palestine. Nonetheless, the calculation method seems to perform relatively well based on the resembling of the FiT in Palestine and the lower-range LCOE estimations that are being discussed further in section 5.1.2. The LCOE estimation referred to (not specific for Palestine) amounts to 0.16 EUR and the latest FiT in Palestine are 0.17 EUR and 0.14 EUR. However, this has to be further examined. An advantage with this simplified calculation method is that it allows for PERC to handle any revisions of the tariffs in-house.

Existence and capacity of required institutions

PEC has the main responsibility when it comes to development and implementation of strategies and programs for distributed solar PV. PEC is an Environment and Energy Research Centre, which in 2007, after working on a project-to-project basis for many years, was established as a permanent public agency under the Energy Authority. There are 15 people working full-time on PEC and, according to personal communication, there is a limited internal knowledge on PV policy (PEC, personal communication, June 9, 2014). The agency has been provided with international consultancy help to conduct a RE assessment and design the PSI and the FiT scheme. Installers and distribution companies have pointed out that, despite limited capacity, PEC has managed to provide clear guidelines on how the PSI works and what the application process for a FiT looks like (SATCO, personal communication, June 10, 2014).

Most of the administrative work and the actual implementation of the FiT scheme are done by PERC, which approves FiT applications and recommends new tariff levels for the Energy Authority to issue. PERC approves FiT applications based on the information obtain from the distribution companies. This is a fairly easy and fast process according to PERC and other interviewed stakeholders. PERC is struggling with financial cutbacks since the FiT was put on hold last year. As mentioned under the policy complexity section above, PERC has internal capacity to handle FiT calculations (PERC, personal communication, June 9, 2014).

As described above, distribution companies play an important role in the application process of the FiT. Customers have to rely on them to make the initial audit and send the application to PERC. Nevertheless, one of the main challenges in the implementation process has been that some of the distribution companies have been reluctant towards the FiT scheme and this has hampered the application process for customers in some areas. Interviewed installers argue that hesitance among distribution companies is caused by limited knowledge about distributed solar PV and low trust in the government to pay their part of the FiT. Another explanation is that distribution companies are worried to lose some of their most reliable customers. As mentioned in the contextual background, distribution companies are struggling with debt collection problems, and believe that the people that are going to install PVs are those who actually have money and pay their bills today. Still, while some distribution companies have been ill disposed towards the FiT scheme and managed to slow down the application process, others have introduced measures that support private financing mechanisms and faster deployment of solar PV.

The main institutional feasibility problem of the PSI is associated with the political commitment and the lack of financial resources to cover the FiT tariff payments. The government stopped paying out subsidies in 2013 with the motivation that it became too expensive. The main issue seems to have been that there was never a solid plan for how the Authority's part of the tariff was going to be financed. There are few tax revenues coming in and none of them have been allocated to cover these expenses. Neither is there a fund or similar to support this type of subsidies (PERC, personal communication, June 9, 2014). Looking at other countries that have adopted FiT schemes, the most frequently used model to finance FiT implies that an extra kWh charge is spread across electricity consumers. And in a model where the tariff is supported by governmental subsidies it is financed via a green tax or an auction of carbon allowance, where revenues are allocated to the FiT purpose (Sawin et al., 2011). One explanation to the sudden change in political commitment regarding the Palestinian scheme could possibly be related to the front-end loaded remuneration model. According to T. Couture & Gagnon (2010), this design is associated with lower political feasibility since it makes the policy looks more costly than it actually is, specially in the beginning of the implementation period.

Private incentives are in place to help finance the upfront cost of a solar PV system. These initiatives will be furthered discussed in the section 5.1.

Appropriateness of responsibility delegation

It is the electricity regulator's opinion that operations are hampered by the fact that it is not allowed to work independently (PERC, personal communication, June 9, 2014). PERC is supposed to be the electricity regulator, but it is unable to issue tariffs. This activity has to be done by the Energy Authority PEA, which is a political institution with interests that differ from those of an independent electricity regulator. Apart from that, it appears to be appropriate to reconsider who should be in charge of the FiT payments, and in which manner. Although it is not entirely transparent, it seems that payments are handled on a central level that is out of reach for anyone operating under the Energy Authority. This has of course its advantages when considering corruption risks and related issues, but leaves, on the other hand, little control for the Energy Authority to administrate and plan payments. Other responsibilities seem to have been divided in an appropriate way, and all institutions, other than some distribution companies, seem very dedicated to the their task.

4.2.4 Effectiveness

Research on policy instruments for solar PV deployment suggests that FiT is one of the most effective measures in stimulating rapid deployment of solar PV (Sawin et al., 2011; del Río, 2012; Couture & Gagnon, 2010; Lesser & Su, 2008). The fact that FIT is an effective policy instrument has been shown during the short amount of time in which the FiT scheme was operating in Palestine (PEC, personal communication, June 9, 2014). By May 2014, a total capacity of 1.25 MW was installed under PSI, achieving 25% of the adopted target for 2015. This constitutes about 250 household installations à 5 kW and all of the systems have been installed in the West Bank. PERC is the body administrating and approving FiT applications that arrive from the distribution companies and claims that about 400 applications were submitted before the program was interrupted in 2013.

The degree of effectiveness of a FiT scheme is determined by the level and design of the remuneration tariffs. The remuneration model applied in Palestine manages to meet some of the main barriers for solar PV deployment. A front-end loaded models advantage is that it allows the prosumer to benefit from higher revenue streams in the early life period of the system (T. Couture & Gagnon, 2010). This enables prosumers to payoff loans more quickly. It is also adding significant investment security since the prosumer can predict the project revenues until the very end of the project. In addition to this remuneration model, the offered tariffs were very favourable in the beginning of the program, increasing policy effectiveness. Other than policy design and tariff levels, there are, by all means, other external factors determining the effectiveness of a policy. It is worth mentioning the exceptionally high electricity tariffs in the country; this contextual factor will be discussed more in detail in section 5.1.2.

4.2.5 Suitability of adopted policy instruments

The adoption and implementation of a FiT scheme in Palestine can be considered unsuitable for many reasons. While there are few causes to criticise the transparent design and remuneration model of the scheme, there are the more reasons to question the appropriateness of a FiT scheme in this specific context. FiT schemes are cost-effective measures in markets where the PV technology is far from competitive. However, the competitiveness of PV panels has increased dramatically during the last years because of decreased panel prices. Countries with unsubsidised electricity tariffs and high solar irradiation are now most likely to be close to grid parity. This means that great subsidies are excessive and that net metering schemes offer a more cost-optimum tool to create a self-sustained market (Christoforidis et al., 2013). Palestine has the highest electricity tariffs in the MENA region, something that provides a great incentive for a net metering scheme in combination with some sort of mechanism to support the high upfront cost. No country-specific LCOE calculations have been performed but according to *Table 5-2*, PV grid parity should not be too distant. Another factor that argues against a FiT scheme for Palestine is the heavy reliance on long-term governmental subsidies. This requires a stable political climate that ensures the cohesion of the policy even in times of temporary economic turbulence. The electricity sector in Palestine represents a huge economic burden for the state budget whilst there are few sources of revenues to replenish the state account (PERC, personal communication, June 9, 2014). This gives a clear signal not to rely on government long-term subsidies. If a country like Palestine wants to boost a solar PV program in the beginning, it is more suitable to offer a subsidy in the form of a grant or rebate. This type of subsidy can be limited to a shorter time-period and be lowered over this time. Such subsidy does not require the same political stability and economic commitment as a 20-year FiT. In terms of building up confidence in public instruments, it is not the best situation to go from a FiT to a less profitable net metering scheme.

Another aspect of the suitability of a FiT relates to the use of the instrument in times of power outages. This issue needs to be further evaluated.

4.3 Tunisia

4.3.1 Power market overview

The electricity demand in Tunisia has been rising steadily during the last decades, due to growing economic activity and an electrification rate reaching 99.6% in 2013. In order to support this development, the total installed power capacity is increasing and reached approximately 4.3 GW in 2013 (STEG, 2014a). State-owned power utility STEG (Tunisian Company for Electricity and Gas) has traditionally relied on gas-fired power plants fuelled by natural gas from the country's own reserves and fuel imports from Algeria. Fossil fuel accounted for more than 98% of the electricity mix in 2012, with the remaining share consisting of a mix of renewable sources in which wind power had the largest deployment (ANME, 2013).

A liberalisation of the electricity market has been taking place since the mid-1990s when the market was opened for Independent Power Producers (IPPs). However, state-owned utility STEG continues to be the largest market actor responsible for approximately 82% of the power production in 2013, operating under monopoly since it is the single buyer of electricity in the country (STEG, 2014a).

Despite the fact that electricity prices in Tunisia are heavily subsidised, they can be considered moderately high compared to other countries in the region, especially when it comes to the residential sector (RCREEE, 2013). A program to increase the tariffs has been introduced and the latest increase came in January 2014 when prices were raised by 8%. Another 10% rise was announced in May and is to be expected during the summer 2014 (CSNER, personal communication, June 4, 2014). Tariff structure reforms were done in January 2014 to improve the effectiveness of the tariff system and better cover the cost of electricity consumed at different times. Just like many other electricity companies in the region, STEG is suffering from a large amount of unpaid electricity bills. By the end of December 2013, these bills reached an amount of approximately 210 million EUR (490 million TND)(RCREEE, unpublished report, 2014).

The electricity tariff structure for the residential sector and non-residential sector connected to the low-voltage grid consists of the economic category, which is for those consuming less than 200 kWh per month, and the normal category for those consuming more than that (STEG, 2014b).

Table 4-4. Electricity retail tariffs and structure for the low-voltage grid in Tunisia. VAT: 12%, and Municipal tax: 0.005 TND/kWh will be added to the price.

<table>
<tr><td rowspan="2">Category</td><td rowspan="2">Sector</td><td colspan="6">Tariff brackets and prices in TND per kWh</td></tr>
<tr><td>1-50 kWh</td><td>51-100</td><td>101-200</td><td>201-300</td><td>301-500</td><td>501 -</td></tr>
<tr><td rowspan="3">Consuming less than 200 kWh per month through the Low-voltage</td><td>Residential</td><td>0.075</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Res and Non-Res</td><td colspan="2">0.108</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Res and Non-Res</td><td colspan="3">0.140</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Consuming more than 200 kWh per month through the Low-voltage</td><td>Residential</td><td colspan="3" rowspan="2">0.151</td><td rowspan="2">0.184</td><td>0.280</td><td>0.350</td></tr>
<tr><td>Non-Residential</td><td>0.250</td><td>0.295</td></tr>
</table>

Source: STEG.

For the industrial and other sectors connected to the medium- and high-voltage grid, time slots illustrated in Table 4-5 determine the electricity tariff. There are additional tariff sectors for agricultural irrigation and cement manufacturers, however, only the general tariffs and tariff structures are presented in Table 4-5.

Table 4-5. Electricity retail tariffs and structure for the medium- and high-voltage grid in Tunisia. VAT: 18%, and Municipal tax: 0.005 TND/kWh will be added to the price.

Category	Sector	Tariff brackets and prices in TND per kWh			
		Day	Morning peak summer	Evening peak	Night
Medium-voltage	Uniform	0.167			
	Shift	0.152	0.238	0.218	0.115
High-voltage	Shift	0.148	0.233	0.212	0.111

Source: STEG.

The main public actors involved in the electricity sector development and the RE policy process are: STEG; STEG RE, which is a subsidiary to STEG focusing only on RE development; ANME, the National Agency for Energy Conservation; and the Ministry of Industry and Energy. No independent electricity regulator exists in Tunisia today.

4.3.2 Policy instruments for distributed solar PV

The two main objectives for Tunisia to increase its share of RE relates to energy security. Additional objectives are to reduce the energy costs and potentially become a net-exporter of RE to Europe (ANME, personal communication, June 5, 2014).

Tunisia's public policy initiatives to support the deployment of solar PV and other renewable energy technologies were modest up until the Tunisian Solar Plan (*Le Plan Solaire Tunisien*) introduction in 2009. This plan contains targets and an overall strategy, mainly for the energy efficiency development in the country but also for the development of RE. In addition to the Solar Plan, a new strategy specifically focusing on RE and solar PV has been developed by ANME, but is not yet published (ANME, personal communication, June 5, 2014). While the Solar Plan from 2009 specifies a general target aiming to reach an installed capacity of RE of 1 GW by 2016 and 4.7 GW by 2030 (ANME, 2014), the new strategy identifies specific targets for distributed solar PV with the goal of reaching an installed capacity of 60MW, 190MW and 590MW during the time horizons of 2016, 2020 and 2030 (ANME, 2013). A new regulatory framework is proposed in the new strategy and a draft has been developed by ANME and sent to the Ministry of Industry and Energy for approval. The proposed law contains a development of support policies, for example a FiT scheme targeting larger scale PV projects.

A number of regulatory and fiscal incentives favouring the deployment of distributed solar PV were introduced with the Solar Plan and are presented in detail in the next sections. In addition to a regulatory framework for solar PV, the Tunisian Solar Plan introduced a particular program to increase the deployment of distributed solar PV within the residential sector. The program is called Prosol Elec and was introduced in the year of 2009. The program makes use of both the regulatory and fiscal instruments available for customers connected to the low-voltage grid, and combines them with a commercial loan. The program is unique in its features and is described more in detail below. The target of Prosol Elec for the first two years 2010-2012 was to install 1000 PV systems with a total capacity of 1.5 MW and the target for the period 2012-2016 is to install 8000 systems with a total capacity of 12 MW (STEG, personal communication, June 3, 2014).

Net metering

The main regulatory instrument to support the deployment of distributed solar PV in Tunisia includes the possibility to sell back surplus electricity, produced for self-consumption, to the utility STEG. The overall conditions for selling back electricity are determined in Law 2004-72 and its modification in Law 2009-7 for Energy Conservation. Details, such as responsibility of tariff levels and the allowed installed capacity, have been specified in Decree 2009-2773.

This regulatory instrument operates as a net metering scheme with different conditions depending on which grid the customer is connected to: the low, medium- or high-voltage grid. Common for different groups of actors, that want to make use of the net metering possibility, is that they have to finance the connection to the grid and installation of meters (Law 2009-7). If the medium-or high-voltage grid needs to be upgraded because of a solar PV installation, this cost falls on the prosumers as well.

As for the industrial sector attached to the medium or high-voltage grid, the Decree (2009-2773) has been designed so that net excess electricity has to be purchased by STEG at the retail tariff, i.e. the tariff that the prosumers would pay for consuming electricity from the grid. The scheme is designed to produce electricity primarily for self-consumption, but prosumers are allowed to sell an amount of surplus electricity that must remain within the limits of 30% of what is being produced annually (Decree n 2009-2773). Since the retail tariff for electricity within this sector is time-based, see Table 4-5*,* the net metering scheme employs a TOU design. TOU does not credit the kWh one-for-one but allows utility rates and charges to be assessed based on when the electricity was used and produced, i.e., day or night and seasonal rates (STEG, 2014c).

For residential and other actors connected to the low-voltage grid, the Decree (2009-2773) has been designed so that self-generated electricity can be fed into the grid and credit the electricity bill on a one-for-one basis. Any net excess electricity at the end of the billing period is rolled over to the next billing period. One billing period is two month. Under this net metering scheme no monetary transfer is ever involved, and, in order to prevent the level of excess electricity from becoming too high, the Decree specifies that prosumers are not allowed to install a higher capacity of solar PV than previous years capacity subscription (Decree n 2009-2773).

Subsidy

Some fiscal incentives in form of tax exemptions were introduced under the Tunisian Solar Plan, including reduced customs duty and an exception of VAT for imported solar PV panels. Nevertheless, these incentives were removed when a smaller local production/assemble of solar PV panels started in 2013 (Gross, 2013). Other fiscal incentives are subsidies provided through the National Fund for Energy Conservation (FNME). The latter has been determined in Decree 2005-2234 and its modification in Decree 2009-362. The fund provides subsidies in form of rebates to finance part of the upfront cost of solar PV installations. For residential and other actors that want to install solar PV and connect to the low-voltage grid, up to 30% of the upfront cost can be covered, with a cap of 6450 EUR (15 000 TND). For the agricultural sector this incentive covers up to 40% of the upfront cost, with a cap of 8600 EUR (20 000 TND). The latter applies for solar PV for lighting and water pumping equipment. There is also the possibility for industrial and other actors connected to the medium and high-voltage grid to apply for a 20% rebate, with a ceiling of 43 500 EUR (100

000 TND) (Decree n 2009-362). The latter is through a part of the FNME fund dedicated to energy efficiency measures.

Implementation through Prosol ELEC

The regulatory and fiscal instruments that have been introduced to support distributed solar PV deployment have been implemented via the Prosol Elec program. The program puts together the net metering possibility with a financial mechanism in which the subsidy from FNME is combined with a preferential loan from a commercial bank. A large majority of the solar energy capacity installed in Tunisia has been realised under the Prosol Elec program and the specific target set up under this program has been reached so far (STEG, personal communication, June 3, 2014). While Prosol Elec is targeting the residential sector, little efforts to implement the regulatory framework for other sectors have been made.

Under the Prosol Elec program, the 30% rebate offered by FNME was determined to 1290 EUR (3000TND) per kW in 2010/2011 and 770 EUR (1800TND) per kW in 2012/2013. From the 1st of January 2013, the rebate has been lowered to 630 EUR (1450TND) for every kW that exceeds 1 kW, with a cap of 6500 EUR (15000 TND). The subsidy is reviewed every year and has been progressively lowered since the panels have become cheaper and the solar PV market more mature (STEG, personal communication, June 3, 2014). The commercial bank Attijari offers a preferential loan to finance the remaining cost of the PV system. Only the first two kW are eligible for the preferential loan, which amounts to 1 500 EUR (3500 TND) for a 1 kW system and 2800 EUR (6500 TND) for a 2 kW system (Attijai bank, personal communication, June 3, 2014). The repayment period is set to be 7 years with an interest rate that has been deemed confidential by Attijari bank (personal communication, June 3, 2014). However, CSNER (personal communication, June 4, 2014) states that the interest rate in 2014 amounts to 6.4-6.6%.

The net metering scheme generates electricity bill savings that allow prosumer to pay back their commercial loan to Attijari bank. This is done automatically through the utility bill every second month. If the bill for any reason is not being paid, the utility cuts the electricity supply. This mechanism provides enough security for the bank to offer the preferential conditions that characterise this loan (Attijari, personal communication, June 3, 2014). The conditions to make use of the program are the following: the customer owns his property and has a subscription to the low-voltage grid with the state utility STEG; the electricity consumption amounts to a minimum of 2000 kWh per year; there is space available for a PV installation in connection to the building. The installers handle the application process and communication with STEG and they are also the ones that receive the rebate from FNME. Consequently, the installers have to cover the upfront cost until rebate is paid out and this has proved to be a challenge for many of them (STEG, personal communication, June 3, 2014).

Other than for the use of the Prosol Elec program, there are few guidelines or standardised routines for how actors should proceed if they want to connect a system for self-consumption to the low, medium- or high-voltage grid. STEG seems to have a fairly clear "grid code light" that specifies the technical conditions that actors have to live up to. ANME, on the other hand, being involved in evaluating the overall feasibility and approval of the deployment, says that it is evaluating projects on a case-to-case basis (ANME, personal communication, June 5, 2014). A case-to-case type of evaluation does not necessarily have to be negative if the projects are very large and complex. However, the procedure becomes more transparent and predictable for the clients if there are standardised ways for how to evaluate and approve a project.

4.3.3 Institutional feasibility

Policy complexity

The net metering scheme in Tunisia is associated with relatively low administrative burden. The residential scheme has been designed according to the most basic net metering model, allowing a one-for-one credit of kWh, no matter when the electricity is consumed or produced. It also allows for any surplus of produced electricity to be rolled over to the next billing period so that no monetary transactions are involved and therefore no need for financing set ups. The net metering scheme for the industrial sector is somewhat more complex than the residential scheme, although it is simpler than other types of policy instruments such as FiT. The TOU requires special metering equipment that can take into account the time of use and production. However, the use of such meters has not been confirmed by STEG and therefore it is unclear how complex the TOU procedures are.

Fiscal incentives such as the subsidy from FNME are easy and straightforward to implement and administrate. No complicated administration is needed and the instrument can be adapted to changing market conditions without losing too much credibility. The challenge is to find a sustainable and legitimate way to finance the subsidy. The Tunisian fiscal instrument takes the form of a rebate instead of a grant. This type of design is favourable from an administrative perspective since it requires less supervision than a subsidy that is paid out before the installation is being done (Michell et al., 2011)

Existence and capacity of required institutions

ANME is the main public body working with solar PV for self-consumption. Its main mission is to develop new strategies and regulatory frameworks including evaluation and adaptation of existing policy frameworks. This is where the policy design details and programs such as Prosol Elec have been formulated. The FNME fund that disburses subsidies available for solar PV systems for self-consumption is also administrated by ANME. The Fund was established already in 2005 and has had about 17 million EUR per year (40 million TND) to spend both on RE and energy efficiency projects. The fund is financed by money coming both from specific tax revenues that have been dedicated for this fund and by means from multilateral and bilateral sources. Consequently, the financial capacity of this fund has been good, which has been of great importance for the early development of Prosol Elec. A stable money flow from tax revenues is considered to be the success factor in this case (ANME, personal communication, June 5, 2014). FNME has a board of representatives led by the Ministry of Industry and Energy. The board consists of representatives from many different ministries and concerned authorities. It takes decisions on the possible use of the fund. This type of governance creates legitimacy to the fund that enables it to develop and survive.

STEG is in charge of the administration of Prosol Elec and the technical evaluations related to grid connection of any solar system. STEG engaged in the Prosol Elec program with a lot of experience from solar PV systems as part of an early rural development program, but more importantly with experience from the Prosol Thermique program. The latter is a program very similar to Prosol Elec with the main difference that it supports the development of solar water heaters. Prosol Thermique had been running for almost 4 years when Prosol Elec was introduced. Based on its earlier experiences, STEG has developed clear guidelines describing the process of connecting a PV system for self-consumption to the low-voltage grid and the conditions for the use of the net metering scheme (CSNER, personal communication, June 4, 2014) (Soften, personal communication, June 3, 2014). The process has been made as clear and simple as possible by putting the responsibility on the installer and not the end-customer to handle the process and the risk of not receiving the rebate. This must be considered a smart design that lowers the transaction cost of the program since installers will get familiar with the application process. Nevertheless, since the Prosol Elec was introduced in 2010, STEG is struggling with the administrative burden that this program together with Prosol Thermique constitutes. STEG's limited administrative capacity implies that the procedure of connecting a solar PV system under the Prosol Elec program can take up to 6 months (CSNER, personal communication, June 4, 2014) (STEG, personal communication, June 3, 2014). This becomes a particularly large problem when taking into consideration that the subsidy is reimbursed to the installer after the PV system has been installed and approved by STEG. According to the interviewed installer (personal communication, June 3, 2014) and CSNER, a national interest organisation for operators working in the renewable energy sector, there are installers that have gone bankrupt waiting for the rebate to be disbursed (CSNER, personal communication, June 4, 2014).

In order to be eligible to do PV installations, operators need to be approved as installers by STEG, which is running a training program together with the CSNER (CSNER, personal communication, June 4, 2014). The PV market is growing steadily and the numbers of local installers that are actively working with solar PV installations are approximately 50, while as many as 130 has been eligible to install solar PV to the low-voltage grid (STEG, personal communication, June 3, 2014). Poor quality products or installations do not seem to be a big problem on the Tunisian market. The interviewees mention that they have confidence in STEG to handle quality issues, while CSNER indicates the need for a more comprehensive qualification program similar for the one existing for Prosol Thermique installers of solar water heaters. A qualification program is under development by CSNER in cooperation with STEG and ANME (CSNER, personal communication, June 4, 2014). This has however not been confirmed by ANME. The price of installed solar PV in Tunisia has gone down from 4300 EUR per kW (10 000 TND) in 2010 to 3300 EUR per kW (7600TND) in 2013. This is before any subsidy has been deducted. According to the interviewed installer, a margin of approximately 25% is put on the price (Soften, personal communication, June 3, 2014).

Appropriateness of responsibility delegation

The division of responsibility between the main public actors involved seems to be rather clear. However, several international reports and personal communication with ANME and other stakeholders in the country highlight the need to allocate resources for the establishment of an independent electricity regulator. STEG is not only responsible for a majority of the electricity generation, transmission and distribution, but also for pricing of electricity (STEG, personal communication, June 3, 2014). STEG proposes tariff rates that are discussed and negotiated with the Ministry of Industry and Energy and the Ministry of Finance. The final approval comes from the Prime Minister. An independent body regulating the electricity market would be important to ensure that the market is fair and competitive. This is not particularly important for the current policy instruments to function well, but if a FiT is introduced in the future, an independent body would give more confidence to actors that want to invest in solar PV systems and sell back their surplus to STEG.

4.3.4 Effectiveness

A combination of the two policy instruments, net metering and rebate, is well known to be effective in stimulating solar PV deployment (Sawin et al., 2011). This has also shown to be the case for the residential sector in Tunisia. The target for the first period of the Prosol Elec program, 2010-2012, was to install 1000 systems with a total capacity of 1500kW. This target was reached with a total of 1388 systems and a capacity of 2609 kW installed. As of end 2013 the level had reached 2636 houses and 5240 kW of capacity (STEG, personal communication, June 3, 2014). Both ANME and STEG project that the target to install 8000 systems of a total capacity of 12 000 kW by 2016 will be met.

It is however difficult to say to which extent the public policy support instruments have caused this effect. Several of the interviewees claim that one of the most crucial factors to reach this level of deployment has been the availability of the commercial loan provided by Attijari bank. This loan is targeting one of the crucial barriers, which is the financing of the upfront cost. Same actors claim that the market has reached such level of maturity (prices have gone down) that it would be enough to provide a commercial loan in combination with the net metering scheme, and still reach the targets for distributed solar PV under the Prosol Elec. However, the more financial support is provided the more effective is a policy in stimulating the deployment.

The industrial and other sectors connected to the low-voltage grid are provided with a more generous net metering scheme but a slightly lower amount of rebate. However, they are not eligible for the commercial loan via Attijari bank, and the two policy support instruments have not been effective at all when it comes to solar PV deployment in this sector. ANME calls for a financial mechanism that specifically targets the industrial sector for RE investments. Current rebate provided by the FNME must be revised to better suit the needs of the sector (ANME, personal communication, June 5, 2014).

All in all, effectiveness of the adopted policy instrument in combination with the bank loans has been high when it comes to the residential sector but the policy instrument in place for the industrial and commercial sector has failed in overcoming the main barriers for deployment.

Although out of scope of this paper, it is worth considering the effect that a rebate has on the level of installed capacity. Timilsina, Kurdgelashvili, & Narbel (2012) claim that the reliance on grants based on capacity installed, which is the case of Tunisia, has lately come under criticism because it is said to incentivise size as opposed to efficiency and performance.

4.3.5 Suitability of adopted policy instruments

The combination of a net metering scheme and a subsidy has shown to be suitable for the residential sector in Tunisia. Despite the rather conservative conditions of the net metering scheme, i.e. no purchase of excess electricity and an installed capacity limitation, the scheme allows residential prosumers to benefit enough from electricity bills savings to stimulate the deployment effectively. The institutional feasibility to handle and finance the subsidy scheme works well with a constant flow of money reaching the FNME fund. However, the branch organisation CSNER and utility STEG believe that the subsidy has been important to encourage deployment but could now be phased out because the net metering scheme, in combination with the commercial loan, is effective enough. The Tunisian authorities and specifically STEG have had some problems in administrating all Prosol Elec applications. This is not associated with a high level of policy complexity, considering the fact that such net metering scheme and a rebate are among the easiest policy instruments to administrate. The administrative problems are rather for a reason of staff shortage. In order to increase the effectiveness of the policy instruments, targeting the residential sector, a few actions can be taken: first of all, increase the administrative capacity at STEG, and secondly, consider a more generous net metering scheme. According to a review of net metering design details in Sawin et al. (2011), the best result of a net metering scheme in terms of installed capacity, can be obtained if the mechanism does not limit system size or capacity and allows for excess generation to be credited to the next settlement period.

As for the industrial sector, the net metering combined with a subsidy has shown to be insufficient to stimulate the market. One major obstacle is that electricity tariffs are still too low and PV installations do not make sense economically. In addition to this, the implementation of the policy instruments has been poor. No financial solution exists, and the guidelines for the use of the net metering scheme are not clear enough. The design details of the net metering scheme for the medium- and high-voltage grid are much more complex than the ones for the low-voltage grid, these need to be clarified. It is also not transparent the possibility of an industrial actor to get the rebate. All in all, investment risk is too high under current circumstances.

5 Discussion

This Chapter begins by further discussing results and experiences from the case studies analysed in the previous chapter. The discussion of case study results and the experiences from the three countries is then followed by a discussion on the methodological and analytical choices and how they have affected the results of the study. The latter includes an examination of the extent to which the research questions have been answered and how generalisable the results are for the MENA region.

5.1 Discussion of results and experiences

As mentioned above, this section aims to further discuss the results and experiences from the three case studies. This will be done partly through a comparative approach based on the criteria identified in Chapter 2, but also based on some contextual factors that have been identified as of important considerations when interpreting the results. These factors either vary between the countries or are common to all three. In *Table 5-1*, the case studies and some contextual factors are summarised and highlighted.

Table 5-1. Compilation of policies and contextual background information from Egypt, Palestine and Tunisia.

	Egypt	**Palestine**	**Tunisia**
Distributed Solar PV Policy			
Targets	No specified targets for distributed solar PV.	5 MW by 2015 20 MW by 2020	60 MW by 2016 160 MW by 2020 390 MW by 2030
Strategies and programs	Public rooftop program	Palestinian Solar Initiative	Prosol Elec
Regulatory support instruments	Net metering	FiT (Private net metering initiative by JEDCO, not regulatory).	Net metering
Fiscal incentives as support policies	None	None	Rebate via FNME
Policy instruments determined by law	No – only decree	No – only decree	Yes – law and decree's in place
Main public actors	NREA EgyptERA	PEA/PEC PERC	ANME STEG (RE)
Contextual background			
Energy situation	Significant gas resources are still available even though the country is a net importer since 2008. Solar PV can free up gas for domestic use.	No production of fossil fuels and no domestic generation of electricity. Solar PV can lower significantly electricity costs and improve energy security.	Significant amounts (50%) of fossil fuels are imported. Solar PV will reduce the need for high-cost fuel imports.
Energy security issues	Fuel and capacity shortage results in daily power outage. High-cost fuel imports.	Depends on electricity and fuel imports from Israel. Power outages and high-cost electricity imports.	High-cost fuel imports.
Electrification rate	99%	99%	99%

Independent electricity regulatory	Partly	Partly	No
Electricity market status	Single-buyer EEHC	Liberalised	Single-buyer STEG
Electricity retail prices (within residential tariff bracket 201 kWh)	Very low 0.025 EUR/kWh	High 0.11 EUR/kWh	High 0.08 EUR/kWh
Availability of financing	No	Green loans via Bank of Palestine	Green loans via Attijari bank
Amount of local suppliers/installers	190 installers in the SWH business. Many looking into solar PV too. 2 PV assemblers.	Around 50 registered solar PV companies. Problems with import via Israel.	136 installers eligible for PV installations. 3 PV assemblers.
Performance and suitability of adopted policy instruments			
Effectiveness in installed capacity	None	1.25 MW Under PSI	6 MW Under Prosol Elec
Fulfilment of targets	-	25% of 2015	10% of 2016
Institutional feasibility of **adopted** policy instruments	Moderate Administrative capacity is moderate, Political feasibility is moderate, and Economic reality is good.	Low Administrative capacity is high, Political feasibility is low, and Economic reality is poor.	High Administrative capacity is high, Political feasibility is high, and Economic reality is rather good.

Source: Own compilation based on (NREA, 2013*; PENRA, 2012;*ANME, 2013; EgyptERA, personal communication, June 17, 2014; NREA, personal communication, June 15, 2014, PEC, personal communication, June 9, 2014; PERC, personal communication, June 9, 2014; ANME, personal communication, June 5, 2014).

5.1.1 Comparison of results based on evaluation criteria

Before moving on with a country comparison it should be mentioned that the effectiveness and institutional feasibility of a policy instrument are highly context-specific and for this reason comparisons are difficult to conduct. Based on the case studies, it is, for example, not possible to say that a certain policy instrument is more effective than another.

Comparison effectiveness

Tunisia is the country, among the three, that has seen the most effective deployment in terms of installed capacity of distributed, grid-connected solar PV. With its 6 MW of installed capacity, Tunisia is the leader both in total and on a proportional per-capita basis. Palestine is second on the list with 1.25 MW installed capacity of distributed grid-connected panels, followed by Egypt who is last with no installed capacity under the support scheme. However, the level of installed capacity is a rather blunt indicator to evaluate the performance of a policy instrument and a country comparison would require more data and analysis to levelise country and policy differences (IRENA, 2012a). While Tunisia is running a successful net metering scheme combined with a rebate and a financial mechanism, Egypt has just adopted, but not yet implemented, a net metering scheme. Palestine implemented an effective FiT policy, which, however, proved to be economically and politically unfeasible. Consequently, when comparing countries, it might be more fruitful to look at more qualitative criteria, such as institutional feasibility.

Comparison institutional feasibility

As a result of the level of administrative, political and economic feasibility related to the policy instruments adopted in each country, the overall institutional feasibility has been determined. The highest level of institutional feasibility has been observed in Tunisia, followed by Egypt, while Palestine has the lowest rank.

The policy complexity of the Tunisian net metering scheme, combined with a subsidy rebate, is rather low. This, in combination with appropriate institutional arrangements between STEG, STEG RE and ANME, results in a high level of administrative feasibility. Palestine, on the other hand, has a moderate administrative capacity due to the fact that its implemented FiT policy is more complex than Tunisia's net metering scheme, but also because of unclear division of responsibility, particularly when it comes to the electricity regulator PERC. Egypt has not yet started the implementation process of its net metering scheme, but based again on the fact that policy design is rather complex and distribution companies are inexperienced with such administration, it is assumed that the administrative capacity is moderate at the moment.

Other than policy complexity and administrative arrangements, it is important to consider the political and economical feasibility in order to determine the overall institutional feasibility of a policy. A factor that influences the political feasibility is the existence of clear and measurable targets. Both Tunisia and Palestine have adopted clear targets when it comes to RE in general and distributed solar PV in particular. This does not only show political commitment, it also allows evaluating performance based on ambitions. Palestine has reached 25% of its target for distributed solar PV for 2015, while Tunisia has reached more than 100% of the specific target for Presold Elec but only 10% of the 2016 target for overall distributed solar PV. Egypt has not yet specified any targets for distributed solar PV. This is troublesome, since policy instruments framed around specific goals and targets are more likely to achieve results (Lipp, 2007). However, political feasibility cannot only be based on initial commitment through adoption of targets. Another important aspect is that the policy instrument can be considered legitimate both in the initial phase and over time. Two ways to increase legitimacy of an instrument are to make sure that as little overcompensation as possible is being paid out, and that the economic feasibility to implement the policy is high. This can be assured through a policy design that can be adapted to changing market conditions and through the establishment of a transparent and well-functioning RE fund. In order to avoid that overcompensation is being paid out via the Tunisian subsidy rebate, this rebate is being revised and reduced every year. In addition to that, Tunisia has in place a well functioning RE fund that can finance its subsidy scheme. The Palestinian FiT has been designed in order to minimise overcompensation as much as possible, for example through a degression rate of 7% per year and a revised FiT for each new implementation phase that is launched. However, the implementation of a FiT in a country characterised by a high electricity tariff as Palestine can be hard to legitimate politically in the first place. The fact that the country lacks economic capacity to support such policy does not ease the issue. As for the situation in Egypt, political feasibility of a net metering scheme is seldom an issue since the risk for overcompensation and economic unfeasibility is low. However, a potential factor that could lower the political feasibility of a net metering scheme in Egypt is related to the demands from distribution companies. This issue is being discussed more in detail in section 5.1.2.

5.1.2 Interpretation of results based on contextual factors

Even though it is difficult to determine exactly what caused the effectiveness and suitability of a policy, it is possible to identify some factors and features that generally play a more important role than others. The importance of factors such as policy features and design details, clarity, commitment and institutional capacity has already been discussed in the case studies and in the section above. Other factors that influence the characteristics, performance and suitability of a policy are contextual factors in the country. An analysis of such factors in these specific contexts can further help interpret and understand the results from the case studies and provide lessons for countries that are in the process of developing policy instruments for distributed solar PV. Some contextual factors that deserve attention in the light of the design and performance of the policies are the electricity prices in relation to grid parity of solar PV, the availability of financing, the availability of rooftop space and the attitude among distribution companies. These factors have been identified as particularly relevant for solar PV deployment in the MENA region and will therefore be discussed below.

Electricity prices and grid parity

According to both interviewees and literature, the factor that seems most likely to drive rapid market adaptation in the MENA region is the economics of deployment (Griffiths, 2013). The most common way to evaluate the economic viability of solar PV deployment is based on a comparison of the levelised cost of solar PV electricity (LCOE) and the cost of conventional utility-generated electricity. If the cost of electricity generated from solar PV (LCOE) is lower than or equal to the local price of conventional generated electricity purchased from the grid, than grid parity[3] has been reached and the deployment of PV is economically viable without any subsidies (Griffiths, 2013).

As mentioned earlier in this paper, LCOE is a measure of the cost per unit of PV electricity generated by a particular system (Pérez et al., 2014). LCOE is based on a number of factors including the initial cost of the installed system cost, operation and maintenance costs, local solar resource and climate, PV panel orientation, financing terms, system lifetime and taxation (Griffiths, 2013). No country-specific LCOE calculations have been possible to perform within the scope of this paper. Nevertheless, through a review of recent published reports and papers, it is possible to get an idea about the LCOE for solar PV rooftop installations in the region. The Global Status Report on Renewables published by REN21 (2014), specifies that the LCOE for Solar PV rooftop systems in non-OECD countries varies between 0.21 and 0.42 EUR per kWh (22-55 U.S. cents/kWh). Considering that the LCOE is sensitive to the local solar resources and climate in terms of the average electricity generated per kW and year, the MENA countries can be assumed to find themselves in the lower part of that range. This assumption is being supported by other studies where LCOE figures are lower. The Oxford Institute for Energy Studies has recently published the Roadmap of Renewable Energy in the MENA (El-Katiri, 2014). This report specifies that the LCOE for an average typical PV rooftop installation is 0.10 EUR per kWh (13 U.S. cents per kWh). The same figure is used in a GIZ report investigating the solar PV market in Tunisia (Gross, 2013). The LCOE for solar PV generation is also examined in a report published by (IRENA, 2012b), showing that the LCOE for residential solar PV in 2011 could be found in the range of 0.19 to 0.49 EUR per kWh (0.25-0.65 U.S. cents per kWh), whilst it is projected that the LCOE for such systems could reach 0.16 to 0.37 EUR per kWh (0.21-0.49 U.S. cents per kWh) by 2015.

Electricity retail prices in the MENA region are, in general, heavily subsidised and do not reflect the actual cost of generation, transmission and distribution (Griffiths, 2013). Among the countries examined in this study, Palestine constitutes an exception. Negligible support has been given to the electricity sector and its consumers; and as consequence, Palestine has the highest electricity tariffs in the region. Based on the belief that it is the financial viability of solar PV that drives the deployment, customers in Palestine should be the ones with the highest incentive to install solar PV rooftop systems, needing low amounts of government

[3] "Socket-parity" is the actual correct term for when the cost of electricity generated from solar PV is lower than or equal to the retail electricity prices paid by the customers (Griffiths, 2013). However, grid parity is widely used and for this reason will be empolyed in this thesis.

support. Tunisia's electricity tariffs are not far from the level of Palestine's ones, despite the fact that they have been heavily subsidised. Egypt, on the other hand, has among the absolute lowest tariffs in the region because of various subsidies in all parts of the fuel supply chain.

Table 5-2, gives an overview of the grid parity situation in the MENA region. The table is based on electricity prices for three different categories of residential customers and the LCOE figures projected by IRENA for 2015. The choice of the (IRENA, 2012b) figures is motivated by the fact these figures stand at an intermediate point between the estimations from other studies.

Table 5-2. Grid-parity situation for rooftop solar PV in Egypt, Palestine and Tunisia.

	Egypt	Palestine	Tunisia
Electricity tariff 201 kWh per month	0.03 EUR	0.11 EUR	0.08 EUR
Electricity tariff 501 kWh per month	0.04 EUR	0.14 EUR	0.15 EUR
Electricity tariff >651 kWh per month	0.06 EUR	0.16 EUR	0.15 EUR
LCOE 2015		0.16 – 0.37 EUR per kWh	
Grid-parity	Far from grid-parity for all categories of consumers	Close to grid-parity for high level consumers	Close grid-parity for high level consumers

Source: Own compilation. Palestinian tariffs are based on the post-paid consumption category. Egyptian tariffs are based on the consumption category consuming more than 100kWh per month and the Tunisian tariffs are based on the consumption category consuming more than 200 kWh per month. All tariffs and sources can be found in Table 4-1*,* Table 4-3*,* Table 4-4*,* Table 4-5. *(1 EUR =9.47 EGP, 2.29 TND, 4.68 ILS. Exchange rate from 24 August 2014* (XE, 2014)*)*

Based on the lower LCOE estimation, *Table 5-2* shows that Palestine reaches grid parity for consumption made in the highest tariff bracket. Tunisia is very close to reaching grid parity for consumption in the two highest brackets, while Egypt, on the other hand, is far from grid parity in any of the consumption categories. The results in the table show that none of the countries. Apart from that, the table gives a general idea about the level of support needed in order to reach an economically feasible investment for different groups of customers and this can to some extent explain the effectiveness of the adopted policy schemes in the different countries. What this factor should be able to explain to a larger extent is the characteristics of the adopted policies, however, seen from a grid-parity perspective it is hard to understand why Egypt has adopted such low supports while the opposite applies to the FiT scheme in Palestine.

Nevertheless, when analysing the table it is important to remember that none of the figures are static. Electricity subsidies in Tunisia and Egypt cause an enormous fiscal burden for the two countries, implying that additional reforms and price increases are necessary to take place in the near future (Fattouh & El-Katiri, 2013). Simultaneously, it is projected that module costs for solar PV will continue to fall while efficiency of the panels will increase, something that will have a positive effect on the LCOE. As a result of this, grid parity will be reached at some point.

Availability of financing

Even if policy instruments allow for the solar PV panels to become financially viable throughout their lifetime, the up-front financing has shown to be a major challenge in many parts of the world (Drury et al., 2012) and also in the MENA region (Attijari, personal communication, June 3, 2014;Bank of Palestine, personal communication, June10, 2014). Commercial financing is still limited for solar PV systems in many of the countries examined (AFD, personal communication, June 16, 2014). This is related to traditional lending institutions being unfamiliar with such projects which results in overestimated risks and lending requirements that are hard to meet for most clients (Attijari, personal communication, June 3, 2014;Bank of Palestine, personal communication, June10, 2014). Public financing mechanisms can help solve such issue through support of the creation of financial products when the private sector is unwilling to act on its own. Moreover, it should be noted that loans is a type of financing that is seen as problematic among groups in the MENA region. One reason for this involves the reluctance towards interest rates because of religious beliefs (Islam prohibits interest based loans).

The availability of financing options should, to a certain extent, be able to explain the effectiveness of the adopted policy schemes. The two groups, among the ones examined in this study, that have seen the highest levels of deployment (residential customers in Tunisia and Palestine) are also the ones that have had access to a bank loan or an alternative financial mechanism to support the upfront cost. So-called "Green" loans (loans with preferential conditions for investment in green technology) are available in Tunisia, Palestine but not in Egypt. The green loan that is available in Palestine is provided by the commercial Bank of Palestine who does not benefit from any public credit line or similar public support. The commercial loan available in Tunisia is part of the Prosol Elec program and has been initiated to some extent through public support. These two are the only available loan options in the countries that have been examined. The loans are being described in the remaining paragraphs of this section. In addition to that, some innovating financing models that have developed in Palestine are being described.

In the case of Tunisia commercial Attijari bank offers a green loan to residential customers. The loan has been designed to fit the conditions of the Prosol Elec program and public administrations have been involved in the design process. Only the first two kW that are being installed under the Prosol Elec program are eligible for the preferential loan via Attijari bank. This loan amounts to 1 500 EUR (3500 TND) for a 1 kW system and 2800 EUR (6500 TND) for a 2 kW system (Attijai bank, personal communication, June 3, 2014). The repayment period is determined to be 7 years with an interest rate that were set to be somewhere around 6.4-6.6% in 2014. The repayment is done automatically through the utility bill every second month. If the bill for any reason is not being paid, the utility cuts the electricity supply. This mechanism provides enough security for the bank to offer the preferential conditions that characterise this loan (Attijari, personal communication, June 3, 2014).

As for Palestine, green loans are offered by the commercial Bank of Palestine. This bank offers concessional loans with lower interest rates than usual and payback requirements that are suitable for a PV system. Households can get a loan that covers 100% of the upfront cost with an interest rate of 5% (the regular interest rate in Palestine is 9%) and a repayment period of 7 years (Bank of Palestine, personal communication, June 10, 2014). The bank has an agreement with one of the distribution companies so that the loans can be paid back via the electricity bill. This provides an important security for the bank, which is enabled to offer this type of loan. In order to be eligible for a green loan, it is necessary to have: a work with a stable income; some sort of personal guarantee (gold, land, money on the bank, etc.); an account with the Bank of Palestine. This bank has provided about hundred green loans in total, but it is unclear how many of these have been used to finance solar PV installations. In a personal communications with the bank it was argued that the demand for green loans is low, and that they wish for installers and PEC to promote the green loans more actively. However, according to an installer, to be approved for a green loan via Bank of Palestine, is not as easy as it sounds and many people that want to install a system struggle to finance the upfront cost.

An alternative to individual bank loans is innovative business models based on third-party ownership. Such models have developed in Palestine. One of the biggest installers in Palestine has developed an innovative business model based on third-party ownership: the installer covers the initial upfront cost of the PV system and installs it on the rooftop of the customer. The customer pays off the system with the monthly FiT revenues through the electricity bill; according to the installer this takes around 6 years. The service is provided to a cost that is put on the total price of the system; instead of paying 6500-7000 EUR (8500-9000 USD), for a 5 kW system the customer ends up paying a total of 8000-8500 EUR (10500-11000 USD) to the installer (SATCO, personal communication, June 10, 2014). Around fifty of the installed PV systems under the Palestinian Solar Initiative have been financed and installed through this business model. The interest among households has been great but the installer has a limited capacity to use this business model because of capital constraints.

The Palestinian distribution company JEDCO is also offering a third-party business model to schools, hospitals and municipalities. JEDCO installs and owns the system for twenty years. The customer benefits from the solar PV system between eight o'clock in the morning until two-three o'clock in the afternoon. The rest of the time, all solar generated electricity is granted the utility. JEDCO has no plans on expanding this business model to also cover households (JEDCO, personal communication, June 10, 2014).

Further research is needed to better understand both the green loan situation, the existence of innovative business models and Islamic banking in the MENA region.

Availability of space

Another contextual factor that highly influences the possibility for solar PV deployment and the effectiveness of policies is the space available for rooftop or nearby ground-mounted installations. The availability of rooftop space is highly context-specific and depends on the characteristics of the housing sector but also on competing use of space by other types of applications, such as solar water heaters (SWH). All three countries in this study have seen a large deployment of SWH, which occupy considerable parts of the rooftops, particularly on apartment blocks. If rooftop space is available on such buildings, it is likely to be an unfavourable location for solar PV because of shading and difficult access for the weekly maintenance. The latter mainly consist of panel cleaning, which is needed up to two times a week in a sand-dusty city like Cairo (EgyptERA, personal communication, June 17, 2014). Another aspect worth considering regarding rooftop mounting is the requirement from distribution companies to have easy access to meters.

The reasoning around space availability mainly concerns the residential and commercial sector. However, the situation for the industrial sector looks somewhat different. One major challenge is that this sector needs larger scale PV systems, which require more space. Even though it is more likely that industries have this sort of rooftop space, it is not always suitable for a solar PV system due to the systems heavy weight.

The countries studied in this paper experience similar challenges concerning the availability of rooftop space. One approach to solve such problem could be to introduce the possibility of electricity *wheeling*. This has in fact been done in Tunisia through Law 2009-7 and Decree

2009-2773. The Decree specifies, among other things, the conditions for the use of the grid to transport electricity from one distant production site to another consumption site. This operation is called wheeling, and makes it possible for prosumers without sufficient space in their surroundings to build their system in a better-suited location somewhere remote from their consumption site. The cost of using the grid for such transportation in Tunisia is specified to be 0.0022 EUR (0.005 TND) per kWh regardless of the distance (STEG, personal communication, June 3, 2014). This decree applies for commercial and industrial customers but no one has made use of it so far. It is unclear if the wheeling possibility can be combined with other policy instruments such as net metering and FiT.

While wheeling of electricity could be a way to solve the challenge of space availability in Egypt and Tunisia, Palestine is faced with a more complex issue when it comes to land control. The Palestinian territory is divided in three types of areas called A, B and C. A and B areas make up roughly 38% of the West Bank and includes most Palestinian cities and rural communities. These two areas are to a large extent controlled by Palestinian Authorities, even though the security responsibility in area B is shared between Israel and Palestine. However, area C, which consequently constitutes 62% of the West Bank, remains under the control of the Israeli Authority. What highly affects the deployment of solar PV in this region is the fact that Israel retains all authority over building and planning in area C (OCHA, 2014). According to interviews with both installers and PEC (personal communication, June 9, 2014), the area C situation constitutes a particular problem for the deployment of large-scale solar PV in the country. It is within area C that most of the illegal Israeli settlements have been constructed, and one major challenge associated with them is settler-related property damage. The high amount of property damage incidents that affect Palestinian farmers and other groups within area C has been confirmed by the UN Office for Coordination of Humanitarian Affairs (OCHA, 2014). According to interviews with installers in the country, the impendent concern over property damage causes solar PV systems not to be installed at all, or alternatively, to be installed in unfavourable orientations and angles in order to protect the panels from being vandalised.

The space factor can to some extent explain the characteristics and effectiveness of the adopted policy schemes. Egypt's scheme is targeting high-level consumers, not only because of an increased financial viability within this group, but also because they are more likely to live in a house with available rooftop space. It is unclear how this factor has influenced policy design in the other two countries, what is more certain is that it has probably influenced the effectiveness of policies negatively.

Distribution companies

An aspect that has been brought up by several interviewees in all three countries is the importance of distribution companies. Many interviewees consider that distribution companies constitute a barrier to large-scale deployment because of their reluctance towards solar PV. From the perspective of the distribution companies, this relates to a concern over technical uncertainties and decreased revenues. Schleicher-Tappeser (2012) states that the connection of distributed power will change conditions fundamentally for distribution companies, particularly when it comes to power generation fluctuations and spatial patterns. However, according to Poullikkas et al. (2013), there are some misconceptions and exaggerations regarding distributed power and how it will hurt utilities by reducing their revenues. Poullikkas et al. mean that utilities would be hurt if all households put solar PV on their rooftops, but emphasise that the current market is still far from reaching this level. Instead, Poullikkas et al. claim that current level of distributed solar PV can actually reinforce the distribution grid. Distributed power can help reduce electricity losses by strengthening voltage in remote parts of the grid (Poullikkas et al., 2013). In addition to this general concern, which is common among distribution companies worldwide, distribution companies in the MENA region are also faced with another issue that seems to increase their level of concern. The latter is constituted by the high level of unpaid electricity bills, which has been shown to be a common problem in the region. The unpaid electricity bills relate to solar PV deployment in two ways. First of all, customers likely to install solar PV are the ones that currently pay their electricity bills on time. Being debt free is usually even a requirement in order to be allowed to connect solar PV to the grid. Second, customers installing solar PV are likely to be high-level electricity consumers. This means that customers likely to install solar PV are some of the most valuable and reliable customers for the distribution companies in the MENA region, which are now concerned about losing them (3k Solar, personal communication, June 10, 2014).

Utilities and distribution companies in the three examined countries are all faced with the challenge of unpaid electricity bills. Egyptian EEHC reported an 8.5% of revenue loss due to unpaid bills in 2011/2012 (RCREEE, unpublished report, 2014) Tunisian STEG reported that their unpaid bills represented 16.6% of their turnover in the end of 2013 (RCREEE, unpublished report, 2014). A figure on lost revenues in Palestine has not been found, but it is clear that this is a major problem in this country as well. In order to overcome the problem, Palestine has introduced the alternative for customers to post-pay their electricity bills to a lower and fixed tariff, see Table 4-3.

It should be mentioned that many distribution companies in the region are cooperating and have opened up their grids to a large extent. However, many interviewees believe that distribution companies have had a large influence when it comes to determined level of allowed installed capacity. Nevertheless, there is one distribution company that stands out when it comes to the question of encouraging solar PV deployment and that is Jerusalem Electricity Distribution Company (JEDCO). This company has on its own initiative introduced a net metering scheme. Such encouraging initiative can be explained by the fact that Palestinian distribution companies are in a slightly different position than most of their correspondents in other countries. Most of Palestinian distribution companies have no other option than to buy their electricity from Israeli IEC. This single supplier of electricity implies a huge dependency and large grid losses, on average 26%, because of the lengthy transportation distance (PERC, personal communication, June 9, 2014). JEDCO seems to have understood that distributed solar PV connected to its grid can reduce both grid losses and the dependency on IEC.

Considering the fact that distribution grids were once conceived to distribute centrally produced electricity according to a certain business model, it is not surprising that these actors react to the emergence of distributed solar PV. This concern can best be met through capacity building and cooperation.

5.2 Discussion of methodology

The research approach taken in this thesis is based on qualitative case studies of three countries and their adopted policy instruments for distributed solar PV deployment. The performance and suitability of adopted policy instruments have been evaluated through the lens of two criteria: effectiveness and institutional feasibility.

5.2.1 Methodological approach

The choice of methodological approach, in form of qualitative case studies, has proved to be appropriate for the purpose of this study since it allowed identifying and examining policies within their particular contexts. No methodological approach more suitable to structure this type of study was identified. Based on the fact that very limited and fragmented information about the policies under examination was available, the data collection process has been the most challenging part. Limited data availability has required a lot of interviews and mail correspondence to understand the policy details. This process has been time-consuming but necessary to reach a stage in which an evaluation of the policies could take place. Consequently, one major limitation of this study is the reliability of data. To increase the reliability it would have been desirable to verify details through more interviews and professionally translated documents.

5.2.2 Choice of evaluation model

After a comprehensive review of the evaluation literature effectiveness and institutional feasibility were selected as evaluation criteria for the study. These criteria and their indicators, in combination with limited data availability, are likely to be the parameters that have most affected the study results. An evaluation based on the other criteria and indicators would have resulted in a very different analysis and conclusion.

The suitability of a certain policy in a specific context is discussed based on its effectiveness and institutional feasibility. This approach assumes that suitability is high when effectiveness and institutional feasibility are high. Depending on the objective of the policy, this does not necessary have to be the case. Many potentially suitable criteria were deselected in the early research process. Out of these, especially efficiency and equity could have given an extra dimension to the analysis on whether a certain policy is suitable or not in a particular context.

A critical challenge was to identify and decide what indicators to use in order to assess how well the policy had done regarding effectiveness and institutional feasibility. The author acknowledges that the selection of indicators has some important implications for the study and it is reasonable to question this choice. In order to increase the chances to replicate the study it would have been appropriate to identify variables and units of measurement under each indicator. Currently, the evaluation of each indicator is somewhat simplified and could be considered rather subjective, something that affects both validity and replicability of the study. However, based on the purpose of the study, the limited information about the policies, and the unavailability of data in the countries under examination, the author is determined that the choices of criteria and the simplified approach were the most suitable for the scope of this study.

5.2.3 Additional concerns

The research questions can be considered legitimate since they have been possible to answer in an adequate way. A *why* question could have complemented and provided a better explanation of the results, but this would have required additional resources. The answer to the first research question concerns the characteristics of the policies and has been thoroughly described in Chapter 4. The answer includes the most relevant policy details and characteristics, which are also highlighted in the literature on policy instruments for solar PV. From this perspective, the first research question can be considered fully answered. The second research question concerns the effectiveness and institutional feasibility of a certain policy instrument in a particular context. This question leaves more room for interpretation and discussion and would have to incorporate additional considerations and details to be considered fully answered.

The study aims to provide a better understanding of the solar PV policy situation in the MENA region. It is however questionable whether the results from the different case studies can be generalised to the rest of the region. Nevertheless, findings and conclusions about the suitability of certain policy instruments should be of great interest for countries with similar institutional characteristics and contextual backgrounds. Such countries are likely to be found in the same region but possibly also in other parts of the world.

To further discuss and validate the findings in this thesis, it is necessary to compare the results with those of other studies using similar approaches. This is however challenging since few published studies have been conducted on this subject in the MENA region before. This forces the author to compare the results with studies from other regions. While effectiveness is a very common evaluation criterion within the RE policy literature, institutional feasibility is unusual. Institutional feasibility has been used to evaluate and compare RE policy instruments in general, but it has not been used to evaluate a certain RE policy in a particular context. Verbruggen & Lauber (2012) consider institutional feasibility in one of their comparative studies of solar PV policy instruments in general. Their study shows that FiT policy complexity is rather low and institutional feasibility should be high if only individual countries adapt their general knowledge to design FiT for local circumstances (should be done within standard administration) (Verbruggen & Lauber, 2012). The results from this thesis show that such knowledge adaptation has been done in Palestine, partly through the establishment of PERC. However, if economic and political constraints are as high as in Palestine, it should be difficult, even with adapted knowledge, to design a suitable FiT scheme. As mentioned before, effectiveness is a very common criterion when evaluating RE policy. However, no studies on effectiveness of solar PV policies have been conducted in the countries under examination, and to compare the results from one country with those from another, would not contribute to this discussion.

6 Conclusion

The problem addressed in this study concerns first of all, the limited amount of analysed information that exists on distributed solar PV policies in the MENA region. Secondly, it relates to the challenging task of designing policies that effectively encourage solar PV deployment in specific contexts. Based on this problem statement the following research questions were formulated in the initial phase of the study. *I. What are the characteristics of the policy instruments for distributed solar PV in Egypt, Palestine and Tunisia? II: Within the context in which they operate, what is the level of effectiveness and institutional feasibility of the adopted policy instruments?*

6.1 Characteristics of policy instruments

The study shows that policy instruments in the three countries have very different characteristics. However, all countries have policies that allow electricity to be fed into the grid under more or less preferential conditions.

The Egyptian policy instrument is characterised by a design that provides minimum incentive for solar PV deployment, other than for very high-level electricity consumers. The country has recently adopted a net metering scheme that targets residential customers. Its design is rather complex since it allows prosumers to offset electricity consumed only in their highest retail tariff bracket with self-produced electricity from the PV system. Any net excess electricity (in the highest tariff bracket) in the end of the month is credited to the next month. Any excess electricity in the end of the year is granted to the utility. No monetary compensations are included under the scheme.

The Palestinian policy instrument (that has now been interrupted) is characterised by a design that provides large incentive for any residential customers to install solar PV. Palestine has adopted, implemented and recently interrupted a feed-in tariff scheme. The policy targets the residential sector and offers a 20-year power purchase agreements with a market-independent tariff. The tariff is reduced by 7% per year and prosumers are guaranteed purchase from a 5 kW system. The scheme has been implemented in phases and the initial offered FiT has been reduced for each new phase.

The Tunisian policy instruments are characterised by a design that provides high incentive for for residential medium and high-level customers to install solar PV, but not for the other sectors targeted by the schemes. Tunisia has adopted a net metering scheme and a subsidy in the form of a rebate. The two policy instruments target both low-voltage (residential, commercial and smaller industries) and medium/high voltage (larger commercial and industries) customers. For the low-voltage group, net metering is used in its most simple form. Any electricity produced by the PV system can be used to credit any electricity consumed from the grid. Net excess electricity in the end of the billing-period of two month, is rolled over to the next billing period. No monetary transfer is ever involved. For the medium/high voltage group, a time-of-use (TOU) metering is employed. The electricity fed back to the grid is net metered in accordance with the TOU tariffs in place for this category of customers. Any excess in the end of the year is purchased by the utility. The subsidy in the form of a rebate covers up to 30% of the upfront cost for the low-voltage group, and up to 20% of the upfront cost for the medium/high voltage group.

6.2 Evaluation of policy instruments

The level of effectiveness and institutional feasibility of the policy instruments, within their particular contexts, vary a lot. However, all countries seem to have a relatively high level of administrative capacity and organisations in place to handle the instruments they have adopted.

Egypt's net metering scheme has not yet been implemented and the reasoning around its potential effectiveness is based on theoretical assumptions. Based on such, a net metering scheme alone will most likely not be effective in encouraging the deployment of solar PV in Egypt. The main argument for this relates to the policy choice in combination with extremely low electricity retail tariffs in the country. The institutional feasibility to handle and implement the scheme is estimated to be moderate. Public institutions are in place and seem to be capable and committed to handling their part of the implementation. What keeps Egypt on a moderate level is the fact that the policy complexity is high and distribution companies, which will be responsible for the administration, are inexperienced.

The Palestinian FiT scheme has been effective in meeting some of the main barriers for deployment in Palestine, namely the investment risk and economic attractiveness. A total capacity of 1.25 MW has been installed under the Palestinian Solar Initiative, achieving 25% of the adopted target for 2015. The institutional feasibility to successfully operate the FiT scheme on a longer-term basis has been determined to be very low. The administrative capacity is high but economic constraints have led to political unwillingness to continue the FiT scheme.

The Tunisian net metering scheme in combination with a subsidy and a preferential bank loan, has shown to be very effective among the group of customers connected to the low-voltage grid, especially residential customers. A level of 5.2 MW of installed capacity has been installed under Prosol Elec, achieving 100% of the target for the program and 10% of the overall target for rooftop installations by 2016. The effectiveness of the net metering and subsidy targeting medium/high voltage customers, have on the other hand, been really low, and very few systems have been installed and connected to the grid. The institutional feasibility for successful implementation is high in the case of instruments targeting the low-voltage customers. All institutions are in place and have a high financial and administrative capacity. However, appropriate administrative arrangements are missing to successfully implement the instruments targeting medium/high voltage customers.

6.3 Concluding remarks

The aim of this master study was to develop a better understanding of policy instruments adopted for distributed solar PV in the MENA region. This aim has been fulfilled through in-depth case studies of adopted policy instruments in three selected countries. It should be noted that more research is required to attain a good understanding of the situation in the whole region.

The experience from the three countries, illustrates first of all, that policies, in order to be successful, have to be carefully chosen and designed according to a country's institutional capacity and contextual background. As concerns institutional capacity, the result shows that the administrative capacity is rather good but particular attention must be taken in relation to a states economic ability to finance a policy instrument. Regarding the contextual background, a number of factors seem to particularly influence the deployment rate and effectiveness of policy instruments in the three countries. Electricity price is the main factor and results show that the countries and sectors with the highest tariffs have seen the largest level of deployment. It also shows that the combination of policy instruments and concessional loans, to support the upfront cost of a system, is a successful concept. Other contextual factors that have shown to be of importance to consider are the availability of rooftop space and attitude of the distribution companies.

The three countries examined are among the ones that have come the furthest regarding the adoption of policies for distributed solar PV deployment in the MENA region. Thus, this study contributes with an initial understanding of the policy situation and can hopefully provide some insights for policy makers in the region as well as contribute to the body of policy evaluation literature. In addition to the findings in terms of characteristics, performance and suitability of the adopted policies, the thesis also contributes to the literature from a methodological perspective. It demonstrates the importance of employing several criteria when evaluating a policy and shows that effectiveness is a rather inadequate criterion on its own. It is also one of the first RE policy evaluation studies that makes an attempt to apply the criterion institutional feasibility to country-specific contexts.

It was stated in the beginning of the thesis that the audience for this study consists of policy makers and stakeholders interested in the deployment of RE in general and solar PV in particular. Based on the findings in this thesis the main recommendation to policy makers in the MENA region is; to not underestimate the importance of choosing and designing policies that meet the country-specific institutional constraints. A policy that has been adopted and implemented successfully in one country might as well fail in another context. When proceeding with policy development in the region it is recommended by the author to conduct ex-ante evaluation studies taking into account institutional feasibility and other contextual factors such as electricity retail prices. Such studies can then be compared with the experiences from other countries and the findings in this thesis.

Other stakeholders that might be interested in the result of this thesis are installers and developers. Many installers and developers are lobbying for comprehensive subsidy schemes, however, based on the insights from this study the main recommendation to them would be not to rely too much on future large-scale subsidies. Instead, it is probably wise to adapt business models, for distributed solar PV, to the fact that more and more countries are looking into net metering schemes. Distribution companies are another group that should be interested in the development of distributed grid-connected policies. The main recommendation to this group is related to its reluctance. Policies for distributed solar PV will most certainly become more common and expand in the whole region. Distribution companies are probably more likely to gain advantages from this development if they cooperate from the beginning.

Since this is an initial study of an unexplored topic, many ideas for further research have developed during the course of the thesis. One suggestion is to evaluate if it would be possible to use an adapted version of the Tunisian Prosol Elec program in other countries in the region. Such evaluation could be performed as a replicability analysis of Prosol Elec. Another topic that requires further research relates to grid-connected solar PV systems in countries with frequent power outages. It is now unclear how FiT schemes and different versions of net metering schemes function in occasions of outages. Further research that could contribute to any analysis of design options is specific LCOE estimations for the MENA countries. The aim of this thesis has not been to investigate why a certain policy was selected and what characterised this process. That is however a topic that could be interesting to look into in order to provide further recommendations on the policy process. The research field is huge and this is just a few of many ideas on what to investigate when it comes to distributed solar PV policies in the MENA region.

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Appendix I – Interview list

Egypt:

AFD (Agence Francaise de Développement), personal communication with Hadrien Gaudin, Projects Officer. June 16, 2014.

EgyptERA (Egyptian Electricity Utility & Consumer Protection Regulatory Agency), personal communication with Khaled M.Shehata, Planning Engineer. June 17, 2014.

NREA (National Renewable Energy Agency), personal communication with Ehab Ismail Amin, General Manager of Plannering and Follow up Department. June 15, 2014.

Onera, personal communication with Mohamed Abdel Hai, General Manager Renewable Business Development Department. June 18, 2014.

SEDA (Solar Energy Development Association), personal communication with Wael Madkour, SEDA Executive Director. Asmaa Ismail, Communication and Marketing Dept, Unit Head. June 16, 2014.

Morocco:

ADEREE (Agence Nationale pour le Développement des Energies Renouvelables et de l'Efficacité Energétique), personal communication with Mohamed EL Haouri, Directeur du Pôle Energies Renouvelables et Efficacité Energétique, and Radouan Yessouf, Chef de Service Bâtiment. May 27, 2014.

AFD (Agence Francaise de développement), personal communication with Mokhtar Chemao, Chargé de Mission. May 29, 2014.

BMCE bank, personal communication with Soraya Sebti, Head of Sustainable Development and CSR. Ghizlaine Nourlil, Project Manager of Sustainable Development and CSR. May 28, 2014.

Crédit Agricole, personal communication with Mariem Dkhil, Directeur de la Direction Financement du Développement Durable. May 28, 2014.

MASEN (Moroccan Agency for Solar Energy), personal communication with Nabil Saimi, Senior Executive Advisor and Director of International Cooperation. May 29, 2014.

MEMEE (Ministére de l'Energies des Mines, de l'Eau, et de l'Environnement), personal communication with Bouchra El Moumane and Monsieur Lisser. May 27, 2014.

SIE (Société d'Investissements Énergétiques), personal communication with Ahmed Baroudi, General Manager. May 30, 2014.

Palestine:

Bank of Palestine, personal communication with Shaker W. Safadi, Head of SME department. June 10, 2014.

JEDCO, personal communication with Rouzan Hassoun, International and public realtions department. Solar systems department. June 10, 2014.

PEA/PEC (Palestinian Energy Authority, Palestinian Energy and Environmental Research Center), personal communication with Ayman Ismail, General Director. June 9, 2014.

PEA/PEC (Palestinian Energy Authority, Palestinian Energy and Environmental Research Center), personal communication with Basel T. Yaseen, Technical Department Director. June 9, 2014.

PEA/PEC (Palestinian Energy Authority, Palestinian Energy and Environmental Research Center), personal communication with Hussein Hamed, General Director. June 9, 2014.

PERC (Palestinian Electricity Regulatory Council), personal communication with Ismail Alexander Alawneh, Director of Consumer affairs department. Layali Musaffer, Financial Analyst. June 9, 2014.

SATCO, personal communication with Ayman Fawzi, General Manger. June 10, 2014.

3K Solar, personal communiation with Ayman Kaloti, Procurement and sales manager. June 10, 2014.

Tunisia:

ANME (National Agency for Energy Conservation), personal communcation with Abdessalem EL Khazen, Deputy Director Renewable energy department. June 5, 2014.

Attijari bank, personal communication with Jamel Ghanmi, Responsable Attijari Conco (Prosol ELEC program), and Nabil Zidi, Responsable Marketing. June 3, 2014.

CSNER (Chambre Syndicale Nationale des Energies Renouvelables), personal communication with Tahar Achor, President. June 4, 2014.

Soften, personal communication with Omar Ettaieb, Directeur General Adjoint. June 3, 2014.

STEG (Société Tunisienne de l'Electricité et du Gaz), personal communication with Samir Cherif, Chef de Division Efficacité Electrique et Projet Energies Renouvelables et Efficacité Energétique. June 3, 2014.