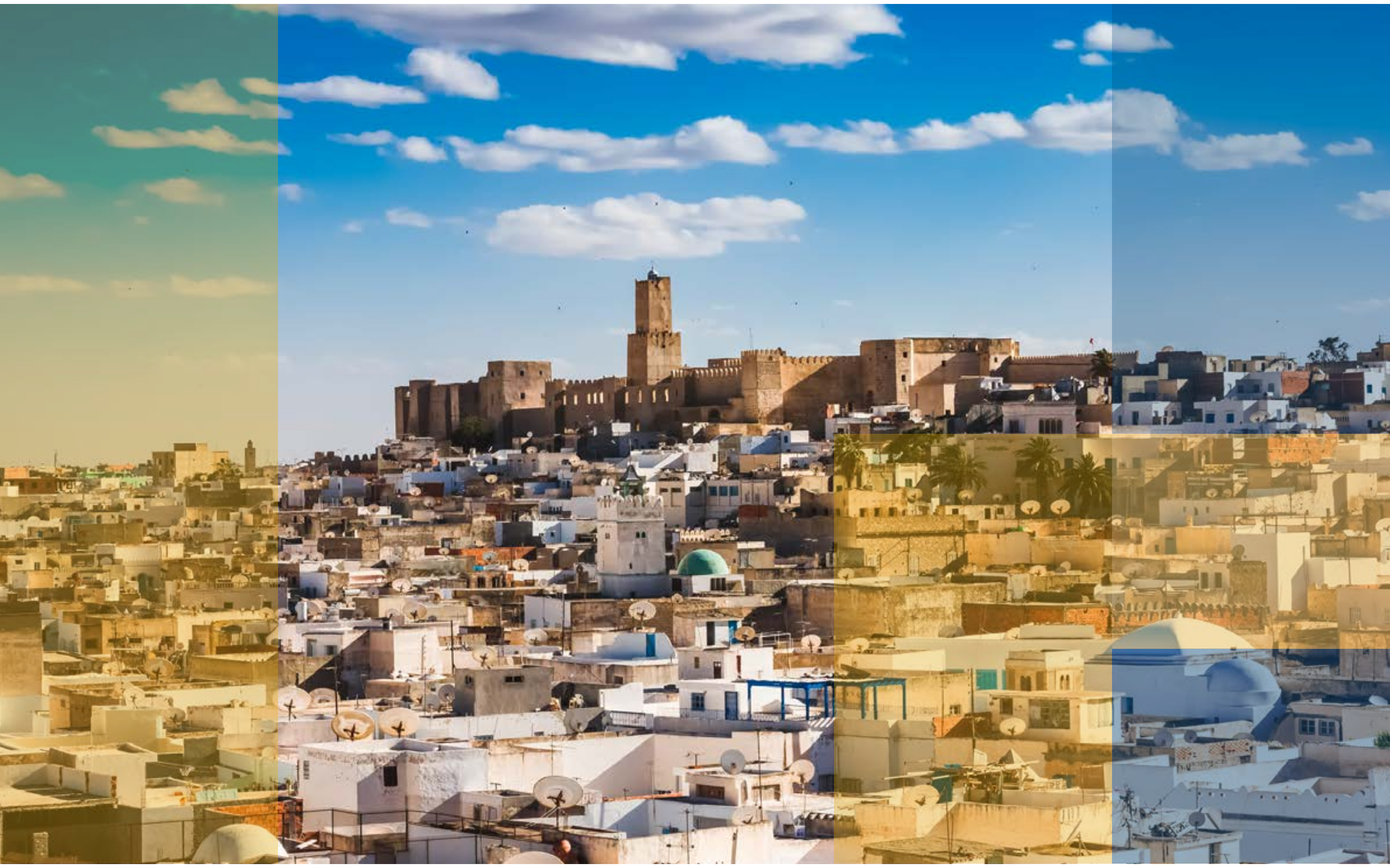

Enabling PV in the MENA Region

The emerging PV market in Tunisia

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Bundesverband Solarwirtschaft

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List of Abbreviations

AFEX: Arab Future Energy Index
AHK: Auslandshandelskammer – Tunisian-German Chamber of Commerce and Industry
ANC: Assemblée Nationale Constituante – National Constituent Assembly
ANME: Agence Nationale pour la Maitrise de l'Énergie – Tunisian National Agency for Energy Management
BMUB: Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit – German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BSW: Bundesverband Solarwirtschaft – German Solar Industry Association
CTC: Commission Technique Consultative – Technical Advisory Committee
FNME: Fonds National de Maîtrise de l'Energie – National Fund for Energy Management (later FTE)
FTE: Fonds de Transition Énergétique – Energy Transition Fund
GIZ: Deutsche Gesellschaft für Internationale Zusammenarbeit – German Federal Enterprise for International Cooperation
HV: High voltage
ICI: International Climate Initiative
kWp: Kilowatt-peak
kWh: Kilowatt per hour
LV: Low voltage
MENA: Middle East and North Africa
MV: Medium voltage
PSM: Plan Solaire Méditerranéen – Mediterrannean Solar Plan
RCREE: Regional Centre for Renewable Energy and Energy Efficiency
STEG: Société tunisienne de l'électricité et du gaz – Tunisian Company of Electricity and Gas
Toe: Tonne of oil equivalent
TND: Tunisian Dinar
IRR: Internal Rate of Return

1. Objectives of the "ENABLING PV" Project

Solar photovoltaic power (PV) is close to achieving grid parity in a number of MENA countries. Simultaneously, more and more governments are promoting large-scale solar projects and encouraging the decentralised installation of photovoltaic systems connected to the grid. In this context, the overall aim of the "Enabling PV" Project is to contribute to the sustainable deployment of solar photovoltaic power in the MENA region. The project was initially focused on the analysis of two separate markets: namely Jordan and Tunisia.

The "ENABLING PV" Project is led by the German Federal Enterprise for International Cooperation (GIZ) as part of a regional project, the "Mediterranean Solar Plan (MSP) – Technological Cooperation". It is funded by the International Climate Initiative (ICI), led by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). The German Solar Industry Association (BSW-Solar), in cooperation with the consulting firm eclareon, is in charge of completing the "ENABLING PV" Project in Jordan and Tunisia. The project is being carried out with the objective to support local renewable energy associations in the MENA region.

The "ENABLING PV" Project provides for the implementation of several activities in Jordan and Tunisia:

- Identifying sustainable business models for photovoltaic solar energy, based on the practical experience of local and foreign project developers and investors
- Analysing legal and administrative procedures for each identified business model and submitting the results to local and international investors
- Identifying existing obstacles hindering the implementation of these business models
- Formulating concrete recommendations to eliminate obstacles and discussing with decision-makers
- Simulating profitability for each business model, sensitivity calculations included
- Reinforcing cooperation and transfer of knowledge between all concerned parties, in particular players of the private sector in Jordan, Tunisia and Germany

2. Introduction

Tunisia is a rapidly expanding photovoltaic market in the MENA region. The country's economic conditions are relatively favourable, while its natural solar exposure conditions are ideal for photovoltaics, enabling installations to produce more than 1,700 kWh/kWp annually. Regarding public support, the PROSOL thermal programme, introduced in 2005, promotes solar thermal system investments. The PROSOL ELEC programme, designed for photovoltaic installations, has been in existence since 2010. So far, this support mechanism has contributed to the installation of a total PV capacity of 6 MWp.

Nearly 150 Tunisian installers are certified by the Tunisian National Agency for Energy Management (ANME). These installers mainly perform installations of small photovoltaic systems, in particular in the private sector. The photovoltaic installation at El Manzah gardens in Tunis is an example of an installation carried out within the PROSOL ELEC programme. This installation provides an output of 2.16 kWp, and enables the owning household to consume 100% of its own photovoltaic production through net metering, or to compensate for its production with electricity drawn from the grid via its electricity bill.

The annual electricity production of the installation is estimated at 3,600 kWh. The installation was carried out by Shams Energy Access and has received a 26,000 TND subsidy as part of the PROSOL ELEC programme.

The same company has also carried out a commercial-scale installation with a generating capacity of 15 kWp, an annual return of 25,250.4 kWh per year, corresponding to a 1,670 kWh/kWp/y. The installation was funded by a state subsidy of 15,000 TND.

As part of the "Bâtiments Solaires" ("Solar Buildings") programme, WS.Energy has installed a multi-part system, of a total capacity of 7.05 kWp. In May 2013, part of a 5.88 kWp capacity produced 8,983 kWh, approximately 30% of which was intended for direct consumption. The

Image 1: PV installation carried out by Shams Energy Access at El Manzah gardens in Tunis (Source: Shams Energy Access)

remaining 70% was counted according to a net metering system with purchase of feed-in electricity.

Another installation was carried out in Sfax for a metal processing company. The Spectra – Energies Renouvelables company designed the photovoltaic system at 30 kWp.

Volta PV is currently carrying out a 60 kWp installation in the Tunis area, designed to be connected to the medium voltage electricity grid. The panels are installed on the roof of a henhouse.

Finally, S.A.T.E.R Solar has completed the first large photovoltaic installation connected to the medium voltage electricity grid, with a total capacity of 149 kWp. The total installation surface is 1,010 m², with a specific annual yield of 1,637 kWh/kWp. The installation was carried out for a farmhouse at Sfax.

The Tunisian photovoltaic market, as many international markets, follows the trend towards business models functioning without financial support mechanisms. Most models meet the following conditions:

- The PV cost continually declines, reaching grid parity, with the prospect of also reaching parity with electricity generated by conventional power stations.
- More and more electricity consumers are subjected to non-subsidised tariffs.
- Photovoltaic installations benefit from a non-discriminatory access to the electricity grid.

Tunisia is on its way to meet all these conditions for PV to be competitive. However, to date, several factors still remain likely to inhibit the development of PV in Tunisia. These factors will be covered in this report in details.

Image 2: PV installation carried out by WS.Energy (Source: WS.Energy)

Image 3: PV Installation carried out by Spectra - Energies Renouvables at Sfax (Source: Spectra)

Image 4: PV Installation carried out by Volta PV (Source: Volta PV)

Image 5: PV Installation carried out by S.A.T.E.R Solar (Source: S.A.T.E.R Solar)

a. Evolution and Current Profile of the Solar Photovoltaic Market in Tunisia

Fundamentals

- In 2012, PV installations that were not connected to the electricity grid represented a total capacity of 1,450 kWp.
- The Tunisian territory is almost entirely covered by its national electricity grid.
- At the end of 2013, the PROSOL ELEC programme for PV installations connected to the LV grid has enabled a total installed capacity of 4 MWp.
- PV projects connected to the MV grid are not yet well-developed in Tunisia. In June 2014, only two installations were listed.

Photovoltaics Not Connected to the Grid

The solar PV sector in Tunisia started in the ‘80s in order to meet the electricity needs of a population that could not access the national electricity grid. Photovoltaic installations were intended for low-income populations in order to reduce precarious energy situations, hence an important financial involvement from the state. Until 2013, photovoltaic installations that were not connected to the electricity grid were enabling the electrification of 13,500 households and 200 rural schools (DER 2014). Today, farms are the main target for photovoltaic installations that are not connected to the electricity grid. Indeed, beyond water pumping, they face the need to improve their energy performance in order to reduce the water needed for irrigation.

Photovoltaics Connected to the LV Grid: The PROSOL ELEC Programme

PV connected to the grid was initiated by the PROSOL ELEC programme. A preliminary experimental phase to prepare the sector and various players was launched in 2010-2011. The aim of this experimental phase was to reach an installed capacity of 1.5 MW.

Following the success of this experimental phase, the Tunisian government decided to extend the PROSOL ELEC programme. At the end of 2013, the PROSOL ELEC programme had equipped next to 1,650 households for an installed capacity totalling approximately 4 MWp (ANME 2013).

Photovoltaics Connected to the MV Grid

Self-generation mechanisms for the installations that are connected to medium voltage, intended for industrial and service industries, have experienced a slow start since the enactment of the Law of 9 February 2009. Indeed, at the end of 2013, only two installations had been carried out. Over the same period, a dozen grid connection requests were officially forwarded to the Technical Advisory Committee, totalling a capacity of around 900 kWp (DER 2014).

General Factors Likely to Inhibit Photovoltaic Development in Tunisia

Several elements have been identified as obstacles to the development of the photovoltaic sector. These factors fall within the broad framework implemented in Tunisia.

1. The Tunisian sovereign rating has been adversely affected a number of times by rating agencies, chiefly owing to increased political and economical risks in the country. Local bank ratings have similarly been affected. Consequently, deferred payment letters of credit (90 days) are no longer accepted by banks in exporting countries. As an example, Attijari bank has to go through its parent company in Morocco to reduce the costs associated with country risk.

2. Typically, release of subsidy funds by the ANME takes anywhere from 1 to 3 months. However, in some cases, the payment of the subsidy takes much longer, resulting in a dramatic increase of financial charges for companies and, at times, in a momentary cessation of activity for companies that no longer have the means to pay their suppliers.

3. Sustainable Business Models Identified for Tunisia

a. Introduction

Owing to the monopolistic nature of the electricity sector in Tunisia, business models that were identified for the production of photovoltaic electricity all fall under the self-generation category. Indeed, the electricity production sector, other than national, from renewable energies, is closely regulated and limited to coverage of the consumers' electricity needs. The self-generation system in Tunisia has therefore only been designed to enable consumers to generate the electricity needed for their own consumption. For consumers that are connected to the low-voltage grid, any surplus electricity generated is "traded" with the Tunisian Company of Electricity and Gas (STEG) for electricity from the national grid.[1] Given that the flow of money was not foreseen in this type of contract, the cumulated electricity surplus is not compensated. Surplus electricity generation of installations connected to the medium and high-voltage grids is sold to the STEG at a fixed price, annually regulated by the Ministry of Energy.

We have chosen to introduce herewith four business models, all based on the self-generation mechanism and complying with the current legislation:

Graph 1: Overview of the business models analysed in the report

1. PROSOL ELEC support programme (Low Voltage)
2. "Solar Building" support programme (Low Voltage)
3. Self-generation mechanism (Low Voltage)
4. Self-generation mechanism (Medium and High Voltage)

- **The PROSOL ELEC support programme.** It is exclusively intended for residential consumers connected to the low-voltage grid, seeking to lower their electricity costs with the acquisition of a photovoltaic system in order to cover their electricity needs. The PROSOL ELEC financial mechanism consists first of all of a subsidy granted by the National Fund for Energy Management (FNME), representing 30% of the investment costs, limited to 1,800 TND/kWp for a 1 kWp installation, and to 1,450 TND for installations of a 2+ kWp capacity. Moreover, this subsidy provides for access to a loan at the reduced rate of MMR+1.2 to be repaid over a period of 7 years, via the STEG electricity bill. The PROSOL ELEC business model is one of the most widely used in Tunisia. However, according to photovoltaics installers, this is not the most profitable, given the cumbersome administrative procedures involved in its financing.

[1] *Current legislation does not include the purchase by the STEG of the electricity surplus generated by photovoltaic installations that are connected to the low-voltage grid. The surplus electricity thus generated by the photovoltaic system is carried over to the next bill following the generation period.*

- **The "Bâtiment solaire" ("Solar Building") programme** is intended for medium-sized installations connected to the low-voltage grid. Residential, tertiary and industrial customers are eligible to receive the financial subsidy offered by the FNME as part of the programme. The installed capacity of the PV installation must at least equal the power subscribed to at the STEG by the producer. The generated surplus electricity is not compensated. The FNME subsidy also corresponds to 30% of the investment costs, and is limited to 15,000 TND per building. However, the "Bâtiment solaire" programme does not provide for access to reduced-rate loans. According to installers, this model is very interesting in that it reaches a large number of customers from the residential and business sectors, wishing to install photovoltaic systems of a capacity of 3 to 25 kWp, or more. Another benefit for the installers: 70% of the financing is paid directly by the customer, which avoids incurring numerous administrative procedures and therefore delayed payment. Finally, this model is beneficial not only for installers, but also for customers. Indeed, their photovoltaic installations connected to LV enable them to significantly reduce their STEG electricity bill, given that this range of customers is subject to the highest scale of tariffs.[2]
- **The self-generation mechanism for photovoltaic installations connected to the low-voltage grid.** The capacity of the installation cannot exceed the power subscribed to at the STEG by the producer. These installations are eligible for a subsidy totalling 20% of the investment costs, limited to between 100,000 and 250,000 TND, depending on the annual electricity consumption of the producer. In practice, this mechanism is currently rarely used. Indeed, most LV consumers tend to turn to the "Solar Building" model, whereas higher capacity PV installations are usually powered by medium voltage. The fact that this mechanism exists, but that it is rarely used, raises the question of the efficiency of currently established support mechanisms for photovoltaics in Tunisia.
- **The self-generation mechanism for installations connected to the medium and high-voltage grids.** In this case, legislation allows the photovoltaic electricity producer to sell up to 30% of its annually generated energy (in surplus) exclusively to the STEG. The purchase price of the surplus electricity is set by a decision of the Ministry of Energy. These installations are also eligible for a subsidy of 20% of the investment costs, limited to between 100,000 TND and 250,000 TND, depending on the annual electricity consumption of the producer. In June 2014, this business model was still scarcely implemented, mainly owing to a still too low consumed kWh and an unsuitable regulatory framework. Indeed, only two installations have so far been registered in medium-voltage. According to installers, this business model holds much promise, given the rise of consumed kWh prices, and could potentially lead to an explosion of PV in Tunisia. Indeed, consumers connected to the medium-voltage grid are more and more interested in photovoltaics, which enables them to reduce their STEG electricity bill. However, the development of this business model is currently hindered by several obstacles, chiefly owing to the heavy administrative procedures, and lack of experience in this type of projects.

Beyond these four business models, one can mention the existence, for many years, of photovoltaic systems that are not connected to the grid in Tunisia. These installations are mainly used for water pumping in order to irrigate agricultural areas. According to the action plan for the development of renewable energies, "the capacity potential of PV pumps is estimated at around 24 MWp" (ANME 2013). In 2012, the total installed capacity of PV pumps corresponded to 0.25 MWp. The action plan provides for an installed capacity goal of 0.6 MWp in 2016, 1.8 MWp in 2020 and 8 MWp in 2030. The installations of PV generated electricity in the farming sector benefit from a subsidy totalling 40% of the investment costs, limited to 20,000 TND. However, the electrification level of the country being of 99.6%, we have chosen to focus on photovoltaic installations connected to the grid in this report.

The PROSOL ELEC programme has enabled the development of a new line of business, through the creation of a network of companies specialised in photovoltaic systems. On 13 February 2014, the ANME listed 148 registered installing companies, amongst which 61 were active. In general, the STEG welcomes the development of small photovoltaic systems connected to the low-voltage grid. Electricity generated by these installations not being

[2] *Find out more information on the STEG electricity tariffs on Chapter 4, Profitability of the Models – Simulation*

subsidised by the STEG, it enables the STEG to lower its energy bill, without threatening the grid stability. The development of larger photovoltaic installations, connected to the medium-voltage grid, remains in itself more problematic. The lack of clarity of the legal framework concerning PV self-generation in the service and industrial sectors is characteristic of the cautiousness of policy-makers in this area.

The following table provides a comparative overview of the main characteristics of the four analysed business models:

Table 1: Comparative overview of the main characteristics of the four analysed business models

	Prosol Elec	Solar Building ("Bâtiment solaire")	Self-generation	Self-generation
Voltage	LV			MV + HV
Target Customer	Residential	Residential * Service+Industrial and Others	Industrial, Service, Agricultural With tax code	Industrial, Service, Agricultural With tax code
Net Metering	Yes	Yes	Yes	Yes
Purchase Tariff of Surplus	No	No	No	Yes (max 30%)
FTE Subsidy (in % of investment costs)	30%	30%	20%	20%
Subsidy Limit	1,800 TND / kWp 1,450 TND/ kWp (2+)	1,800 TND / kWp 1,450 TND / kWp (2+)	According to the legal decision of the Tunisian Ministry of Energy	According to the legal decision of the Tunisian Ministry of Energy
Attijari Loan	Yes	No	No	No
Conventional Financing	No	Yes	Yes	Yes

Four main Stakeholders participate in the business models aforementioned:

1. The Tunisian National Agency for Energy Management (ANME)

The Tunisian National Agency for Energy Management (ANME) is one of the main institutions responsible for the development of renewable energies in Tunisia. Created in 1985, the ANME is in charge of implementing the energy policy of the State and aims at diversifying energy sources, through the promotion of energy efficiency and the support of renewable energies. It is a public institution placed under the authority of the Ministry of Industry, Energy and Mining. Other than the promotion of existing mechanisms supporting the photovoltaic electricity generation, the ANME is in charge of approving and issuing licences for companies specialised in the installation of photovoltaic systems, as well as establishing a list of PV equipment eligible for support programmes. The ANME is also responsible for managing the Energy Transition Fund (FTE), which issues subsidies for investments geared towards promoting renewable energies and the rational use of energy. This Fund is "financed by a specific tax owed at the initial registration of cars acquired by private individuals." (Cessac 2014) Finally, the ANME presides over the Technical Advisory Committee (CTC) in charge of granting subsidies regulated in the Decree n° 2009-362 of 9 February 2009. The CTC members are designated by decision of the Ministry of Industry. The composition of the Committee can be modified at any time.

2. The Tunisian Company of Electricity and Gas (STEG)

The Tunisian Company of Electricity and Gas (STEG) is a company governed by public law of commercial and industrial nature created in 1962. It is in charge of the production, transport and distribution of electricity and gas on the Tunisian territory. Regarding photovoltaics, it is the STEG that establishes access and connection contracts to the national public grid, after evaluation and approval of technical applications requesting connection. The STEG also serves on the Technical Advisory Committee (CTC), chaired by the Tunisian National Agency for Energy Management (ANME), responsible for providing advice on self-generation projects connected to the medium and high-voltage grids.

3. Installers

On 13 February 2014, Tunisia totalled 148 companies authorised by the ANME to install photovoltaic systems.[3] These companies are unavoidable for the residential and service sectors, for they provide access to the PROSOL ELEC support programme. They accompany their customers in every stage of the completion of photovoltaic projects, from the application for grid connection, to securing subsidies. Moreover, it is installers who receive the FNME subsidy directly, as well as the credit obtained through Attijari bank for 1 and 2 kWp installations, as part of the PROSOL ELEC programme. This procedure enables the PV producers to reduce their initial financial contribution to the photovoltaic installation investment.

Regarding the eligibility of installers, a detailed bill of specifications defines the criteria and requirements they have to meet in order to obtain the authorisation to install under the PROSOL ELEC programme.[4]

4. Attijari Bank

Attijari bank is the only Tunisian bank to have signed an agreement with the STEG for the development of a bank credit mechanism in the form of a subsidised loan at a 5.94% rate over a period of 7 years, intended for 1 or 2 kWp photovoltaic installations. The allocated budget totals approximately 40 million TND, covering a period of four years, from 2012 to 2016.

b. Net Metering Within the PROSOL ELEC Programme

Description of the Business Model

Within the framework of prevailing regulations authorising electricity generation to cover one's energy needs, the Tunisian government has implemented an incentive system, PROSOL ELEC. This programme aims at promoting the development of photovoltaic installations connected to the low-voltage grid for the purpose of self-generation, mainly in the residential sector. The low-voltage grid corresponds to 230/400V at a 50 Hz frequency. The size of photovoltaic systems allowed to be installed by customers is determined by their annual electricity consumption, in order to minimise as much as possible the introduction of surplus energy in the grid. In case of surplus generation, a bi-directional meter calculates the amount of kWh injected, and notes the electricity volume which may be used on the grid, based on the principle of net metering. The STEG electricity billing system is unique for all residential customers: meter readings are done every 4 months and bills are issued every 2 months. One bill is estimated while the next one is based on meter readings. Each bill assesses generated kWh and consumed kWh. The residue of generated kWh that were not consumed is carried over to the following bill.

From an economic point of view, the PROSOL ELEC programme is particularly interesting for residential customers connected to the low-voltage grid and with an electricity consumption of more than 200 kWh per month. Indeed, electricity tariffs for low-income households being the most subsidised, the total saved on the electricity bill thanks to consumption of photovoltaic energy generated by a residential customer consuming less than 200 kWh will be lower than that of the customers aforementioned. Another particularity of the PROSOL ELEC programme resides in the possibility for the PV electricity producer to reduce the amount of private capital in the initial investment of the PV installation. Indeed, the financing of photovoltaic installations is comprised of three different contributions:

- The purchaser's own contribution
- The State's subsidy
- An Attijari bank loan

The initial financial contribution largely comes from the installer, who directly receives the FNME subsidy, as well as the Attijari bank loan, in order to acquire and complete the installation in the name of the PV owner. Once the installation operational, the PV owner reimburses the entirety of the loan through his electricity bill over a period of 7 years. Monthly payments to be paid for the loan reimbursement are set in the loan application form

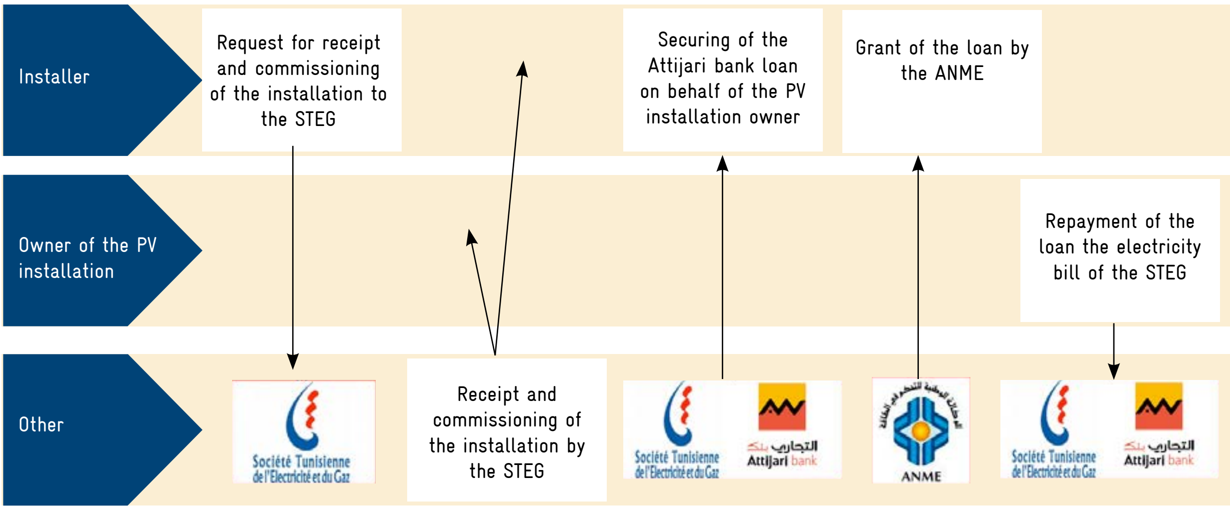
[3] *The current list of installers eligible to the PROSOL ELEC programme can be found at the following address: http://www.steg.com.tn/dwl/Societe_eligibles_prosol_elec.pdf*

[4] *At the time of publication of this report, this bill of specifications was not suitable for larger installations, not eligible under the PROSOL ELEC programme*

submitted to Attijari bank and depend on the installation capacity (1 or 2 kWp).[5] This financing process is intended to balance electricity savings and loan reimbursements for the customer. The repayment of the loan to Attijari bank by the STEG also involves financial equalisation between the STEG and Attijari bank.

The different stages of the financial agreement within the PROSOL ELEC programme are illustrated in the graph below:

Graph 2: Stages of the financial agreement concerning ANME subsidies and Attijari bank loans (Source: Graph based on STEG information)



Support Mechanism

According to the national plan of action for the development of renewable energies in Tunisia, the PROSOL ELEC programme intends to reach a total photovoltaic capacity of 190 MW in 2020 (ANME 2013). In order to achieve this goal, this support system involves two different types of assistance:

- An incentive of 30% of the investment costs, limited to 15,000 TND per project, granted by the National Fund for Energy Management (FNME). Following the price decline of photovoltaic panels on the global market, the limit of the subsidy has been revised in June 2012. Since 1 January 2013, this subsidy is therefore limited to 1,800 TND for 1 kWp installations and 1,450 TND for 2+ kWp installations.
- A loan over 7 years at an MMR+1.2 rate, without guaranty, granted by Attijari bank and repayable through STEG billing.[6] The loan amount is set according to the kWp capacity of the installation:
  – 1 kWp installations: 3,500 TND
  – 2 kWp installations: 6,500 TND

[5] *The bank loan application form can be found on the STEG website in the "Downloads" section: https://www.steg.com.tn/fr/prosol_elec/Demandes_Formulaires.html*

[6] *To determine the current MMR, please refer to the Central Bank of Tunisia website: http://www.bct.gov.tn/bct/siteprod/tableau_statistique_a.jsp?params=PL203105*

In theory, installations superior to 2 kWp can claim an Attijari bank loan for the first two kWp of the installation. However, loan applications for installations superior to 2 kWp are denied by the STEG.

The eligibility criteria for the PROSOL ELEC programme are as follows:

- The photovoltaic capacity to be installed must be of 1 or 2 kW.
- The applicant must own the premises to be equipped.
- The applicant must have a valid and current STEG low-voltage subscription in his name.
- The applicant must have a minimum annual electricity consumption of:
  – 2,000 kWh for 1 kWp installations
  – 4,000 kWh for 2 kWp installations

Lastly, photovoltaic installations are eligible for specific tax benefits. First of all, equipments and products used for energy management that do not have any equivalent produced in Tunisia are subject to the minimum customs duty, 15%.[7] Moreover, capital goods and energy-saving products can claim exemption from VAT.

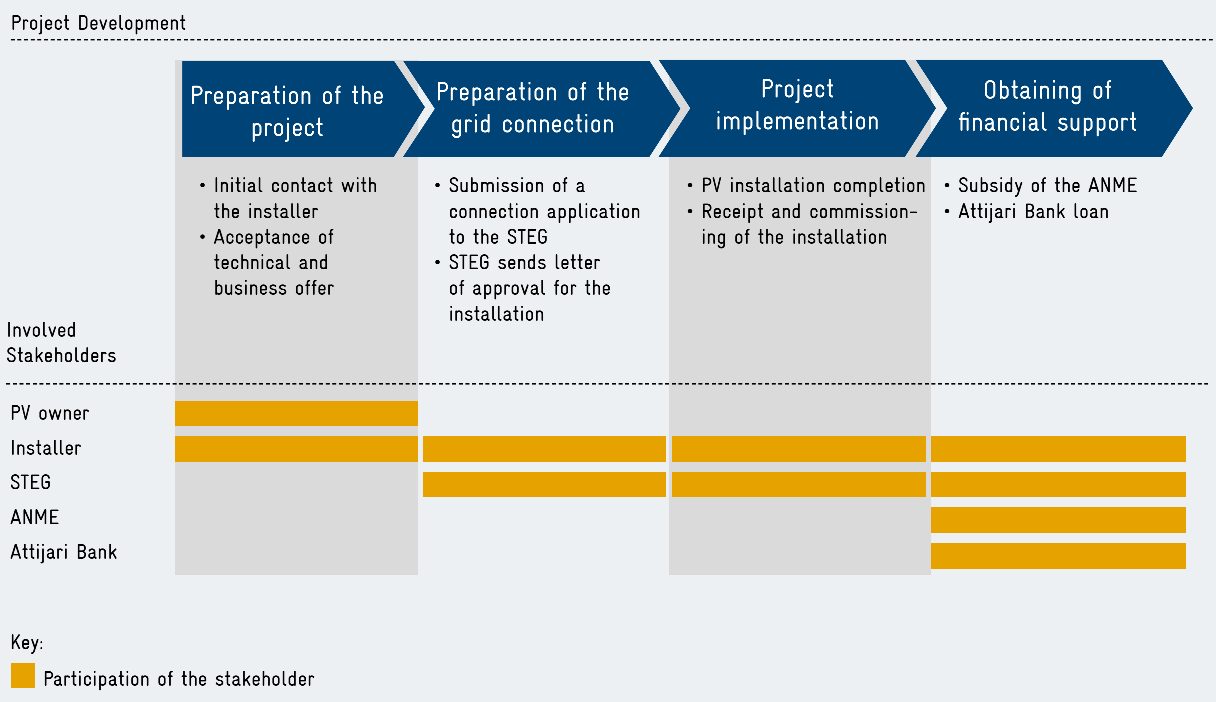
Project Stages

The different stages of photovoltaic projects within the PROSOL ELEC programme, from the initial contact with the installer to the subsidy payments, are explained in details on the STEG website. Moreover, the forms and documents required to start administrative procedures with the STEG are also available as downloads on the site.[8]

[7] *The current minimum legal rate of customs duty can be found on the Tunisian Customs website: http://www.douane.gov.tn/index.php?id=441*

[8] *A description of the administrative procedures, as well as documents and forms, can be found at the following address: https://www.steg.com.tn/fr/prosol_elec/procedures.html*

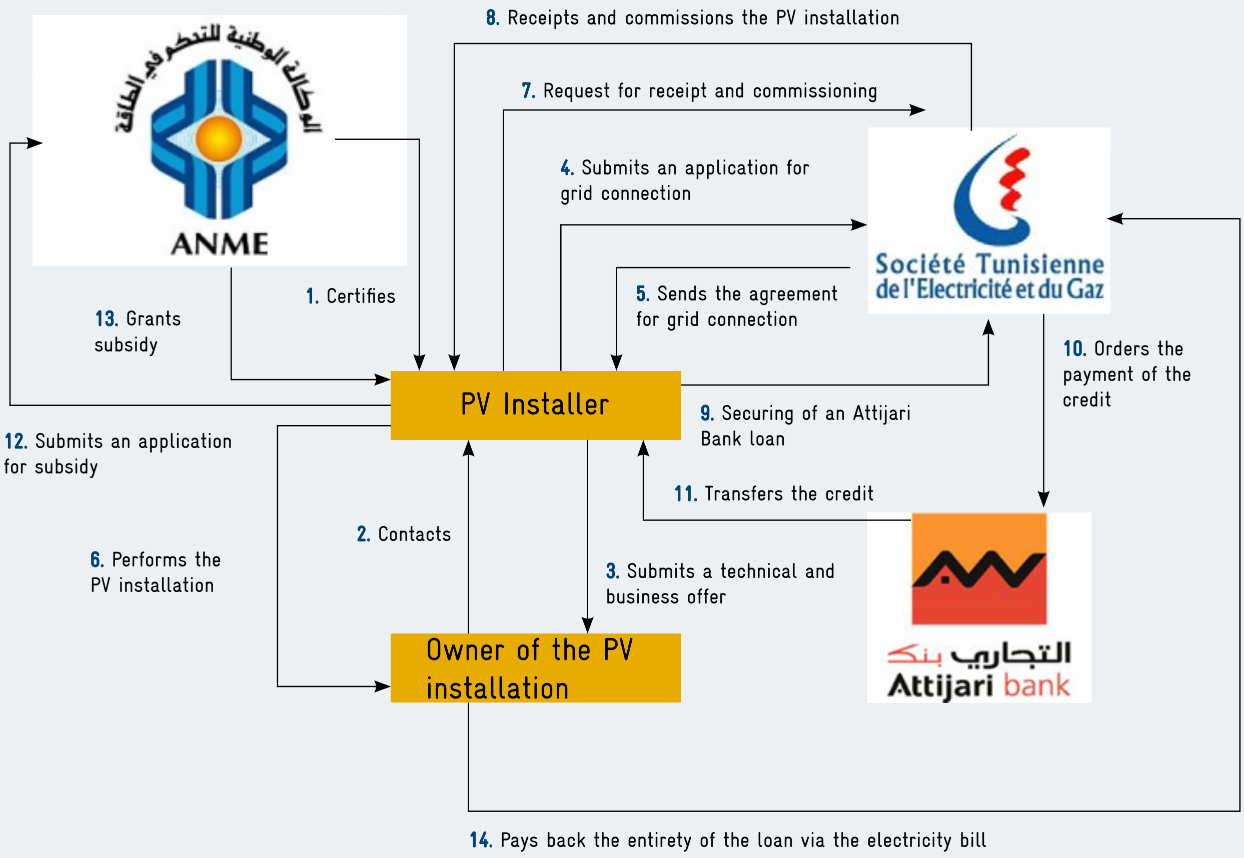
Graph 3: Stages of the implementation process for PROSOL ELEC-eligible installations



(Source: STEG information)

The process of implementation of projects falling under the PROSOL ELEC programme is illustrated by the following graph:

Graph 4: Implementation process for PROSOL ELEC eligible installations



(Source: STEG information)

Projects Stages for Installations Eligible for the PROSOL ELEC Programme		
1. Initial contact with the installer	**Description**	A list of installing companies licensed by the ANME and eligible for the PROSOL ELEC programme can be found on the STEG website (http://www.steg.com.tn/dwl/Societe_eligibles_prosol_elec.pdf). On 13 February 2014, there were 148 registered companies. After initial contact from the customer, the installer will travel to the premises in order to establish a feasibility study and a project estimate, thus constituting the technical and business offer submitted to the customer, depending on the annual electric consumption of the customer, on the available space on the building and the available investment funds.
	Stakeholders	Installer
2. Business offer	**Description**	The installer will then submit a technical and business offer to the customer. This offer will include the feasibility study reporting the technical specificities of the installation, such as the installation capacity, the number of modules, the number of inverters, etc. Moreover, the business offer will detail the cost of components in the photovoltaic installation, the amount of VAT, as well as the administration and installation fees.
	Stakeholders	Installer
3. Submission of an application to connect to the STEG	**Description**	After customer agreement on the business offer, the installer submits the application of connection to the STEG. The technical file consists of the following documents: – A copy of the customer's National Identity Card (CIN) – A "Contract stipulating that the STEG agrees to purchase any surplus energy generated through photovoltaic solar energy by the residential producer in low-voltage subscribing to 1 or 2 kWp" (for customers wishing to benefit from the PROSOL ELEC programme) – The application form to the PROSOL ELEC programme and bank loan subscription signed by the customer (certified signature), for projects in conjunction with Attijari bank – An electric diagram of the installation – A technical document certifying that the equipment complies with the technical requirements specified by the STEG/ANME, with respect to standards. Every year, the ANME approves a number of PV modules available on the market. Inverters are supplied by the STEG.
	Stakeholders	Installer
4. STEG sends letter of approval for the installation	**Description**	Upon reception, the corresponding STEG district reviews the application of connection, verifying the completeness of the file, the consistency of the information, the solvency of the customer, the eligibility of the equipment, the report on the annual consumption of the customer and the estimated energy capacity of the solar source.[9] The STEG states on their website that the installer may contact the district a week after the application is submitted to enquire about the decision taken by the STEG. In practice, installers have noticed that, depending on the district size and the number of applications received, the decision from the STEG may take up to two months. The STEG then sends a letter of approval for the installation to the installer, who may finally proceed to the installation.
	Stakeholders	STEG
	Duration	1 week (in theory) to 2 months (in some rare cases). In general, the STEG takes a decision within 2 weeks.

[9] *Information based on the STEG website: https://www.steg.com.tn/fr/prosol_elec/procedures.html*

5. PV installation completion	**Description**	After receiving STEG approval, the installer may start completing the PV system installation. The PV installation must meet specific STEG requirements concerning technical conditions and safety rules, outlined in the following documents: – "Technical requirements for the eligibility of photovoltaic installations" – "On-site safety measures to be observed for photovoltaic installations connected to the grid" These documents are not available on the STEG website.
	Stakeholders	Installer
	Duration	The installation takes from 2 days to a week, depending on the installation size and the installers' availability.
6. Receipt and commissioning request to the STEG	**Description**	Once the system installed, the installer sends a receipt and commissioning request to the STEG district in order to be able to start using the installation and feed the generated electricity into the grid. According to information from the STEG, "the STEG may arrange a time to visit the installation within 10 days following the submission date of the receipt and commissioning request. The STEG district is required to inform the installer of the date of the visit at least three days in advance." Currently, installers claim that response time of the STEG district depends on the receipt request queue, as well as the period of the month during which the receipt request has been sent to the district. Indeed, district teams in charge of PV installation receipts are limited in number and have numerous responsibilities. At the end of the month for example, STEG agents are overwhelmed, due to medium-voltage meter readings. According to installers, the commissioning date may occasionally be differed, depending on the availability of bi-directional meters. Those are indeed only delivered by the STEG and may be out of stock.
	Stakeholders	Installer, STEG
	Duration	According to the STEG, commissioning occurs within a maximum of 10 days after the commissioning request has been submitted. When meters are out of stock, commissioning may be delayed by 2 months.
7. Receipt and commissioning of the installation	**Description**	At receipt, STEG agents check the compliance of the PV installation with the specifications set forth in "Technical requirements for the eligibility of photovoltaic installations". Compliance of the installation with safety conditions are also checked. STEG agents then carry out the installation of the bi-directional meter, before commissioning the installation. The installation commissioning is attested by a receipt certification, signed by the STEG agent, the producer and the installer. This document is required to secure an Attijari bank loan, as well as for the ANME subsidy within the PROSOL ELEC programme (see Stages 8 and 9). During this stage, the STEG issues a signed contract of connection to the grid to the installer.
	Stakeholders	STEG
	Duration	The installation of a bi-directional meter can take from 15 days to 3 months.

8. Securing of an Attijari bank loan	**Description**	Under an agreement signed between the STEG and Attijari bank, STEG customers owning a 1 or 2 kWp photovoltaic installation are eligible for an Attijari bank loan. The installer receives the loan directly in order to complete the installation for the customer. Once the installation is commissioned, the customer repays the entirety of the loan via their electricity bill. The monthly instalments towards repaying the loan are set on the loan request form of Attijari bank, available on the STEG website: https://www.steg.com.tn/fr/prosol_elec/Demandes_Formulaires.html The loan amount is set according to the kWp capacity: – 1 kWp installations: 3,500 TND – 2 kWp installations: 6,500 TND Customers may, if they wish, obtain loans of a lower amount. Loans are granted over a period of 7 years and are repayable on the STEG bill at a preferential rate, MMR+1,2. For current loan rates, please refer to the Central Bank of Tunisia website: http://www.bct.gov.tn/bct/siteprod/tableau_statistique_a.jsp?params=PL203105. Bank guaranty is provided by the STEG. In theory, installations of a capacity superior to 2 kWp may secure a loan with Attijari bank for the first two kWp of the installation. However in practice, credit loan requests for installations over 2 kWp are declined by the STEG. In order to secure a loan, the installer files a request at the STEG, including the following documents: – The Prosol Elec programme application form and application to a loan – The installation receipt and commissioning form Approvals of loans are sent directly by the districts, but the file and contact with Attijari bank are managed by the central STEG office. According to the STEG, "the Management sends, on the 25th of the month (m+1), to Attijari bank, a transfer order in favour of the installer. The bank will then proceed with the payment of the loan on the 2nd of the month (m+2)."[10]
	Stakeholders	Installer, STEG, Attijari bank
	Duration	Between 1 to 2 weeks
9. Grant of the subsidy by the ANME	**Description**	Once the installation is commissioned and the PV receipt is issued by the STEG, the installer applies for an ANME subsidy. Since January 2014, a new procedure is applicable, with new forms. Under this procedure, the installer must take pictures of the PV equipment (panels, inverters, wiring), in order to confirm compliance of the installation. After review of the request, the ANME wire transfers the subsidy. The subsidy corresponds to 30% of the investment, and is limited to: – 1,800 TND per kWp if the installed capacity is of 1 kWp – 1,450 TND per kWp if the installed capacity is of 2+ kWp – 15,000 TND per solar building
	Stakeholders	Installer, ANME
	Duration	The file application can take 1 to 2 days. The ANME may take up to 3 months to reply.

[10] *Information based on the STEG website: https://www.steg.com.tn/fr/prosol_elec/procedures.html*

Obstacles and Recommendations

Since its inception in February 2010, the PROSOL ELEC programme has enabled the installation of many a photovoltaic system connected to the low-voltage grid in the residential sector. Even though it is the most widespread photovoltaic business model, its application remains however limited, particularly due to eligibility requirements of the support mechanism, as well as current legislation concerning self-generation. The following tables illustrate the challenges identified and offer recommendations in order to optimise the PROSOL ELEC programme and promote the development of photovoltaics in Tunisia.

Constraints of Eligibility for the PROSOL ELEC Programme	
Obstacles	Constraints for the investors: – Only accommodation owners are eligible. – They must have a STEG low-voltage subscription. This criterion remains problematic, especially when it concerns covering the electricity needs of renters wishing to install solar panels on the roof of a residential building.
Recommendations	– Involvement of renters associations, solar associations, in order to suggest regulations to expand eligibility for the PROSOL ELEC programme – Public involvement in the Tunisian energy transition, that could amount to additional support to PV – More initiatives from PV installers regarding landlords, to raise awareness to the benefits of PV installations – Communication on the possibility for landlords to acquire PV installations and raise rents in exchange
Potential foreseeable stages	– Detailed analysis of obstacles to a model in which the renter could consume the PV electricity generated by the landlord – Drafting of a financial support proposal intended for landlords and PV owners. This proposal could be submitted to the ANME for review
Slow Administrative Procedures	
Obstacle	Administrative procedures related to the review of subsidy and loan applications are slow and penalise the sector's operators, given delayed payment. For example: the ANME procedure stipulates that the installers take pictures of the PV equipment in order to validate compliance of the installation.
Recommendations	– Balancing the costs linked to paperwork on one side, to the advantages linked to the loan on the other side – Using the installers accreditation as a guaranty to access the grid (in Germany, the installers' accreditation complying with the VDE 1000 standard allows access to the grid)
Limitations of the Allocation of the Subsidised Loan from Attijari Bank	
Obstacle	Following a common agreement between the STEG, the ANME and Attijari bank, allocation of the Attijari bank loan is limited to 1 and 2 kWp installations. The STEG justifies their decision by the fact that the PROSOL programme is intended to accompany in priority low-income customers in their purchase of photovoltaic installations to cover their electricity needs. It is not intended for consumers consuming more than 4,000 kWh of electricity a year.
Recommendation	The introduction of a degressive rate loan for installations superior to 2 kWp would enable a development of the PV installation market in the residential sector connected to the low-voltage grid.

Potential foreseeable stages	Households consuming more electricity and subjected to higher rates beneficiate, through PV use, from a greater cut in their electricity bills than small consumers, who are subjected to more subsidised electricity rates. The saving percentage on electricity rates should be accompanied by a degressive factor applied to the total of the credit line. A calculation method should be submitted to the ANME and Attijari bank.
Understaffing of the STEG	
Obstacle	Installers lament the shortage of qualified agents available in each district of the STEG able to perform receipt of PV installations. This shortage of agents leads to delays in the commissioning of installations.
Recommendation	– Implementation of training programmes specialised in the photovoltaic technologies specified by the STEG for STEG employees
Limits of Current Legislation	
Obstacle	The PROSOL ELEC programme is limited by current legislation. Indeed, in accordance with the Law n°2009-7 and the implementing Decree n°2009-2773, electricity generation is only permitted for the purpose of self-consumption in Tunisia. In low-voltage, the installed electrical capacity of the equipment producing electricity shall not exceed the electrical capacity subscribed to by the producer at the STEG.
Recommendation	– Improvement of the capacity licence fee in order to cover the costs incurred by the STEG (in cases where the grid capacities are the reason for PV capacity limitations) – Improvement of PV installation system services to enable a better stability of the local distribution grid (for example, the use of the VDE 4105 Standard in Germany)
Potential foreseeable stages	– Reviewing the possible practical application of the VDE 4105 Standard in the Tunisian context. Drafting of a standard application proposal
Non-Compliance with the Bill of Specifications for LV Installations and Non-Existence of Grid Code	
Obstacles	A number of installers deplore the fact that districts do not comply with the bill of specifications describing required technical conditions. According to them, each district has its own technical requirements. Moreover, installers highlight their difficulties linked to the non-existence of a grid code stating access conditions to the grid of installations connected to the low-voltage grid. In this regard, they also highlight the limitations of the authorisation to transport photovoltaic energy that is only valid on the transport grid. Consequently, photovoltaic electricity produced in isolated areas cannot be transported to private individuals or to companies connected to the distribution grid. Documents describing the "Technical requirements for the eligibility of photovoltaic installations", as well as the "On-site safety measures to be observed for photovoltaic installations connected to the grid", necessary to complete installations complying with the STEG requirements are not available on the Internet.[11]
Recommendations	– A uniform safety measures guide, co-developed by the PV sector and the STEG – Clearing process within the STEG, in cases where technical specifications required at the regional level are different from specifications at the central level of the STEG – Training programmes offered by the STEG to STEG employees and installers

[11] *The document detailing technical requirements for the eligibility of photovoltaic installations can be found in the Annex*

Potential foreseeable stages	– The German-Tunisian Energy Partnership Secretariat and the GIZ ("Mediterranean Solar Plan" project) are working closely with the STEG in order to develop a grid code for the Tunisian electricity grid. – Development of a training programme on safety standards for PV installations intended for STEG employees. This programme could be supervised by the GIZ in Tunis. – Implementation of a committee composed of STEG and ANME representatives, as well as sector professionals, in order to agree on procedures to be followed and technical documents to use in PV projects. – Development of communication operations with installers on current procedures and reference technical documents for photovoltaic project implementation. These awareness campaigns could be led by the committee aforementioned.
High system prices due to 30% subsidy within PROSOL ELEC	
Obstacles	The PROSOL ELEC grant is exclusively dedicated to small PV installations of 1 – 2 kWp and gives a subsidy of 30% of the investment costs, limited to 1.450 TND/kWp, respectively 1.800 TND/kWp for 1 kWp-installations. As market shows, system prices for the customers reach up to 10.000 TND for a 2 kWp installation. Compared to global market prices, those 5.000 TND/kWp (2.200 €) are in a very high range. Market actors report, that those market prices are artificially raised by the subsidy, not reflecting decreasing module prices nor decreasing system prices due to competition among wholesalers and installers. The PROSOL ELEC subsidy is seen as a market barrier for reaching lower system prices and – consequently – a broader rollout of PV in Tunisia.
Recommendations	The PROSOL ELEC programme should abolish its 30% subsidy for small installations in order to enforce price competition, give broader access to cheap PV and save public money, which could be used for less profitable market segments above the small residential market. Other existing or planned upfront subsidies for PV installations should be set with degression factors that are linked to profit margins of the system.
Potential foreseeable stages	– Conduct detailed cost analysis of small PV installations in order to identify potential windfall profits, stimulated by the investment grant – Define time plan for fading out the investment subsidy with appropriate preliminary lead time for the market – Communicate fading out in a manner that doesn't induce wait-and-see-behaviour of potential investors nor does it stimulate a last minute investment rush that creates exorbitant sales before and a shrunk market after the deadline.

c. Net Metering Within the "Bâtiments Solaires" ("Solar Buildings") Programme

Description of the Business Model

The "Solar Buildings" programme is aimed at promoting the development of photovoltaic installations connected to the low-voltage grid for the purpose of self-generation. Unlike the PROSOL ELEC programme, it is intended for residential, as well as service and industrial customers. The low-voltage grid corresponds to 230/400 V at a 50 Hz frequency. The output of the photovoltaic system that may be installed by the customer may not exceed the capacity subscribed to by the customer at the STEG. Electricity generated by the photovoltaic installation is entirely fed into the STEG grid and recorded via the electricity meter. The consumer then consumes the STEG grid electricity on the principle of net metering. Each modified bill summarises generated kWh and consumed kWh. The remainder of generated but not consumed kWh is carried over to the following bill.

Support Mechanism

The "Solar Buildings" programme provides for the grant of a subsidy from the National Energy Management Commission (FNME). As for the PROSOL ELEC programme, this subsidy amounts to 30% of the investment costs, and is limited to 15,000 TND per project. Following the decline in photovoltaic panels prices on the international market, the subsidy limit has been revised in June 2012. Since 1 January 2013, this subsidy is therefore limited to 1,800 TND for 1 kWp installations and 1,450 TND per kWp for 2+ kWp installations.

Unlike with the PROSOL ELEC programme, installations completed under the Solar Buildings programme do not have access to the subsidised loans offered by Attijari bank and guaranteed by the STEG.

Eligibility criteria of the "Solar Buildings" programme are as follows:

- Owning the premises to equip and being currently subscribed to a valid low-voltage STEG contract under one's name
- The installed capacity is at most equal to that subscribed to the STEG by the producer.

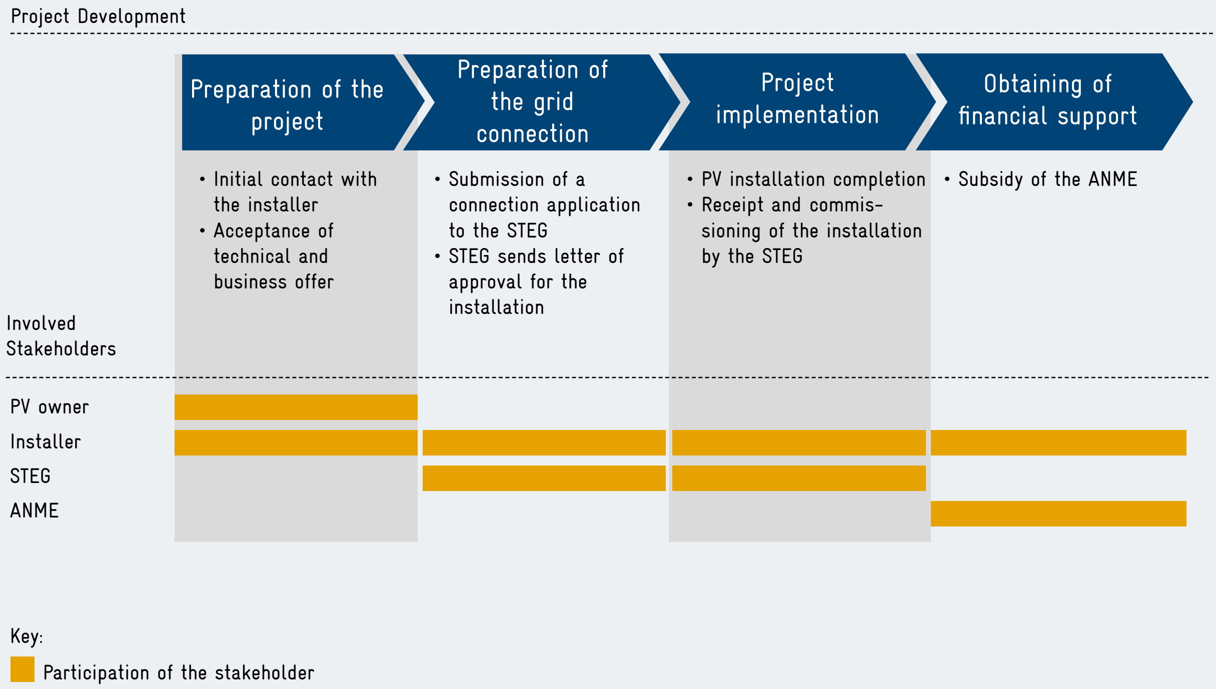
Moreover, the photovoltaic installation may benefit from several tax benefits. First, equipments and products used for energy management that do not have equivalents manufactured in Tunisia benefit from the lowest minimum customs duty, 15%.[12] Furthermore, energy-saving equipment and products benefit from VAT exemption.

Project Stages

As for the PROSOL ELEC programme, the installer receives the FNME subsidy directly in order to acquire and complete the installation in the name of the producer. The installer also receives an up-front payment from the customer to complete the installation. Project stages within the "Solar Buildings" programme are therefore the same as for installations completed under the PROSOL ELEC programme, except for the stages related to the Attijari bank loans. The commissioning process of projects completed under the "Solar Buildings" programme is illustrated in the following graph:

[12] *The current minimum legal rate of customs duty can be found on the Tunisian Customs website: http://www.douane.gov.tn/index.php?id=441*

Graph 5: Completion stages for "Solar Buildings" projects



(Source: Graph based on STEG information, as well as interviews with the sector players)

Projects Stages for Installations Eligible for the « Solar Buildings » Programme		
1. Initial contact with the installer	**Description**	A list of installing companies licensed by the ANME can be found on the STEG website (http://www.steg.com.tn/dwl/Societe_eligibles_prosol_elec.pdf). On 13 February 2014, there were 148 registered companies. After initial contact from the customer, the installer will travel to the premises in order to establish a feasibility study and a project estimate, thus constituting the technical and business offer submitted to the customer, depending on the annual electric consumption of the customer, on the available space on the building and the available investment funds.
	Player	Installer
2. Business offer	**Description**	The installer will then submit a technical and business offer to the customer. This offer will include the feasibility study reporting the technical specificities of the installation, such as the installation capacity, the number of modules, the number of inverters, etc. Moreover, the business offer will detail the cost of components in the photovoltaic installation, the amount of VAT, as well as the administration and installation fees.
	Player	Installer

3. Submission of an application to connect to the STEG	**Description**	After customer agreement on the business offer, the installer submits the application of connection to the STEG. The technical file consists of the following documents: – A copy of the customer's National Identity Card (CIN) – A "Contract stipulating that the STEG agrees to purchase any surplus electricity generated through renewable energy installations and fed into the low-voltage grid" – An electric diagram of the installation – A technical document certifying that the equipment complies with the technical requirements specified by the STEG/ANME, with respect to standards. Every year, the ANME approves a number of PV modules available on the market. Inverters are supplied by the STEG.
	Players	Installer
4. STEG sends letter of approval for the installation	**Description**	Upon reception, the corresponding STEG district reviews the application of connection, verifying the completeness of the file, the consistency of the information, the solvency of the customer, the eligibility of the equipment, the report on the annual consumption of the customer and the estimated energy capacity of the solar source.[13] The STEG states on their website that the installer may contact the district a week after the application is submitted to enquire about the decision taken by the STEG. In practice, installers have noticed that, depending on the district size and the number of applications received, the decision from the STEG may take up to two months. The STEG then sends a letter of approval for the installation to the installer, who may finally proceed to the installation.
	Players	STEG
	Duration	1 week (in theory) to 2 months (in some rare cases). In general, the STEG takes a decision within 2 weeks.
5. PV installation completion	**Description**	After receiving STEG approval, the installer may start completing the PV system installation. The PV installation must meet specific STEG requirements concerning technical conditions and safety rules, outlined in the following documents: – "Technical requirements for the eligibility of photovoltaic installations" – "On-site safety measures to be observed for photovoltaic installations connected to the grid" These documents are not available on the STEG website.
	Players	Installer
	Duration	The installation takes from 2 days to a week, depending on the installation size and the installers' availability.

[13] *Information based on the STEG website: https://www.steg.com.tn/fr/prosol_elec/procedures.html*

6. Receipt and commissioning request to the STEG	**Description**	Once the system installed, the installer sends a receipt and commissioning request to the STEG district in order to be able to start using the installation and feed the generated electricity into the grid. According to information from the STEG, "the STEG may arrange a time to visit the installation within 10 days following the submission date of the receipt and commissioning request. The STEG district is required to inform the installer of the date of the visit at least three days in advance." Currently, installers claim that response time of the STEG district depends on the receipt request queue, as well as the period of the month during which the receipt request has been sent to the district. Indeed, district teams in charge of PV installation receipts are limited in number and have numerous responsibilities. At the end of the month for example, STEG agents are overwhelmed, due to medium-voltage meter readings. According to installers, the commissioning date may occasionally be differed, depending on the availability of bi-directional meters. Those are indeed only delivered by the STEG and may be out of stock.
	Players	Installer, STEG
	Duration	According to the STEG, commissioning occurs within a maximum of 10 days after the commissioning request has been submitted. When meters are out of stock, commissioning may be delayed by 2 months.
7. Receipt and commissioning of the installation	**Description**	At receipt, STEG agents check the compliance of the PV installation with the specifications set forth in "Technical requirements for the eligibility of photovoltaic installations". Compliance of the installation with safety conditions are also checked. STEG agents then carry out the installation of the bi-directional meter, before commissioning the installation. The installation commissioning is attested by a receipt certification, signed by the STEG agent, the producer and the installer. This document is required for the ANME subsidy within the "Solar buildings" programme (see Stage 8). During this stage, the STEG issues a signed contract of connection to the grid to the installer.
	Players	STEG
	Duration	The installation of a bi-directional meter can take from 15 days to 3 months.
8. Grant of the loan by the ANME	**Description**	Once the installation is commissioned and the PV receipt is issued by the STEG, the installer applies for an ANME subsidy. Since January 2014, a new procedure is applicable, with new forms. Under this procedure, the installer must take pictures of the PV equipment (panels, inverters, wiring), in order to confirm compliance of the installation. After review of the request, the ANME wire transfers the subsidy. The subsidy corresponds to 30% of the investment, and is limited to: – 1,800 TND per kWp if the installed capacity is of 1 kWp – 1,450 TND per kWp if the installed capacity is of 2+ kWp – 15,000 TND per solar building
	Players	Installer, ANME
	Duration	The file application can take 1 to 2 days. The ANME may take up to 3 months to reply.

Obstacles and Recommendations

The barriers identified within the framework of the « Solar buildings » programme are largely similar to the challenges observed within the PROSOL ELEC programme.

Slow Administrative Procedures	
Obstacle	Administrative procedures related to the review of subsidy and loan applications are slow and penalise the sector's operators, given delayed payment. For example: the ANME procedure stipulates that the installers take pictures of the PV equipment in order to validate compliance of the installation.
Recommendations	– Balancing the costs linked to paperwork on one side, to the advantages linked to the loan on the other side – Using the installers accreditation as a guaranty to access the grid (in Germany, the installers' accreditation complying with the VDE 1000 standard allows access to the grid)
Limits of Current Legislation	
Obstacle	In accordance with the Law n°2009-7 and the implementing Decree n°2009-2773, electricity generation is only permitted for the purpose of self-consumption in Tunisia. In low-voltage, the installed electrical capacity of the equipment producing electricity shall not exceed the electrical capacity subscribed to by the producer at the STEG.
Recommendations	– Improvement of the capacity licence fee in order to cover the costs incurred by the STEG (in cases where the grid capacities are the reason for PV capacity limitations) – Improvement of PV installation system services to enable a better stability of the local distribution grid (for example, the use of the VDE 4105 Standard in Germany)
Potential foreseeable stages	– Reviewing the possible practical application of the VDE 4105 Standard in the Tunisian context. Drafting of a standard application proposal
Non-Compliance with the Bill of Specifications for LV Installations and Non-Existence of Grid Code	
Obstacles	A number of installers deplore the fact that districts do not comply with the bill of specifications describing required technical conditions. According to them, each district has its own technical requirements. Moreover, installers highlight their difficulties linked to the non-existence of a grid code stating access conditions to the grid of installations connected to the low-voltage grid. In this regard, they also highlight the limitations of the authorisation to transport photovoltaic energy that is only valid on the transport grid. Consequently, photovoltaic electricity produced in isolated areas cannot be transported to private individuals or to companies connected to the distribution grid. Documents describing the "Technical requirements for the eligibility of photovoltaic installations", as well as the "On-site safety measures to be observed for photovoltaic installations connected to the grid", necessary to complete installations complying with the STEG requirements are not available on the Internet.[14]

[14] *The document detailing technical requirements for the eligibility of photovoltaic installations can be found in the Annex*

Recommendations	– A uniform safety measures guide, co-developed by the PV sector and the STEG – Clearing process within the STEG, in cases where technical specifications required at the regional level are different from specifications at the central level of the STEG – Training programmes offered by the STEG to STEG employees and installers
Potential foreseeable stages	– The German-Tunisian Energy Partnership Secretariat and the GIZ ("Mediterranean Solar Plan" project) are working closely with the STEG in order to develop a grid code for the Tunisian electricity grid. – Development of a training programme on safety standards for PV installations intended for STEG employees. This programme could be supervised by the GIZ in Tunis. – Implementation of a committee composed of STEG and ANME representatives, as well as sector professionals, in order to agree on procedures to be followed and technical documents to use in PV projects. – Development of communication operations with installers on current procedures and reference technical documents for photovoltaic project implementation. These awareness campaigns could be led by the committee aforementioned.

d. Low-Voltage Self- Generation

Business Model Description

This business model applies to installations completed in the service, industrial and agricultural sectors and connected to the low-voltage grid. The low-voltage grid corresponds to 230/400V at a 50 Hz frequency. The installed capacity of the customer's photovoltaic system may not be higher than the customer's subscribed STEG capacity. Companies in the aforementioned sectors are allowed to feed up to 30% of their annual electricity production in the STEG national grid. However, unlike for installations connected to the medium and high-voltage grids, low-voltage installations cannot be compensated for the surplus electricity injected in the STEG grid. The remaining generated but not consumed kWh are therefore carried over to the following bill.

Support Mechanism

As for self-generation installations connected to medium and high voltage, self-generation installations connected to the low-voltage grid are eligible for FNME subsidies, provided for in the Decree 2009-362 concerning investments in the energy management sector. These subsidies correspond to 20% of the material investment costs and are limited to:

- 100,000 TND for institutions whose global annual energy consumption does not exceed 4,000 tons of oil equivalent (toe)
- 200,000 TND for institutions whose global annual energy consumption varies between 4,000 and 7,000 tons of oil equivalent (toe)
- 250,000 TND for institutions whose global annual energy consumption exceeds 7,000 tons of oil equivalent (toe)

Eligibility criteria for the self-generation mechanism on low-voltage are as follows:

- The installed capacity is at most equal to the customer's subscribed STEG capacity.
- The producer is a service, industrial or agricultural company. An extract from the trade directory is required to become eligible for FNME subsidies.
- Owning a valid STEG low-voltage subscription in one's name

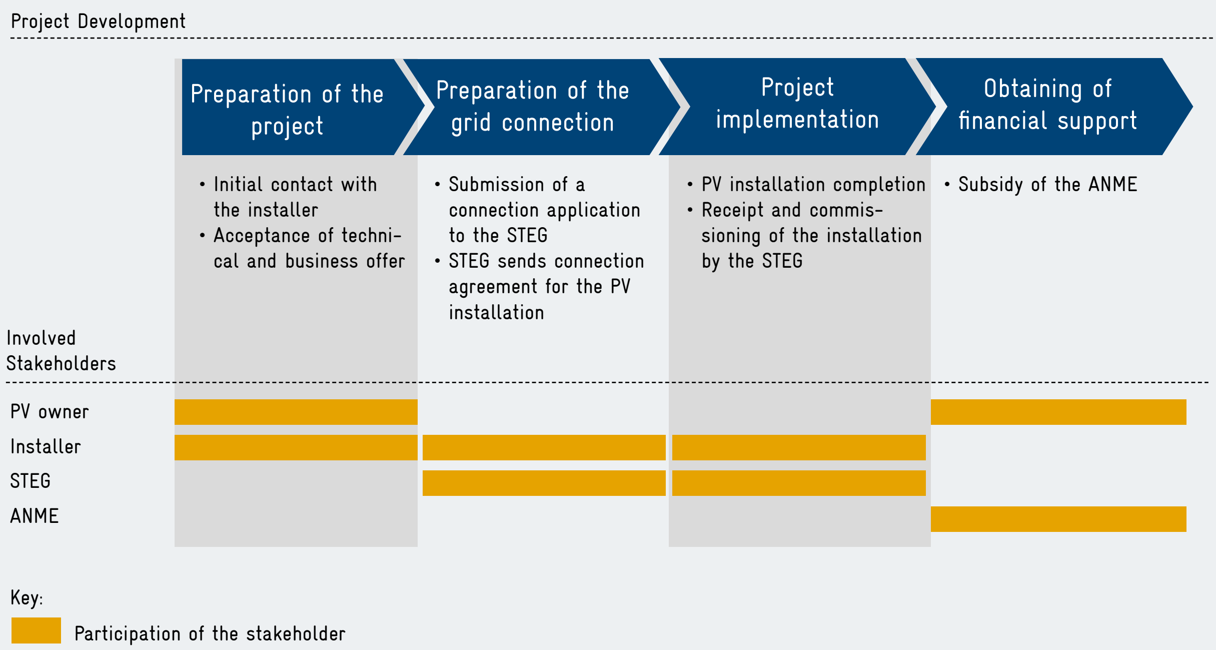
Project Stages

The completion stages of self-generation projects connected to the low-voltage grid are similar to those described in the section dedicated to self-generation installations connected to medium and high voltages. The recipient of the FNME subsidy is the owner of the installation. Please note that installations following this business model are connected to low-voltage, and cannot be contingent on the compliance to technical requirements described in the bill of specifications of 12 May 2011[15], only intended for installations connected to the medium and high-voltage grids.

The implementation process of projects under the "Self-generation in low-voltage" business model is illustrated in the graph below:

[15] *The 12 May 2011 Decree approving the bill of specifications related to technical requirements of electrical energy connection and evacuation of cogenerating and renewable energy installations on the national electricity grid is published in the Official Journal of 20 May 2011. It can be found at the following address: http://www.cnudst.rnrt.tn/jortsrc/2011/2011f/jo0362011.pdf*

Graph 6: Implementation stages for low-voltage self-generating installations



(Source: interviews with sector players)

Projects Stages for Installations Eligible for the « Low-Voltage Self-Generation» Programme		
1. Initial contact with the installer	**Description**	A list of installing companies licensed by the ANME can be found on the STEG website (http://www.steg.com.tn/dwl/Societe_eligibles_prosol_elec.pdf). On 13 February 2014, there were 148 registered companies. After initial contact from the customer, the installer will travel to the premises in order to establish a feasibility study and a project estimate, thus constituting the technical and business offer submitted to the customer, depending on the annual electric consumption of the customer, on the available space on the building and the available investment funds.
	Player	Installer/project developer
2. Business offer	**Description**	The installer will then submit a technical and business offer to the customer. This offer will include the feasibility study reporting the technical specificities of the installation, such as the installation capacity, the number of modules, the number of inverters, etc. Moreover, the business offer will detail the cost of components in the photovoltaic installation, the amount of VAT, as well as the administration and installation fees.
	Player	Installer/project developer

3. Submission of an application to connect to the STEG	**Description**	After customer agreement on the business offer, the installer/project developer submits the application of connection to the STEG. The technical file consists of the following documents: – A copy of the customer's National Identity Card (CIN) – A "Contract stipulating that the STEG agrees to purchase any surplus electricity generated through renewable energy installations and fed into the low-voltage grid" – An electric diagram of the installation – A technical document certifying that the equipment complies with the technical requirements specified by the STEG/ANME, with respect to standards. Every year, the ANME approves a number of PV modules available on the market. Inverters are supplied by the STEG.
	Player	Installer/project developer, owner of the installation, STEG
4. STEG sends grid connection agreement	**Description**	Upon reception, the corresponding STEG district reviews the application of connection, verifying the completeness of the file, the consistency of the information, the solvency of the customer, the eligibility of the equipment, the report on the annual consumption of the customer and the estimated energy capacity of the solar source.[16] The STEG states on their website that the installer may contact the district a week after the application is submitted to enquire about the decision taken by the STEG. In practice, installers have noticed that, depending on the district size and the number of applications received, the decision from the STEG may take up to two months. The STEG then sends a grid connection agreement to the installer, who may finally proceed to the installation.
	Players	STEG
	Duration	1 week (in theory) to 2 months (in some rare cases).
5. PV installation completion	**Description**	After receiving STEG approval, the installer may start completing the PV system installation. The PV installation must meet specific STEG requirements concerning technical conditions and safety rules, outlined in the following documents: – "Technical requirements for the eligibility of photovoltaic installations" – "On-site safety measures to be observed for photovoltaic installations connected to the grid" These documents are not available on the STEG website.
	Players	Installer/project developer
6. Receipt and commissioning request to the STEG	**Description**	Once the system installed, the installer sends a receipt and commissioning request to the STEG district in order to be able to start using the installation and feed the generated electricity into the grid. According to information from the STEG, "the STEG may arrange a time to visit the installation within 10 days following the submission date of the receipt and commissioning request. The STEG district is required to inform the installer of the date of the visit at least three days in advance." Currently, installers claim that response time of the STEG district depends on the receipt request queue, as well as the period of the month during which the receipt request has been sent to the district. Indeed, district teams in charge of PV installation receipts are limited in number and have numerous responsibilities. At the end of the month for example, STEG agents are overwhelmed, due to medium-voltage meter readings. According to installers, the commissioning date may occasionally be differed, depending on the availability of bi-directional meters. Those are indeed only delivered by the STEG and may be out of stock.
	Players	Installer, STEG
	Duration	According to the STEG, commissioning occurs within a maximum of 10 days after the commissioning request has been submitted. When meters are out of stock, commissioning may be delayed by 2 months.

[16] *Information based on the STEG website: https://www.steg.com.tn/fr/prosol_elec/procedures.html*

7. Receipt and commissioning of the installation	**Description**	At receipt, STEG agents check the compliance of the PV installation with the specifications set forth in "Technical requirements for the eligibility of photovoltaic installations". Compliance of the installation with safety conditions are also checked. STEG agents then carry out the installation of the bi-directional meter, before commissioning the installation. The installation commissioning is attested by a receipt certification, signed by the STEG agent, the producer and the installer.
	Players	STEG
8. Grant of the loan by the ANME	**Description**	Once the installation is commissioned and the PV receipt is issued by the STEG, the installer applies for an ANME subsidy. Since January 2014, a new procedure is applicable, with new forms. Under this procedure, the installer must take pictures of the PV equipment (panels, inverters, wiring), in order to confirm compliance of the installation. Once the file is reviewed, the ANME wire transfers the subsidy. The subsidy corresponds to 20% of the material investment cost, limited to: – 100,000 TND for institutions whose global annual energy consumption does not exceed 4,000 tons of oil equivalent (toe) – 200,000 TND for institutions whose global annual energy consumption varies between 4,000 and 7,000 tons of oil equivalent (toe) – 250,000 TND for institutions whose global annual energy consumption exceed 7.000 tons of oil equivalent (toe)
	Players	Installation owner, ANME

Obstacles and Recommendations

The barriers identified within the framework of the « Low-Voltage Self-Generation» programme are largely similar to the challenges observed within the PROSOL ELEC programme.

Slow Administrative Procedures	
Obstacle	Administrative procedures related to the review of subsidy and loan applications are slow and penalise the sector's operators, given delayed payment. For example: the ANME procedure stipulates that the installers take pictures of the PV equipment in order to validate compliance of the installation.
Recommendations	– Balancing the costs linked to paperwork on one side, to the advantages linked to the loan on the other side – Using the installers accreditation as a guaranty to access the grid (in Germany, the installers' accreditation complying with the VDE 1000 standard allows access to the grid)
Limits of Current Legislation	
Obstacle	In accordance with the Law n°2009-7 and the implementing Decree n°2009-2773, electricity generation is only permitted for the purpose of self-consumption in Tunisia. In low-voltage, the installed electrical capacity of the equipment producing electricity shall not exceed the electrical capacity subscribed to by the producer at the STEG.

Recommendations	– Improvement of the capacity licence fee in order to cover the costs incurred by the STEG (in cases where the grid capacities are the reason for PV capacity limitations) – Improvement of PV installation system services to enable a better stability of the local distribution grid (for example, the use of the VDE 4105 Standard in Germany)
Potential foreseeable stages	– Reviewing the possible practical application of the VDE 4105 Standard in the Tunisian context. Drafting of a standard application proposal
Non-Compliance with the Bill of Specifications for LV Installations and Non-Existence of Grid Code	
Obstacles	A number of installers deplore the fact that districts do not comply with the bill of specifications describing required technical conditions. According to them, each district has its own technical requirements. Moreover, installers highlight their difficulties linked to the non-existence of a grid code stating access conditions to the grid of installations connected to the low-voltage grid. In this regard, they also highlight the limitations of the authorisation to transport photovoltaic energy that is only valid on the transport grid. Consequently, photovoltaic electricity produced in isolated areas cannot be transported to private individuals or to companies connected to the distribution grid. Documents describing the "Technical requirements for the eligibility of photovoltaic installations", as well as the "On-site safety measures to be observed for photovoltaic installations connected to the grid", necessary to complete installations complying with the STEG requirements are not available on the Internet.[17]
Recommendations	– A uniform safety measures guide, co-developed by the PV sector and the STEG – Clearing process within the STEG, in cases where technical specifications required at the regional level are different from specifications at the central level of the STEG – Training programmes offered by the STEG to STEG employees and installers
Potential foreseeable stages	– The German-Tunisian Energy Partnership Secretariat and the GIZ ("Mediterranean Solar Plan" project) are working closely with the STEG in order to develop a grid code for the Tunisian electricity grid. – Development of a training programme on safety standards for PV installations intended for STEG employees. This programme could be supervised by the GIZ in Tunis. – Implementation of a committee composed of STEG and ANME representatives, as well as sector professionals, in order to agree on procedures to be followed and technical documents to use in PV projects. – Development of communication operations with installers on current procedures and reference technical documents for photovoltaic project implementation. These awareness campaigns could be led by the committee aforementioned.

[17] *The document detailing technical requirements for the eligibility of photovoltaic installations can be found in the Annex*

e. Medium and High-Voltage Self-Generation

Business Model Description

Within the electricity self-generation framework, current legislation in Tunisia allows companies from the industrial, agricultural and service sectors to feed up to 30% of their annual electricity production surplus into the STEG national grid. The feed-in purchase tariff is set by decision of the Ministry of Energy. Currently, the feed-in rate applied to electricity produced by photovoltaics is the same as the applicable STEG sales tariff.

In the event that the electricity consumption and production sites are located at two different connection points, the transport of electricity from the production site to the consumption site is billed by the STEG to the installation owner. The transport price is set by decision of the Ministry of Energy. For customers on high and medium voltage grids, "the billing involves the difference between the electricity delivered by the STEG, on the one hand, and that produced and delivered by the self-producer. The applicable rate is that which is subscribed to by the customer and depends on times of consumption." (Cessac 2014) Bills to medium and high-voltage customers are edited every month via meter readings. At the end of each year, the STEG establishes an annual balance sheet which assesses the amount of electricity sold to the STEG by the PV producer. Should this amount exceed the allowed limit of the 30% surplus allowance described above, then the STEG will charge the difference to the PV producer on his next electricity bill.

Moreover, the self-producer shall bear any expenses associated with the connection of the installation to the grid and with the reinforcement of the grid, if necessary. The conditions of connection and energy evacuation are set forth by the bill of specifications of 12 May 2011.[18]

This business model is interesting partly for the agribusiness customers, such as henhouses or supermarkets wishing to install up to 100 kWp photovoltaic systems.

Moreover, industrial customers with photovoltaic systems between 100 kWp and 1 MWp are also very interested in this business model. Even though the hospitality sector constitutes a very promising target audience for this type of projects, the rather unstable current situation of tourism in Tunisia holds back the willingness of hotel owners to contemplate PV projects.

Support Mechanism

Photovoltaic installations connected to the medium and high-voltage grid are eligible for subsidies provided for by Decree 2009-362 concerning investments performed in the energy management sector, equivalent to 20% of the material investment costs and limited to:

- 100,000 TND for institutions whose annual global energy consumption does not exceed 4,000 tons oil equivalent (toe)
- 200,000 TND for institutions whose annual global energy consumption varies between 4,000 and 7,000 tons oil equivalent (toe)
- 250,000 TND for institutions whose annual global energy consumption exceeds 7,000 tons oil equivalent (toe)

In practice however, only very few companies with a high primary energy consumption are likely to receive the subsidies amounting to 200,000 TND and 250,000 TND. Moreover, photovoltaic installations may benefit from several tax benefits. First of all, equipments and products used for energy management that do not have any equivalent manufactured in Tunisia (there are three PV panels manufacturers in Tunisia!) beneficiate from the minimum customs duty, 15%. Then, energy-saving equipment and products beneficiate from VAT exemption.

Eligibility conditions for the ANME subsidies for installations connected to MV and HV are as follows:

- The company AND/OR the business group owning the installation must belong to the industrial, service or agricultural sectors.

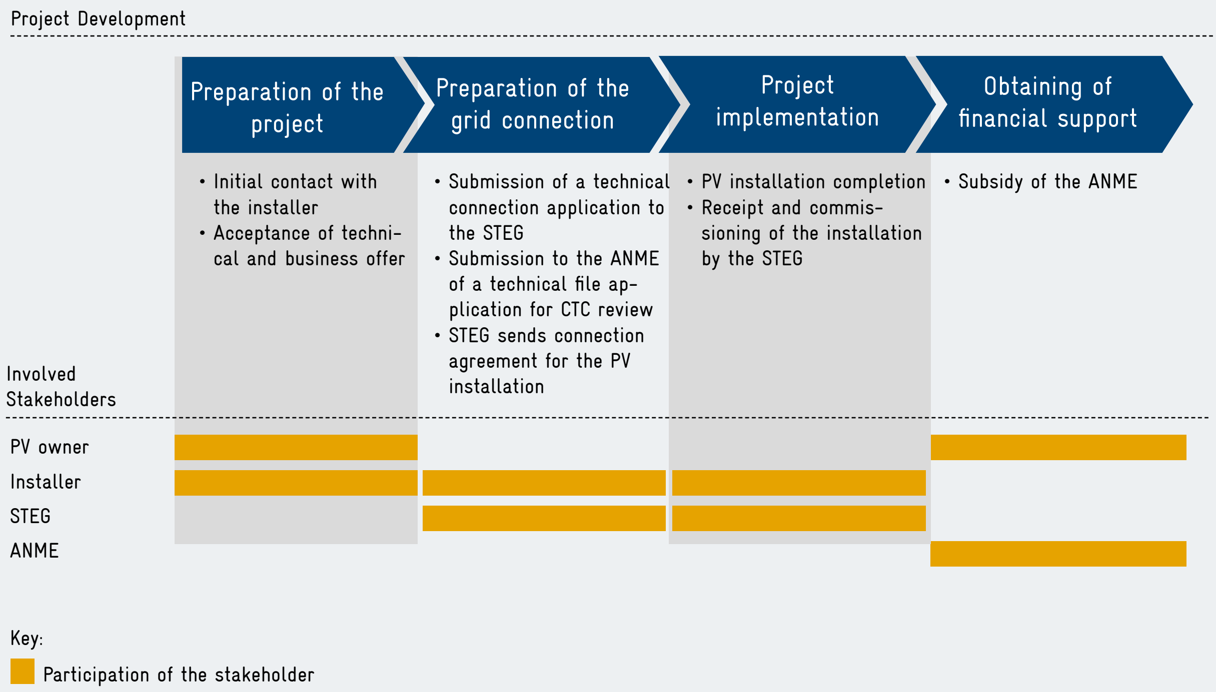
[18] *The 12 May 2011 Decree approving the bill of specifications related to technical requirements of electrical energy connection and evacuation of cogenerating and renewable energy installations on the national electricity grid is published in the Official Journal of 20 May 2011. It can be found at the following address: http://www.cnudst.rnrt.tn/jortsrc/2011/2011f/jo0362011.pdf*

- The energy producing company must be registered on the national trade registry. Access to an FNME subsidy is contingent upon submission of an extract of the owning company's registration with the Chamber of Commerce. In the case of a business corporation, this group must create a management entity for the installation.
- Surplus electricity fed in the grid may not exceed 30% of the annual electricity generation of the producer. The electricity is billed on the basis of prices set by the Ministry of Energy.

Project Stages

The implementation process of projects completed according to the "Medium and high-voltage self-generation" business model is illustrated by the following graph:

Graph 7: Implementation stages of medium and high-voltage self-generating installations



(Source: interviews with sector players)

Projects Stages for Installations Eligible for the « MV and HV Self-Generation» Programme		
1. Initial contact with the project developer	**Description**	The list of installing companies licensed by the ANME can be found on the STEG website (http://www.steg.com.tn/dwl/Societe_eligibles_prosol_elec.pdf). On 13 February 2014, there were 148 registered companies. After initial contact from the customer, the installer will travel to the premises in order to establish a feasibility study and a project estimate, that will constitute the technical and business offer submitted to the customer, depending on the annual electric consumption of the customer, of the available space on the building and the available investment funds.
	Players	Installer/project developer
2. Business offer	**Description**	The installer will then submit a technical and business offer to the customer. This offer will include the feasibility study, reporting the technical specificities of the installation, such as the installation capacity, the number of modules, the number of inverters, etc. For larger installations, the feasibility study also includes an environmental impact study, as well as a connection study in order to verify that the electricity grid in the chosen site can handle the capacity of the project. Moreover, the business offer will detail the costs of components in the photovoltaic installation, the amount of VAT, as well as the administration and installation fees.
	Players	Installer/project developer
3. Submission of a grid connection application to the STEG	**Description**	After customer agreement on the business offer, the installer/the owner of the installation submits a technical grid connection application to the STEG. The list of documents is indicated in the contract regarding selling the surplus electrical energy signed with the STEG. It includes the following documents (Cessac 2014): – A copy of the customer's National Identity Card (CIN) – An electric diagram of the producing installation – A technical description of potential autonomous energy sources able to, if need be, supply energy to the electrical systems normally fed by the producing installation – A control and protection diagram of the generating installation equipment – The site plan of the generating installation indicating property boundaries and point of delivery – The receipt and commissioning application – A certificate of compliance to the CEM04/108/CE directive and the VDE 0126 standard, or equivalent, for the inverter. The technical requirements of the installation are specified by the bill of specifications of 12 May 2011.[19] This file will provide a basis for the STEG to verify compliance to connection requirements and assess the impact of the installation on the grid.
	Players	Installer/project developer, owner of the installation, STEG

[19] *The 12 May 2011 Decree approving the bill of specifications related to technical requirements of electrical energy connection and evacuation of cogenerating and renewable energy installations on the national electricity grid is published in the Official Journal of 20 May 2011. It can be found at the following address: http://www.cnudst.rnrt.tn/jortsrc/2011/2011f/jo0362011.pdf*

4. Technical file application at the ANME for CTC review	**Description**	Before any connection can be completed, projects of electricity production based on renewable energies, connected to the national electricity grid, are submitted to the CTC (Technical Advisory Committee). The Committee provides its opinion based on a technical file submitted to the ANME including the following documents: – An extract from the trade directory for the institution – A technical and economical feasibility study – The planned location and electric capacity to install – Electricity consumption sites – The annual electricity consumption of the institution or corporation – The planned annual electricity generation. The CTC meets monthly. Once the decision issued by the CTC, electricity production projects based on renewable energies, connected to the national electricity grid, are approved by a Ministry of Energy decision. Once the Minister approves the project, the ANME administration drafts a contract-programme to oversee completion of the PV project.
	Players	Installer/project developer, installation owner, ANME, CTC
5. Installation completion	**Description**	Once the project approved by the CTC and the contract of connection to the grid sent by the STEG, the installer may proceed to the completion of the installation.
	Players	Installer/project developer
6. Receipt of installation	**Description**	Receipt of the installation is required for the customer (installation owner). Currently, this stage is not clear, due to lack of experience associated with projects connected to medium-voltage. The standard procedure for receipt of an electricity installation includes asserting compliance of the installation, verifying compliance of the MV/HV transformer, as well as verifying the grid protection device at the STEG point of connection. Electricity meters for medium voltage are already bi-directional.
	Players	Installation owner, STEG
7. Connection and commissioning of the installation	**Description**	Access of the photovoltaic installation to the grid is contingent upon complying with the technical requirements described in the bill of specifications of 12 May 2011.
	Players	STEG
8. Securing an ANME subsidy	**Description**	Once the installation operational, the installer submits a file to secure an ANME subsidy. Since January 2014, a new procedure is applicable, with new forms. According to the new procedure, the installer must submit a report to the ANME, including a range of information on the material, the installation diagram and a few pictures of the PV equipment of the installation (panels, inverters, wiring), in order to confirm the compliance of the installation. Once the file is reviewed, the ANME wire transfers the subsidy. The subsidy corresponds to 20% of the material investment cost, limited to: – 100,000 TND for institutions whose global annual energy consumption does not exceed 4,000 tons of oil equivalent (toe) – 200,000 TND for institutions whose global annual energy consumption varies between 4,000 and 7,000 tons of oil equivalent (toe) – 250,000 TND for institutions whose global annual energy consumption exceed 7.000 tons of oil equivalent (toe)
	Players	Installer/project developer, installation owner, ANME

Obstacles and Recommendations

Even though current legislation allows the connection of photovoltaic installations to the medium-voltage grid, implementation of such projects is still hampered, in June 2014, by many obstacles of administrative, regulatory and structural natures. The main obstacle remains the fact that prices for consumers are still too low, and do not lead to profitable investments. Given the willingness of the state to suppress energy subsidies, it is likely that prices for subscribers to medium-voltage will increase as fast as prices for subscribers to low-voltage.

Unclear Implementation Procedure	
Obstacles	The procedure relating to self-generation remains unclear. Operators are unable to master the different stages, the players and the administrative procedures involved. Moreover, installers highlight a lack of clarity concerning competencies and responsibilities of the involved institutions, that is to say the STEG and the ANME. Consequently, projects connected to the MV grid have very long completion time, reaching up to 10-12 months.
Recommendations	– First of all, a clear legal definition of competencies attributed to the STEG, and the ANME for MV and HV projects, should be formulated. Then, the Ministry of Energy, as the responsible authority of the renewable energy development policy, could entrust the ANME and STEG to outline in details the procedure to apply for MV and HV projects. The ANME could be put in charge of defining administrative procedures for subsidy grants, whereas the STEG could be responsible for determining technical details concerning the connection procedure of the PV installations to the grid. The Ministry of Energy would be responsible for supervising the ANME and the STEG.
Potential foreseeable stages	– Creation of a task force consisting of ANME and STEG representatives, in order to jointly establish an administrative procedure concerning medium and high-voltage projects
Difficulty to Secure Bank Financing	
Obstacles	Beyond the problem of securing a contract for the connection to medium-voltage, larger project developers lament the difficulty of securing bank loans. According to them, bank institutions do not trust larger photovoltaic installations. The agreement between the STEG and Attijari bank overcomes the difficulty to finance smaller projects under the PROSOL ELEC programme. However, it is unlikely that the STEG negotiates a similar agreement with banks in order to guaranty loans for larger photovoltaic systems. Indeed, the financial risk for the STEG would be too high for these projects, should repayment not be made.
Recommendations	– Organising seminars and information meetings with banks and main players of the PV sector, in order to improve bank institutions' understanding of PV profitability. Ideally, seminars should be held in conjunction with conferences or trade shows on photovoltaics or renewable energies in general. Thereupon, the "Droit au but" ("Straight to the point") workshop, organised in Tunis on 15 March 2014, with the Tunisian-German partnership on Energy has already formulated concrete recommendations in its financial section. These recommendations suggest organising manufactures and PV companies visits for financiers.[20]

[20] *These recommendations have already been suggested during the "Droit au but" ("Straight to the point") workshop. A summary of actions to be taken in Tunisia in order to reach its renewable energy goals by 2030 can be found at the following address: https://energypedia.info/wiki/Droit_au_But_Workshop*

	– Implementation of long-term, transparent, reliable information, particularly concerning the evolution of electricity tariffs applied by the STEG. This information could be communicated through tools accessible to the public (for example, an online tool calculating electricity rates depending on monthly consumption).[21] – Definition of financing criteria for banks, in order to facilitate a uniform and effective assessment of PV projects – Reinforcement of the exemplary role of the State concerning the use of renewal energies. The ANME could accompany and support the completion of a number of projects, thereby reassuring banks.
Potential foreseeable stages	– Preparation of seminars on photovoltaic technology and financing possibilities, intended for private banking institutions. The programme should integrate the participation of international experts as well as feedback from Tunisian project developers. During those seminars, communication and exchange of positive experiences between international banks and their Tunisian counterparts could improve banks' understanding of PV technology.
Absence of a Standard Model Agreement for the Purchase of Electricity Injected into the MV-HV Grid	
Obstacles	A standardised model agreement for the purchase of electricity by the STEG for installations connected to the MV grid was awaiting publication in June 2014. The publication of a standardised model agreement was delayed due to a regulatory uncertainty concerning VAT application on the energy produced by photovoltaic installations, a problem already solved. The drafting of a standardised model contract has moreover been delayed due to the fact that the licence fee required to use the electricity grid does not cover enough of the additional costs created by the connection of PV installations to the MV and HV grid. According to the ANME, a standard model agreement of purchase of photovoltaic electricity has been approved by the Ministry of Energy. It is within the competency of the STEG to publish this standard agreement on its website. In June 2014, even though 50 projects had been technically approved by the STEG, none of them had been completed due to the non-existence of a purchase contract.
Recommendations	– Appeal to the STEG to publish a standard contract, in order to allow for the development of larger PV projects
Lack of Installing Companies Specialised in Large Projects	
Obstacles	The PROSOL ELEC programme has led to the creation of companies specialised in small installations. However, there is a lack of installing companies with sufficient financial capacity and workforce to complete large capacity installations.
Recommendations	– Implementation of bank loans specifically intended for active companies in the photovoltaic sector – Training programmes and collaborative work with associations, for example with a week of training, similar to the "German Solar Training weeks", organised by the GIZ or the German Export Initiative "Renewables - Made in Germany"

[21] *Ibid.*

Limitations of the Current Legislation	
Obstacles	The limitation to the industrial, service and agricultural sectors of the authorisation to sell PV electricity surplus to the STEG remains a hindrance to PV development. For example, local communities cannot, to this day, install PV systems to reduce their bills, even though those communities' bills represent 60% of the outstanding debts owed to the STEG. Moreover, these communities have the necessary finances to invest in this sector.
Recommendations	– Widen eligibility to electricity surplus sale to other sectors. Beyond private sectors, the public sector players, such as municipalities, could also be authorised to become independent electricity producers.[22]

[22] *Regarding this subject, please visit the "Kommunal erneuerbar" website, introducing successful models of communities using renewable energies in Germany: http://www.kommunal-erneuerbar.de/. This site is only available in German.*

4. Profitability of the Models – Simulation

a. Input Variables (Parameters) and Profitability Calculation Method

The various business models presented above impose themselves on the market if the minimum expectations of the investor and PV installation operator concerning the profitability of the installation are met. Profitability depends on numerous input variables that are either pre-established, or dependent from external factors. These factors can be linked to the passage of time as well as the specific situation of the project. In order to detect the influence of different variables on the profitability of those business models, sensitivity analysis covering a large spectrum of potential results has been completed.

Each sensitivity analysis calculation includes investment amortization time as well as internal profitability rate. These investment decision tools are indeed paramount for investors and project developers.

Sensitivity analysis calculations are based on the following information:

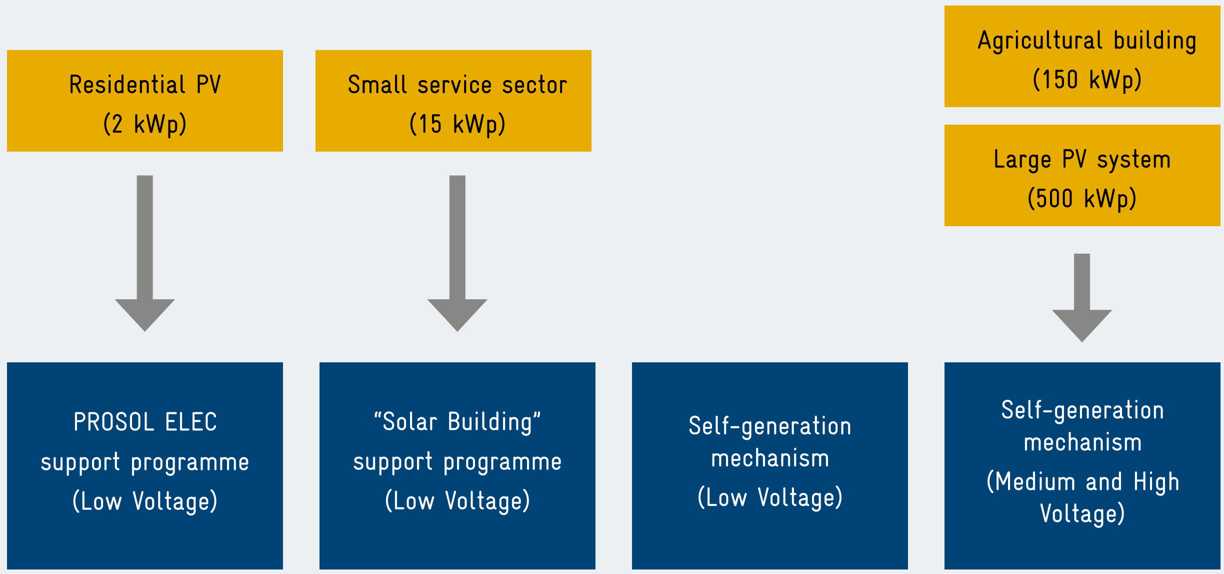
- BSW-Solar/eclareon profitability calculations
- Information gathered during interviews
- Price offers from installers for different installation sizes on the Tunisian market

The profitability of these business models has been calculated on the basis of four types of installations. These four cases mainly differ in installation size and corresponding support mechanism. The four types of installations are as follows:

- Residential PV: A PV installation intended for private individuals, of a 2 kWp capacity. This installation is eligible for the PROSOL ELEC programme
- Small service sector: A small PV system for commercial use, of a 15 kWp capacity, and eligible for the "Solar Buildings" programme
- Agricultural building: A medium-size PV installation, used in the industrial or agricultural sectors, of a 150 kWp capacity. This installation is eligible for subsidies intended for medium-voltage self-generation installations
- Large system: A large industrial PV installation, of a 500 kWp capacity. This installation beneficiates from subsidies for medium-voltage self-generation installations

As shown in the following graph, chosen installations correspond to three of the four identified business models. The "Low-voltage self-generation" model has not been studied, being hardly implemented.

Graph 8: Overview of the four installation types and corresponding support mechanisms



Input variables for these profitability calculations are divided into three categories. A distinction is therefore made between parameters concerning the PV installation, those concerning electricity consumption, and those concerning investment. With these categories in mind, sensitivity analysis calculations have been made according to a base scenario.

Table 2: Input variables for the profitability calculations

PV Installation Parameters	Consumption Parameters	Investment and Financing Parameters
■ System size ■ Specific investment cost ■ Absolute investment cost ■ Specific yield ■ Operation & Maintenance	■ Monthly consumption ■ Average electricity tariffs ■ Residual electricity price ■ Indirect savings ■ Increase in electricity prices ■ Grid use costs ■ Inflation	■ Project duration ■ Subsidies ■ Equity ■ Repayment due date ■ Interest rate ■ Discount rate ■ Net present value

The net metering system applied in Tunisia has a unique effect on electricity tariffs obtained through PV electricity production. Indeed, the current Tunisian pricing structure for the low-voltage grid is constituted of tariff ranges based on the customer's monthly consumption. The more the customer consumes, the higher the tariffs, as illustrated by the table below:

Table 3: Electricity tariffs for the low-voltage grid, in force from 1 May 2014

Tariff	Sector	Capacity fee (mill/kVa/ month)	Electricity price for each monthly consumption block (mill/kWh)					
			1-50	51-100	101-200	201-300	301-500	501 +
Economy rate (1 and 2 kVA & C° ≤ 200 kWh/ month)	Residential	500	75					
	Residential and Non-Residential		108					
	Residential and Non-Residential		140					
Economy rate (1 and 2 kVA & C° > 200 kWh/ month) **Normal rate** (> 2kVA)	Residential	500	151			184	280	350
	Non-Residential						250	295

(Source: STEG)

Example: If a business or a company (belonging to the “non-residential” sector) consumes 500 kWh of electricity per month, the first 200 kWh will be billed at a tariff of 151 millimes, whereas the next 100 kWh will cost 184 millimes, and the remaining 200 kWh will cost 250 millimes.

Taking into consideration the self-generated photovoltaic electricity, total monthly electricity consumption from the grid decreases. Consequently, higher tariffs linked to higher electricity consumption ranges are avoided. The saved electricity costs thanks to PV installations is therefore relatively high. Electricity debited from the electricity grid is billed according to the tariff structure explained above, starting from the first brackets. Therefore, profitability of these business models is calculated by differentiating two separate tariffs: the relatively high tariff avoided thanks to PV production (“avoided cost by PV”) and the lower tariff corresponding to residual electricity consumption (“cost of residual import”).

The following table details the calculations made for these two tariffs (with and without PV) for a 15 kWp installation. The result is a tariff of 295 millimes/kWh for avoided cost by PV (corresponding to the “Average grid electricity tariff” parameter). The tariff for residual electricity consumption corresponds to 204 millimes/kWh (“Cost for residual import”).

Table 4: Calculations of electricity tariffs with and without PV (source: calculations based on STEG low-voltage electricity tariffs in effect since 1 May 2014)

Example: installation PV Small service sector, 15 kWp

		yearly	monthly
Consumption	kWh	30000	2500
PV capacity	kWh	15	
PV yield (1.600 kWh/kW) - degrad.	kWh	23520	1960
Residual import from grid	kWh		540
Electricity costs without PV		**tariff (mill)**	**cost (mill)**
0-200 kWh / month		151	30200
201 - 300 kWh / month		184	18400
301 - 500 kWh / month		250	50000
500 - X kWh / month		295	11800
total costs / month (mill)	mill		110400
total costs / month (TND)	TND		110,4
Cost / kWh	TND		0,275
Electricity costs with PV		**tariff (mill)**	**cost (mill)**
0-200 kWh / month		151	30200
201 - 300 kWh / month		184	18400
301 - 500 kWh / month		250	50000
500 - X kWh / month		295	11800
total costs / month (mill)	mill		110400
total costs / month (TND)	TND		110,4
Cost for residual import	DT / kWh =110,4 DT / 540 kWh		0,204
Savings by PV / month	TND = 688,6 TND - 110,4 DT		578,2
Avoided cost by PV	TND / kWh = 578,2 TND / 1960 kWh		0,295

This benefit increases the economic attractiveness of net metering for photovoltaics. Investment in a PV installation reveals itself encouraging, especially for larger electricity consumers. However, higher electricity tariffs applied to these consumers are necessary for the operation of the structured system. Indeed, it is the higher tariffs that "finance" the overall costs of the grid, to the smaller consumers' benefit, who pay a lower electricity tariff. In a slowly developing market, the impact of general costs repartition remains limited. In the long run, this effect must however be contained, at the risk of seeing policy-makers turn away from the net metering system.

As far as the current pricing structure for the medium-voltage grid is concerned, the electricity tariffs are defined according to four different time slots, namely: day time, peak hours in the morning, peak hours in the evening and night time. Electricity consumers also have the possibility to choose to pay their electricity through a uniform tariff, as illustrated by the table below:

Table 5: Electricity tariffs for the medium-voltage grid, in force from 1 May 2014

Voltage Level	Tariff	Capacity fee (mill/kVa/ month)	Electricity tariff (mill/kWh)			
			Day time	Peak hours in the morning (summer)	Peak hours in the evening	Night time
Medium-Voltage Grid	Uniform	2600[3]	167			
	Tariff Per Time Slots	8000	152	238	218	115
	Cement sector (grey cement)	6500	177	311	268	129
	Water pumping for irrigation purposes	-	160	NA	Curtailment	115
	Agricultural Irrigation	-	114	Curtailment	132[5]	88
	Emergency Relief	3700	170	295	258	123

(Source: STEG)

The profitability and sensitivity calculations for the projects connected on the medium voltage grid (cases # 3 and 4) take into account the tariff structure according to the four time slots. The average grid electricity price for these four time slots was calculated on the basis of the knowledge and experience of experts, considering the fact that PV systems do not produce the same amount of electricity throughout the day.

All grid electricity tariffs considered for the profitability and sensibility calculations include the municipal surcharge amounting to 5 millimes per kWh. Finally, profitability and sensitivity calculations are calculated according to the principle of constant annuities.

b. Results Presentation – Case #1: Residential PV (2 kWp)

The basic premises for a residential photovoltaic installation take into consideration the following parameters:

Table 6: Parameters for a 2 kWp PV installation

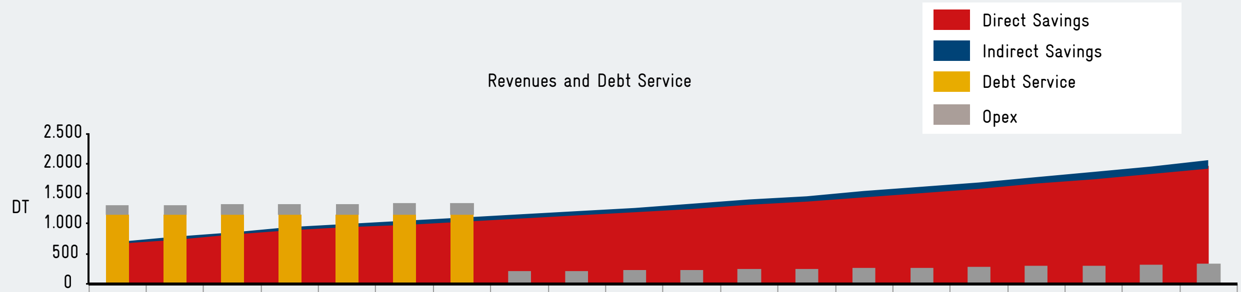
PV System		
System Size	kWp	2
Specific Investment Cost	DT/kWp	4.500
Absolute Investment Cost*	DT	6.300
Specific Yield	kWh/kWp/a	1.600
Operation & Maintenance	DT/kWp/a	76
Price Parameter		
Monthly Consumption	kWh	416
Average Grid Electricity Price**	DT/kWh	0,2233
Price for Residual Electricity**	DT/kWh	0,1741
Indirect Savings	DT/kWh	0,0208
Electricity Price Escalation 2015 - 2017 after 2017	 % p.a. % p.a.	 10% 5%
Grid usage fee	DT/kWh	-
Inflation	% p.a.	4%
Investment		
Project Duration	Years	20
Subsidies	DT	1.890
Loan Amount	DT	6.500
Debt Tenor	Years	7
Interest Rate	%	5,94%
Discount Rate	%	4,00%
Net-Present-Value	DT	7.615
Project IRR	%	13,10%
Amortization	Years	9,46

* after subsidies
**including TVA

- The average electricity tariff was calculated according to the corresponding price structure of a low-voltage connection and a consumption of 416 kWh per month.
- The average electricity tariff of a consumer who does not own a photovoltaic installation constitutes the basis from which the avoided costs, thanks to self-generated and consumed PV electricity, are calculated.
- As explained above, the tariff of the electricity consumed from the grid, as not covered by the production of the PV installation, is lower, because it corresponds to a lower monthly consumption range.
- The difference between both tariffs corresponds to indirect savings made thanks to the PV installation.
- The ANME subsidy corresponding to 30% of investment costs is deducted from specific investment costs.
- The future discounted rate of cash flow is of 4%.

Results

Graph 9: Operating revenue and debt servicing for a 2 kWp installation

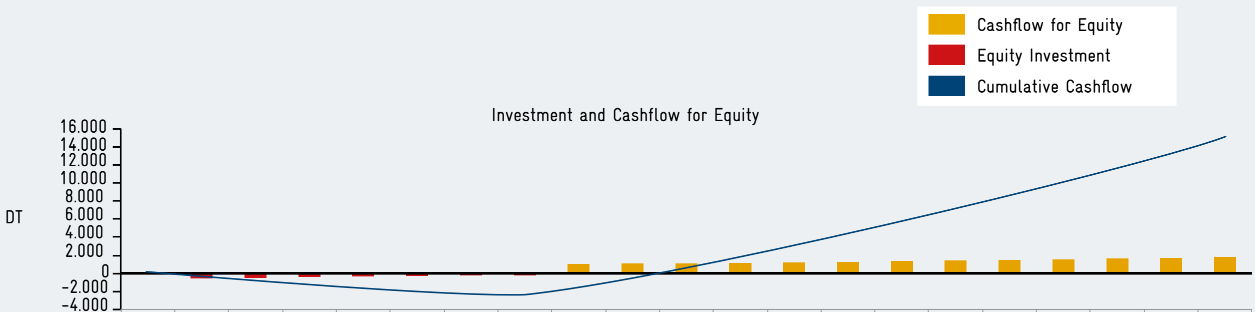


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Indirect Savings	39	43	49	54	58	61	64	68	72	76	80	85	90	94	100	105	111	117	123	130
Direct Savings	713	781	858	938	982	1.029	1.080	1.128	1.181	1.237	1.299	1.357	1.421	1.488	1.563	1.633	1.710	1.791	1.881	1.965
Opex	158	164	171	178	185	192	200	208	216	225	234	243	253	263	274	285	296	308	320	333
Dept Service	1.147	1.147	1.147	1.147	1.147	1.147	1.147	-	-	-	-	-	-	-	-	-	-	-	-	-

Operation Year

In the case of a 2 kWp PV installation, direct and indirect savings obtained during the first years are not sufficient to cover payment of the debt service and operational expenses. The duration of the Attijari bank loan, 7 years, is problematic, because the amount of debt servicing is higher than savings made. Consequently, the installation owner has to make up the difference through a higher electricity bill, corresponding to the repayment of the Attijari bank loan though the STEG bill.

Graph 10: Investment and equity cash flows for a 2 kWp installation



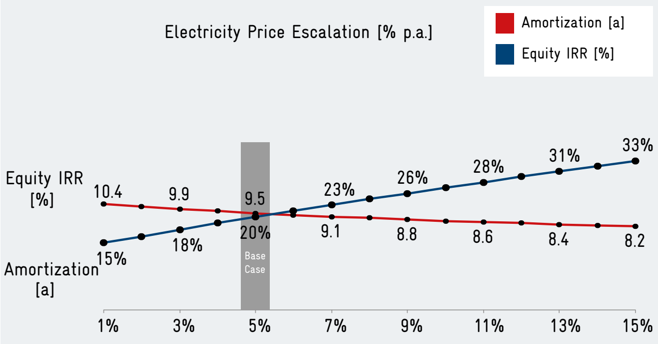
	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(0)																				
Cashflow for Equity	-	(554)	(487)	(411)	(332)	(292)	(250)	(203)	988	1.037	1.088	1.145	1.198	1.257	1.319	1.389	1.453	1.525	1.600	1.684	1.762
Cumulative Cashflow	(0)	(554)	(1.041)	(1.452)	(1.784)	(2.076)	(2.326)	(2.529)	(1.541)	(504)	584	1.729	2.927	4.185	5.504	6.893	8.346	9.870	11.470	13.155	14.917

Operation Year

In the graph above, equity cash flows increase after 7 years once the loan has been paid off, whereas cumulated savings reach 14,917 TND after 20 years. The break-even point is reached after 10 years, as indicated by the cash flow curve, in blue.

Sensitivity Analysis

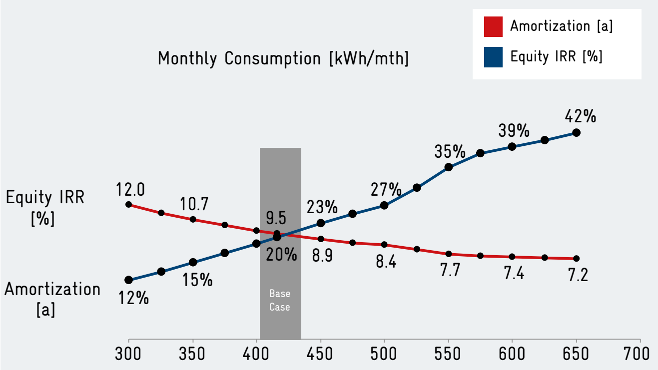
Graph 11: Electricity Price Escalation for a 2 kWp PV installation



Future price increases have a moderate influence on the amortization period.

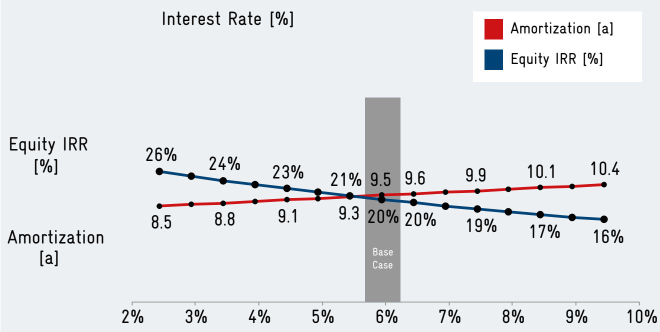
The basic premise takes into consideration an average increase of 10% per year until 2017 and 5% per year after 2017 given the current subsidy phase-out policy of the Tunisian government, resulting in an amortization period of 9.5 years. An electricity price increase of 15% would move the amortization period to around 8 years. This sensitivity calculation also clearly shows that the installation cannot be refinanced during the Attijari bank loan.

Graph 12: Monthly Consumption for a 2 kWp PV installation



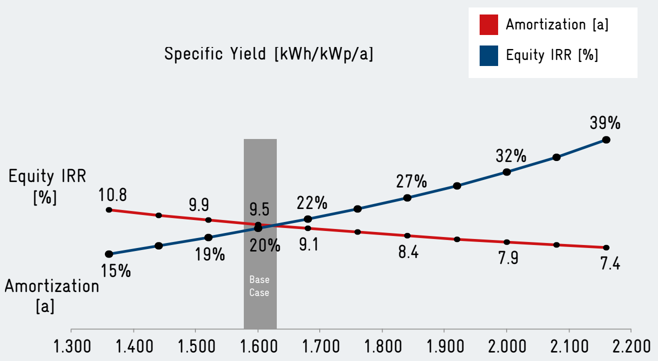
The graph shows the effect of monthly consumption on the project's profitability. It will be noted that the profitability of the installation is much higher when the monthly consumption increases. This is due to the fact that electricity tariffs, and therefore avoided costs, increase according to consumption.

Graph 13: Interest Rate for a 2 kWp PV installation



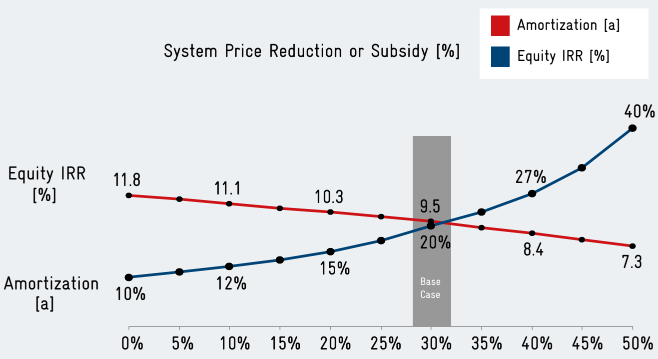
The graph shows the influence of the loan's interest rate on the project profitability. Due to the fact that the financing of the loan corresponds to 100%, a certain correlation between the profitability of the installation and the amount of the interest rate can be noted. The amortization period increases slightly with an increase of the cost of the debt.

Graph 14: Specific Yield for a 2 kWp PV installation



The graph analyses the correlation between the specific yield produced by the installation and the profitability of the project. With a basic premise taking into consideration a specific return of 1,600 kWh/kW/per year, it can be noted that the amortization period varies more or less of a year depending on the geographic location of the installation.

Graph 15: System Price Reduction for a 2 kWp PV installation



The graph illustrates the influence of the evolution of PV system prices over the profitability of the project. The amount of subsidy is directly correlated to the price of the photovoltaic system, given that an increase in the subsidy corresponds to a decrease of price of the system for the installer. The decrease of installation price can also be explained by the experience acquired by the installer as well as a decrease in the price of components. A subsidy rate of less than 30% would significantly increase the amortization period, supposing that the system price does not also decrease at the same time. If the system costs are reduced by 10% or if the subsidy goes from 30% to 40% of the investment, then the amortization period is reduced by one year.

c. Results Presentation – Case #2: Small service sector (15 kWp)

The basic premises for a small PV system for commercial use, of a 15 kWp capacity, and eligible for the "Solar Buildings" programme take into consideration the following parameters:

Table 7: Parameters for a 15 kWp PV installation

PV System		
System Size	kWp	15
Specific Investment Cost	DT/kWp	3.200
Absolute Investment Cost*	DT	33.600
Specific Yield	kWh/kWp/a	1.600
Operation & Maintenance	DT/kWp/a	52
Price Parameter		
Monthly Consumption	kWh	2.500
Average Grid Electricity Price	DT/kWh	0,2804
Price for Residual Electricity	DT/kWh	0,2095
Indirect Savings	DT/kWh	0,0710
Electricity Price Escalation 2015 - 2017 after 2017	 % p.a. % p.a.	 10% 5%
Grid usage fee	DT/kWh	-
Inflation	% p.a.	4%
Investment		
Project Duration	Years	20
Subsidies	DT	10.080
Equity	%	30%
Debt Tenor	Years	7
Interest Rate	%	6,75%
Discount Rate	%	10%
Net-Present-Value	DT	53.910
Equity IRR	%	37,72%
Amortization	Years	3,52

* after subsidies

- The average electricity tariff was calculated according to the corresponding price structure of a low-voltage connection and a consumption of 2500 kWh per month.
- The average electricity tariff of a consumer who does not own a photovoltaic installation constitutes the basis from which the avoided costs, thanks to self-generated and consumed PV electricity, are calculated.
- As explained above, the tariff of the electricity con sumed from the grid, as not covered by the production of the PV installation, is lower, because it corre sponds to a lower monthly consumption range.
- The ANME subsidy corresponding to 30% of invest ment costs is deducted from specific investment costs. The system price of the installation amounts to 3200 TND/kWp, whereas the investment corre sponds to 33,600 TND.
- In this scenario, equity cash flows correspond to 30% of the investment, whereas the rate of the bank loan amounts to 6.75%.

Results

Graph 16: Operating revenue and debt servicing for a 15 kWp installation

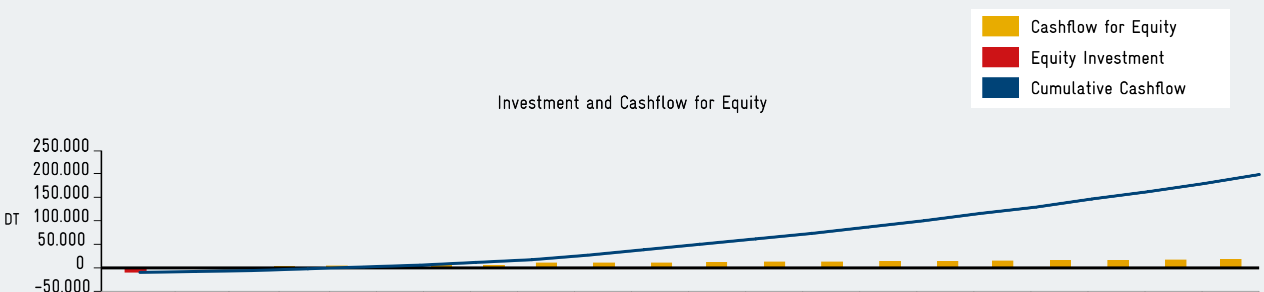
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Indirect Savings	460	506	557	612	643	675	709	744	781	821	862	905	950	997	1.047	1.100	1.155	1.212	1.273	1.337
Direct Savings	6.717	7.362	8.092	8.848	9.265	9.703	10.190	10.643	11.147	11.675	12.262	12.808	13.416	14.053	14.760	15.419	16.152	16.920	17.773	18.568
Debt Service	4.377	4.377	4.377	4.377	4.377	4.377	4.377	-	-	-	-	-	-	-	-	-	-	-	-	-
Opex	805	838	871	906	942	980	1.019	1.060	1.102	1.146	1.192	1.240	1.289	1.341	1.395	1.450	1.508	1.569	1.632	1.697

Operation Year

In the case of a 15 kWp installation in the small service sector, direct and indirect savings are particularly high due to the significant electricity consumption. Therefore, the amount of debt servicing linked to the duration of the Attijari bank loan is not problematic, even if the debt corresponds to 70% of the investment. In the graph above, the steady increase in income is due to the electricity price escalation, which is estimated at 10% p.a. until 2017 and 5% p.a. after 2017.

An annuity loan structure has been used for the modelling in the graph above. In fact, an amortization loan would make the situation worse because it has higher debt service during the first years.

Graph 17: Investment and equity cash flows for a 15 kWp installation



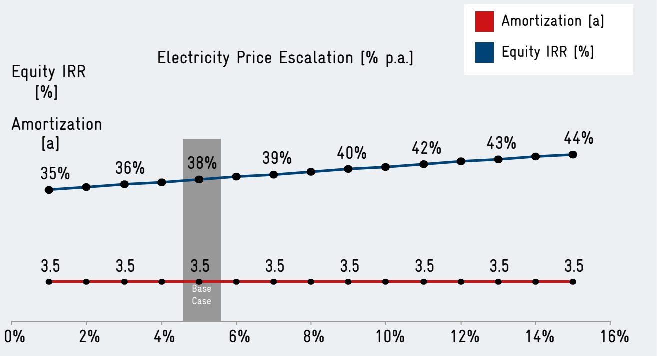
	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	-10231.2																				
Cashflow for Equity	-	1.994	2.653	3.400	4.176	4.589	5.021	5.502	10.327	10.826	11.349	11.931	12.473	13.076	13.709	14.413	15.068	15.798	16.563	17.415	18.208
Cumulative Cashflow	(10.231)	(8.237)	(5.584)	(2.183)	1.993	6.582	11.603	17.105	27.432	38.258	49.608	61.539	74.012	87.088	100.797	115.210	130.278	146.077	162.640	180.054	198.262

Operation Year

- Equity cash flows increase after year 7 when the loan has been repaid
- The investment breaks-even after 4 years as indicated by the cumulative cash-flow line
- Cumulative savings reach 198,262 TND after 20 years

Sensitivity Analysis

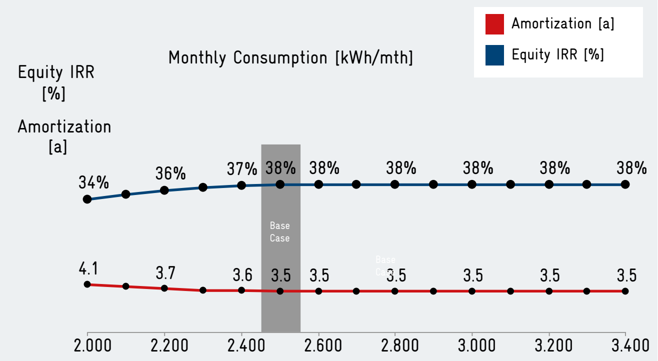
Graph 18: Electricity Price Escalation for a 15 kWp PV installation



The basic premise takes into consideration an average increase of 10% per year until 2017 and 5% per year after 2017.

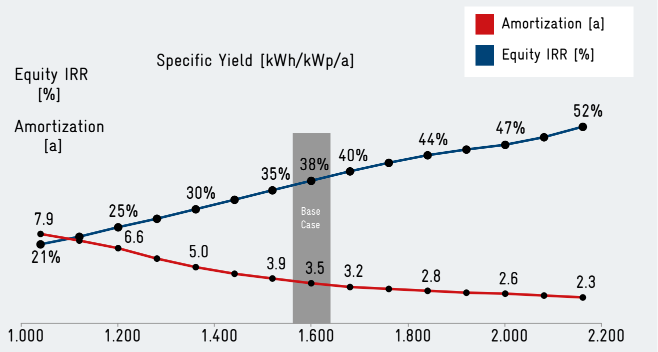
For this scenario, the internal rate of return (IRR) corresponds to 38%, whereas the amortization period is of 3.5 years.

Graph 19 : Monthly Electricity Consumption for a 15 kWp PV installation



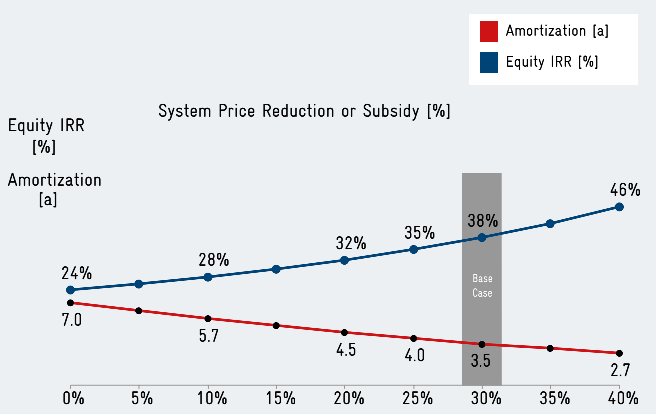
The graph shows the effect of monthly consumption on the project's profitability. Due to the significant monthly electricity consumption, the majority of the consumed electricity is subject to the highest electricity tariff. As a result, one observes in this graph that the profitability of the installation does not vary depending on the monthly consumption.

Graph 20: Specific yield for a 15 kWp PV installation



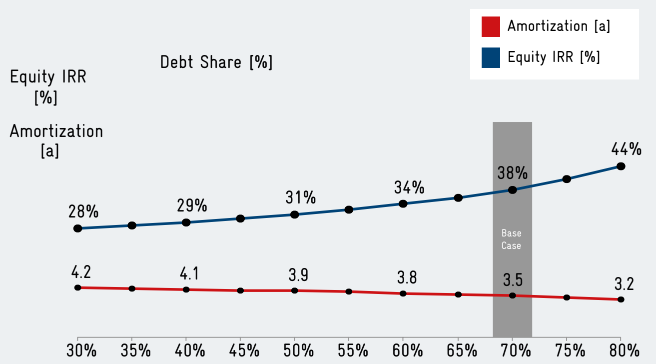
The graph analyses the correlation between the specific yield produced by the installation and the profitability of the project. It can be noted that the sensitivity curves of the amortization period and the equity IRR are not linear, due to the fact that the electricity tariffs are not defined in a linear way.

Graph 21: System Price Reduction for a 15 kWp PV installation



The graph illustrates the influence of the evolution of PV system prices over the profitability of the project. The amount of subsidy is directly correlated to the price of the photovoltaic system, given that an increase in the subsidy corresponds to a decrease of price of the system for the installer. The decrease of installation price can also be explained by a decrease in the price of components. A subsidy rate of less than 30% would significantly increase the amortization period, supposing that the system price does not also decrease at the same time. If the system costs are reduced by 10% or if the subsidy goes from 30% to 40% of the investment, then the amortization period is reduced by one year.

Graph 22: Debt Share for a 15 kWp PV installation



The graph analyses the correlation between the debt share in the total investment volume and the profitability of the project. In this scenario, the amortization of the equity investment happens already during the debt tenor, thus additional debt decreases the amortization period

d. Results Presentation – Case #3: Agricultural building (150 kWp)

The basic premises for a medium-size PV installation with a capacity of 150 kWp, used in the industrial or agricultural sectors, take into consideration the following parameters:

Table 8: Parameters for a 150 kWp PV installation

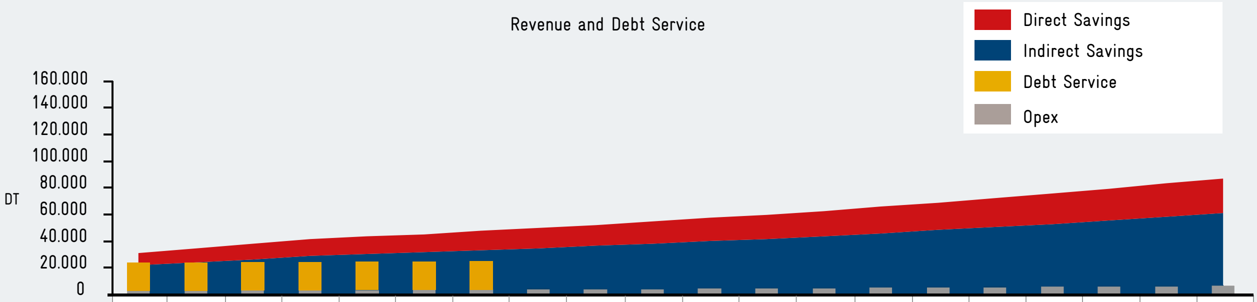
PV System		
System Size	kWp	150
Specific Investment Cost	DT/kWp	2.800
Absolute Investment Cost*	DT	336.000
Specific Yield	kWh/kWp/a	1.600
Direct-consumption Rate	%	70%
Operation & Maintenance	DT/kWp/a	33
Price Parameter		
Average Grid Electricity Price**	DT/kWh	0,2145
Electricity Price Escalation 2015 - 2017 after 2017	 % p.a. % p.a.	 10% 5%
Grid usage fee	DT/kWh	-
Inflation	% p.a.	4%
Investment		
Project Duration	Years	20
Subsidies	DT	67.200
Equity	%	45%
Debt Tenor	Years	7
Interest Rate	%	6,75%
Discount Rate	%	10%
Net-Present-Value	DT	296.947
Equity IRR	%	22,91%
Amortization	Years	6,29

* Amortization
** including TVA

- The system price of the installation amounts to 2800 TND/kWp, which leads to a total investment amount of 336,000 TND.
- In this scenario, equity cash flows correspond to 45% of the investment, whereas the rate of the bank loan amounts to 6.75%.
- The specific yield of the installation corresponds in this scenario to 1,600 kWh/kWp.

Results

Graph 23: Operating revenue and debt servicing for a 150 kWp installation



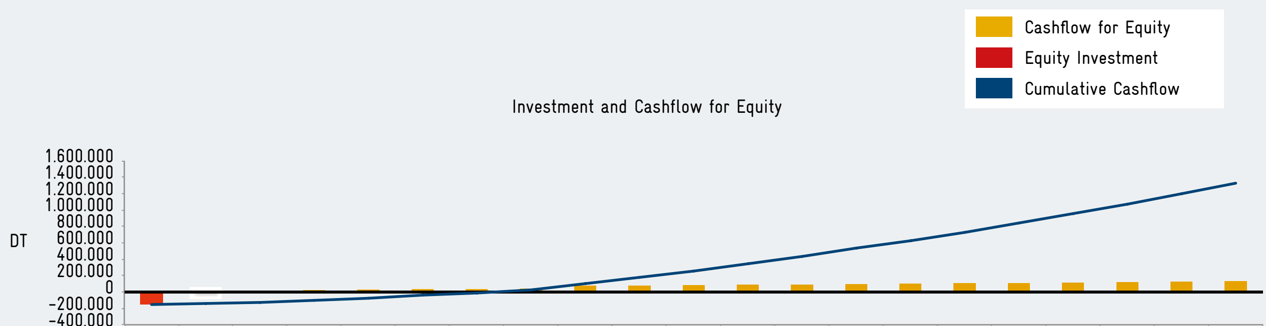
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Net-metering	15.412	16.883	18.549	20.272	21.225	22.224	23.334	24.368	25.517	26.722	28.061	29.307	30.693	32.146	33.761	35.264	36.935	38.687	40.634	42.447
Direct-consumption	35.960	39.394	43.281	47.301	49.525	51.856	54.447	56.858	59.540	62.351	65.475	68.383	71.618	75.007	78.775	82.282	86.183	90.270	94.813	99.043
Dept Service	34.158	34.158	34.158	34.158	34.158	34.158	34.158	-	-	-	-	-	-	-	-	-	-	-	-	-
Opex	5.176	5.383	5.598	5.822	6.055	6.297	6.549	6.811	7.084	7.367	7.662	7.968	8.287	8.618	8.963	9.322	9.694	10.082	10.486	10.905

Operation Year

In the graph above, debt servicing (the ratio of interest payments and reimbursement of capital principal repayments over disposable income) and operational expenses are covered by savings made on the energy bill. However, it can be noted that during the first few years, the investment may prove risky if savings made are not sufficient to cover the payment of debt servicing and operational expenses. That is why a credit duration of more than 7 years could be considered. The regular increase of revenues (red and blue curves) is due to the increase of electricity prices, estimated at 10% p.a. until 2017 and 5% p.a. after 2017.

Calculations for the graph above have been made on the basis of an annuity loan. A loan with straight-line amortization would have led to more costly debt servicing during the first few years.

Graph 24: Investment and equity cash flows for a 150 kWp installation



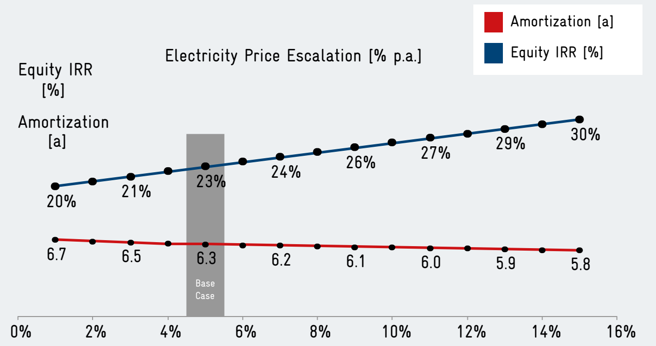
	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(153.468)																				
Cashflow for Equity	-	12.038	16.736	22.074	27.593	30.537	33.624	37.074	74.414	77.974	81.706	85.875	89.722	94.024	98.535	103.572	108.224	113.424	118.875	124.961	130.584
Cumulative Cashflow	(153.468)	(141.430)	(124.694)	(102.620)	(75.028)	(44.491)	(10.866)	26.208	100.622	178.596	260.302	346.177	435.899	529.923	628.458	732.031	840.255	953.678	1.072.553	1.197.515	1.328.099

Operation Year

In the graph above, equity cash flows increase after 7 years once the loan has been paid off, whereas cumulated savings reach 1,328,099 TND after 20 years. The break-even point is reached after 6 years, as indicated by the cash flow curve, in blue.

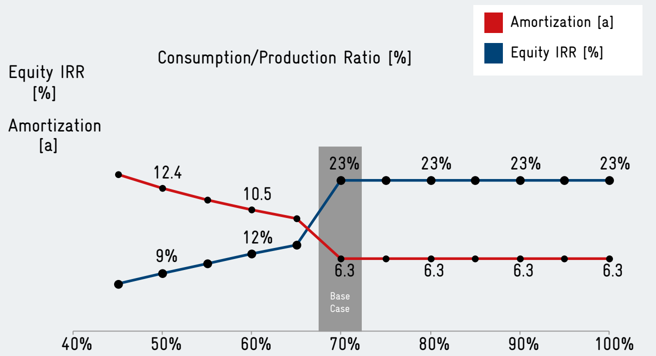
Sensitivity Analysis

Graph 25: Electricity Price Escalation for a 150 kWp PV installation



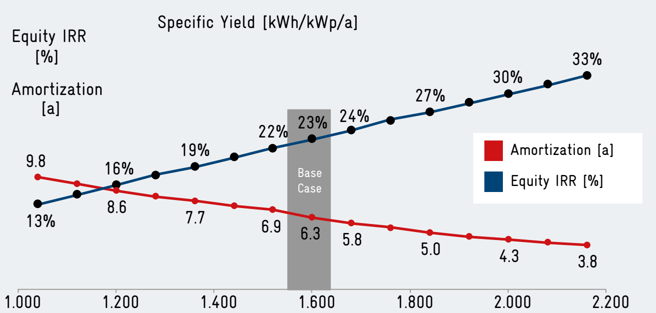
The basic premise takes into consideration an average increase of 10% p.a. until 2017 and 5% p.a. after 2017. For this scenario, the internal rate of return (IRR) corresponds to 23%, whereas the amortization period is of 6,3 years.

Graph 26: Consumption/Production Ratio for a 150 kWp PV installation



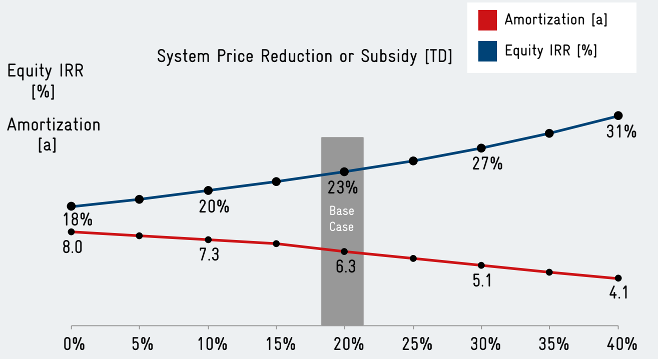
The graph analyses the effect of consumption/production ratio on the project's profitability. Since plant operators are only allowed to do net-metering for 30% of the yearly generated PV electricity, direct consumption rates below 70% result in "lost" PV electricity which severely impacts profitability. However most of the time, this situation does not occur since the size of the PV installation is defined according to the annual electricity consumption of the PV producer in order only to cover its own electricity needs.

Graph 27: Specific Yield for a 150 kWp PV installation



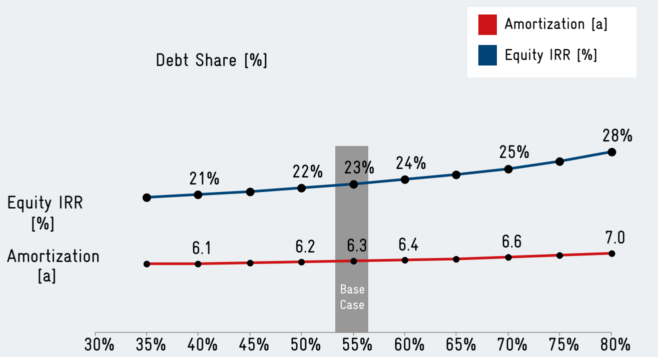
The graph analyses the correlation between the specific yield produced by the installation and the profitability of the project. It can be noted that a lower yield of 1,600 kWh/kWp/a has a moderate impact on the amortization period.

Graph 28: System Price Reduction for a 150 kWp PV installation



The graph illustrates the influence of the evolution of PV system prices over the profitability of the project. The amount of subsidy is directly correlated to the price of the photovoltaic system, given that an increase in the subsidy corresponds to a decrease of price of the system for the installer. The decrease of installation price can also be explained by the decrease in the price of components. A reduction of the subsidy in 10% steps would lead to an increase of the amortization period of 1 year per 10%, if system prices do not decrease. If system prices decrease by 10%, or if the subsidy increases from 20% to 30%, then one observes that the amortization period decreases by more than one year.

Graph 29: Debt Share for a 150 kWp PV installation



The graph analyses the correlation between the debt share in the total investment volume and the profitability of the project. It can be noted that the amortization period increases slightly due to higher interest rates applied to higher loan amounts.

e. Results Presentation – Case #4: Large System (500 kWp)

The basic premise for this large industrial PV installation of a 500 kWp capacity takes into consideration the following parameters:

Table 9: Parameters for a 500 kWp PV installation

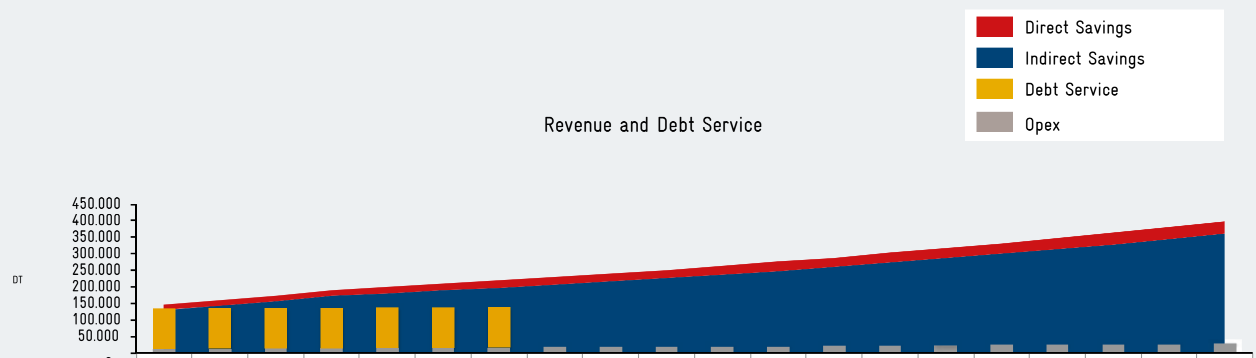
PV System		
System Size	kWp	500
Specific Investment Cost	DT/kWp	2.600
Absolute Investment Cost*	DT	1.200.000
Specific Yield	kWh/kWp/a	1.600
Direct-consumption Rate	%	90%
Operation & Maintenance	DT/kWp/a	26
Price Parameter		
Average Grid Electricity Price**	DT/kWh	0,1825
Electricity Price Escalation 2015 - 2017 after 2017	 % p.a. % p.a.	 10% 5%
Grid usage fee	DT/kWh	0,005
Inflation	% p.a.	4%
Investment		
Project Duration	Years	20
Subsidies	DT	100.000
Equity	%	45%
Debt Tenor	Years	7
Interest Rate	%	6,75%
Discount Rate	%	10%
Net-Present-Value	DT	615.758
Equity IRR	%	17,71%
Amortization	Years	7,99

* after subsidies
** excluding TVA

- The cost of the system is estimated at 2,600 TND/kWp, resulting in a total investment of 1,200,000 TND.
- In this scenario, invested equity corresponds to 45% of the investment, whereas the loan is secured at a 6.75% rate.
- For this scenario, the specific yield of the installation corresponds to 1,600 kWh/kWp.

Results

Graph 30: Operating revenue and debt servicing for a 500 kWp installation



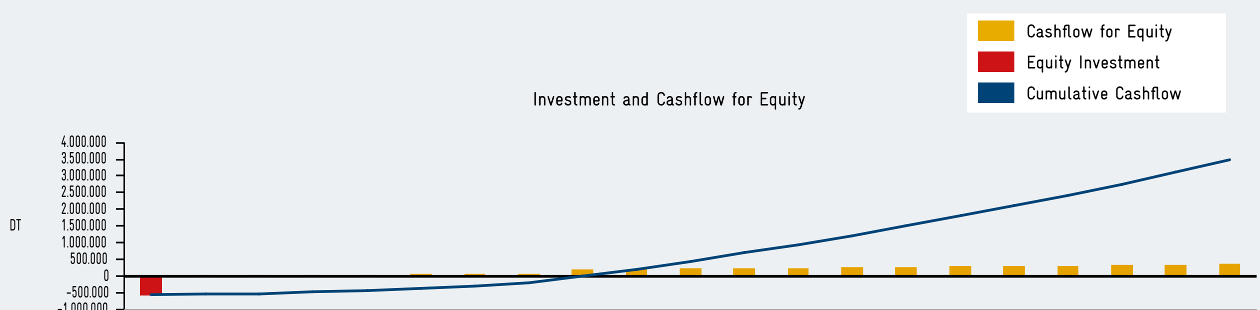
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Net-metering	14.174	15.560	17.126	18.748	19.644	20.584	21.627	22.599	23.680	24.813	26.072	27.245	28.549	29.915	31.433	32.848	34.420	36.068	37.899	39.605
Direct-consumption	131.155	143.624	157.743	172.340	180.417	188.881	198.293	207.046	216.787	226.995	238.343	248.901	260.648	272.958	286.641	299.377	313.543	328.388	344.887	360.246
Debt Service	121.993	121.993	121.993	121.993	121.993	121.993	121.993	-	-	-	-	-	-	-	-	-	-	-	-	-
Opex	13.692	14.240	14.810	15.402	16.018	16.659	17.325	18.018	18.739	19.488	20.268	21.079	21.922	22.799	23.711	24.659	25.645	26.671	27.738	28.848

Operation Year

In the case of a 500 kWp photovoltaic installation, debt servicing (the ratio of interest payments and reimbursement of capital principal repayments over disposable income) and operational expenses are covered by savings made on the energy bill. However, it can be noted that during the first few years, the investment may prove risky if savings made are not sufficient to cover the payment of debt servicing and operational expenses. That is why a credit duration of more than 7 years could be considered. In the graph above, the regular increase of revenues is due to the increase of electricity prices, estimated at 10% p.a. until 2017 and 5% p.a. after 2017.

Calculations for the graph above have been made on the basis of an annuity loan. A loan with straight-line amortization would have led to a more costly debt servicing during the first few years.

Graph 31: Investment and equity cash flows for a 500 kWp installation



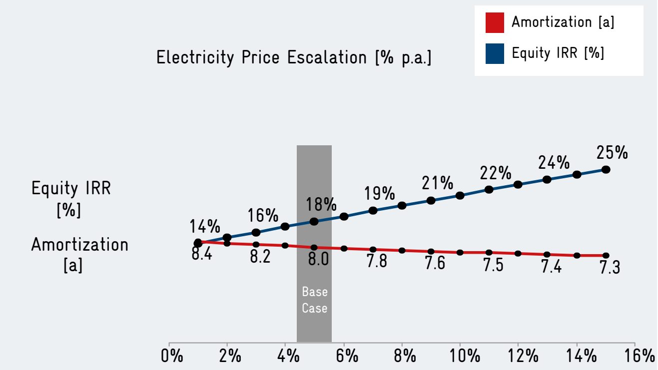
	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	-548099.998																				
Cashflow for Equity	-	9.643	22.950	38.067	53.693	62.050	70.813	80.602	211.627	221.729	232.320	244.147	255.067	267.275	280.075	294.364	307.565	322.318	337.785	355.048	371.004
Cumulative Cashflow	(548.100)	(538.457)	(515.506)	(477.440)	(423.746)	(361.696)	(290.883)	(210.282)	1.346	223.074	455.394	699.540	954.608	1.221.883	1.501.958	1.796.322	2.103.887	2.426.205	2.763.990	3.119.037	3.490.041

Operation Year

In the graph above, equity cash flows increase after 7 years once the loan has been paid off, whereas cumulated savings reach 3,490,041 TND after 20 years. The break-even point is reached after 8 years, as indicated by the cash flow curve, in blue.

Sensitivity Analysis

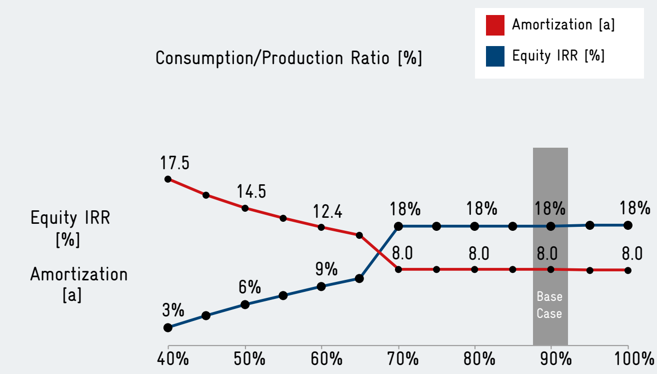
Graph 32: Electricity Price Escalation for a 500 kWp PV installation



The basic premise takes into consideration an average increase of 10% p.a. until 2017 and 5% p.a. after 2017.

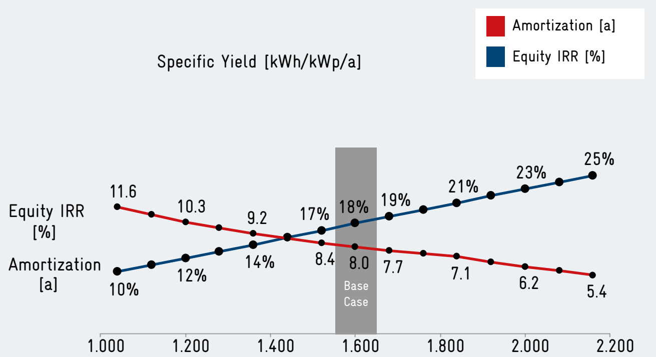
For this scenario, the internal rate of return (IRR) corresponds to 18%, whereas the amortization period is of 8 years.

Graph 33: Consumption/Production Ratio for a 500 kWp PV installation



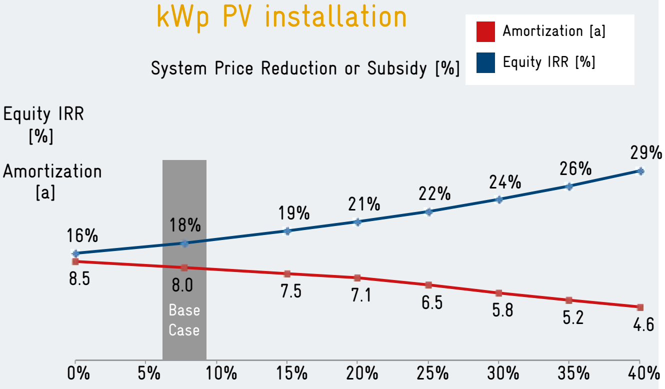
The graph analyses the effect of the consumption/p roduction ratio on the project's profitability. Since plant operators are only allowed to do net-metering for 30% of the yearly generated PV electricity, direct consumption rates below 70% result in "lost" PV electricity, which severely impact profitability. However most of the time, this situation does not occur since the size of the PV installation is defined according to the annual electricity consumption of the PV producer in order only to cover its own electricity needs.

Graph 34: Specific Yield for a 500 kWp PV installation



The graph analyses the correlation between the specific yield produced by the installation and the profitability of the project. It can be noted that a lower or a higher yield has a non-negligible impact on the amortization period.

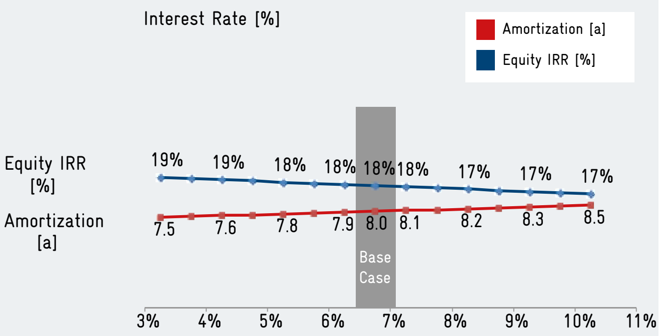
Graph 35: System Price Reduction for a 500 kWp PV installation



The graph illustrates the influence of the evolution of PV system prices over the profitability of the project. The amount of subsidy is directly correlated to the price of the photovoltaic system, given that an increase in the subsidy corresponds to a decrease of price of the system for the installer.

The existence of investment subsidies holds back the reduction of system prices for PV in Tunisia. Currently, system prices for PV installations are relatively high in the country, which mainly results from the existence of investment subsidies.

Graph 36: Interest Rate for a 500 kWp PV installation



The graph shows the influence of the loan's interest rate on the project profitability. It can be noted that the amortization period increases slightly due to higher interest rates applied to higher loan amounts.

f. Conclusions

The four cases analysed above show us that any photovoltaic system installed in Tunisia is amortised during their 20-year project duration, and this no matter what market segment is concerned. In theory, implemented photovoltaic projects are therefore economically profitable. Several market segments offer an amortization period shorter than 10 years and therefore represent a true investment opportunity. The table below summarises, for the four types of photovoltaic projects, the main results based on the sensitivity analysis and profitability calculations carried out:

Table 10: Overview of the main results based on the sensibility analysis and profitability calculations

	Residential PV (2 kWp)	Small Service (15 kWp)	Agricultural Building (150 kWp)	Large system (500 kWp)
Main Characteristics				
Support Mechanism	PROSOL ELEC	Solar Building	Self-Generation (MV)	Self-Generation (MV)
Internal Profitability Rate for the Basic Premise	13%	38%	23%	18%
Amortization (in years)	9,5	3,5	6	8
Influence of the Sensitivity Factors*				
Evolution of Electricity Tariffs	+++	++	++	++
Consumption/ Production Ratio**	0	0	0	0
Interest Rate	+	/	/	+
Specific Yield	++	++	+	++
Evolution of the Subsidy Rate/PV System Costs	+++	+++	++	+++
Percentage of Debt	/	0	+	/

* On a scale of 0 (no influence) to +++ (high influence)
** Assuming that during the lifetime of the project (20 years), the annual electricity consumption of the PV producer does not vary by more than 30% compared to the consumption originally taken into consideration to define the size of the PV installation.

As illustrated in the table above, the case of the commercial PV installation of a capacity of 15 kWp and eligible to the "Solar Buildings" programme benefits from the lowest amortization period. The case of the agricultural building of a 150 kWp capacity is the second most profitable case, with an internal rate of return of 23% and an amortization period of 6 years.

Sensitivity calculations enable us to identify the factors that most influence the profitability of photovoltaic systems. Therefore, it can be noted that the subsidy level determining the photovoltaic system costs is the most influential factor regarding project profitability. The sunshine rate also has a non-negligible impact on project profitability. Both the system costs and the sunshine rate are linked factors, since the performance of a photovoltaic installation highly depends on the quality and therefore cost of the modules.

Two of the factors having the least influence on the profitability of an installation are the change of loan rate and the percentage of the debt. This is due on the one hand to the fact that the duration of the loan is rather short, which leads to lower interest rates. On the other hand, the calculation of projects' profitability with a net-metering system implies the consideration of electricity price escalation over the duration of the project. Therefore, the effect of electricity price escalation outweighs the effect of the interest loan during the project's lifetime.

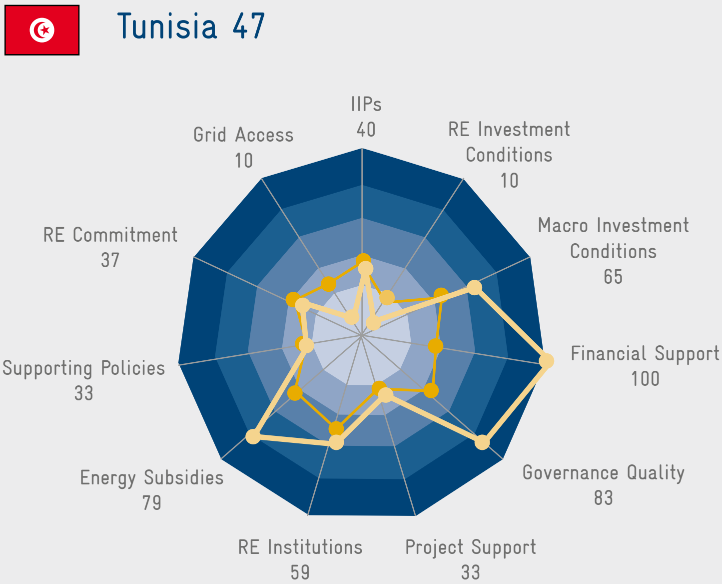
5. Market Entry for Companies

a. Market Entry for Companies

According to the Arab Future Energy Index (AFEX), launched in September 2013 by the Regional Centre for Renewable Energy and Energy Efficiency (RCREEE), Tunisia ranks in the first half of MENA countries, in regards to conditions for the development of renewable energies. This ranking is based on four evaluation categories: "Market structure", "Policy framework", "Institutional capacity" and "Finance and investment".

Table 11: Results of the Arab Future Energy Index, with focus on Tunisia (Source: AFEX 2013)

	Final Scores	Market Structure	Policy Framework	Institutional Capacity	Finance and Investment
Morocco	71	70	73	69	74
Jordan	59	68	56	61	51
Egypt	53	63	32	79	38
Palestine	47	58	61	49	27
Tunisia	47	30	43	56	58
Algeria	45	60	26	60	34
Lebanon	33	14	31	50	38
Syria	29	28	27	45	17
Bahrain	28	25	12	45	17
Sudan	25	18	22	29	33
Yemen	25	25	31	24	20
Libya	20	10	18	28	23
Iraq	13	18	14	12	10



(Source: AFEX 2013)

Tunisia's global ranking totals 47 points out of 100. As detailed in the graph above, those 47 points result from an evaluation of 11 different factors, analysing grid access, energy subsidies or else renewable energy institutions. The highest-ranking factor for Tunisia is that of financial support (score: 100 points), whereas "grid access" and "RE investment conditions" receive the lowest scores (score: 10). The "Financial support" factor analyses the degree of State financial support in renewable energy projects. It is established taking into consideration several indicators, amongst which the existence of renewable energy funds established by law, and whose financing sources and disbursement procedures are clear and transparent. The "Financial support" factor does not evaluate the efficiency of administrative procedures for securing subsidies, which explains the high score Tunisia is getting for this factor. The 2013 AFEX report offers the following analysis: "Tunisia has contradictions within its renewable energy industry. On the one hand it has adopted incentives for the development of small-scale renewable projects by offering clearly stipulated financial support. On the other hand, the Tunisian electricity market remains closed for large-scale private development of renewable energy. Its current legal framework does not allow for unsolicited private generation of renewables, thereby preventing private developers from entering the market. Tunisia has the potential to attract investments in renewable energy based on their generally favourable business conditions. It scores high in ease of doing business, has a relatively high inflow of foreign direct investment and is perceived to have strong institutional capacity, which all point to investor confidence in Tunisia." (AFEX 2013) This last argument from the AFEX is however to be considered with a certain amount of insight. Indeed, a high governance quality in favour of renewable energies does not directly relate to the capacity to meet the needs in this sector.

Concerning the photovoltaic market, the ENABLING PV project has enabled to identify the following risks and opportunities in Tunisia:

Opportunities

- The Tunisian government has set ambitious goals concerning renewable energies in general and photovoltaics in particular. Under these circumstances, the maintaining of a stable support policy on the long-term, supported by a transparent and reliable legal framework, is to be expected. This perspective is all the more justified given that the policy supporting photovoltaics in Tunisia represents a model for numerous neighbouring countries.
- Tunisia has clearly stated a political determination to suppress fossil fuel subsidies. Regarding this subject, the government has announced in March 2013 the phasing-out of energy subsidies by sector until 2017, resulting in an increase of electricity tariffs. Thus, since June 2014, the cement sector is the first sector to have been subject to electricity tariffs reflecting market prices.
- Consumers have been made aware of solar technologies for many years, especially through thermal solar installations used to produce hot water (solar water heater).
- The solar photovoltaic installation market is relatively well developed with a dense distribution network and experienced installers possessing good expertise.
- Quality products, especially photovoltaic equipment made in Germany, are well received on the market.
- Tunisia possesses excellent natural conditions, with a high sunshine rate and a favourable climate for photovoltaic electricity production.
- The country offers an excellent electrification rate, enabling photovoltaic installations to be connected to the grid in more than 99% of the territory.
- Financial support that photovoltaic producers can benefit from, in the form of subsidies or loans, contributes quite significantly to the profitability of the projects.
- The sector enjoys the support of the Tunisian National Agency for Energy Management (ANME), who has clearly stated its determination to develop renewable projects.
- Tunisia receives political support from Germany with the Tunisian-German Energy Partnership as well as from other national and international institutions. Moreover, the GIZ and AHK structures are well developed on the field.

Risks

- Players in the sector regret delays of subsidy payments from subsidy institutions. Indeed, in 2014 for example, several beneficiaries of the PROSOL ELEC subsidy have had to wait for several months to receive their ANME subsidies.
- The adoption of laws and decrees related to renewable energies suffer from a certain legal procedures slowness.
- Tunisia does not have a sufficiently involved national association for solar industry that could represent a unified voice for the sector's interests. Political demands of the sector's players can only be expressed separately, thus conferring them little weight.
- The sector players highlight the arbitrary character of the grid connection authorisations. Despite the existence of a bill of specifications, there is still a lack of binding national standards for grid connection and photovoltaic installation connections.
- The procedures related to the connection to the grid of photovoltaic projects sometimes take too long.
- The sovereign rating of Tunisia has been lowered several times by rating agencies, chiefly owing to an increase in political and economic risks in the country. Ratings from local banks have also been downgraded. Consequently, deferred payment letters of credit (90 days) are no longer accepted by banks in the exporting country.
- It remains difficult in Tunisia to conduct business in English. Even though it is possible to trade in English with Tunisian partners, proficiency in French remains highly recommended.
- Different corporate cultures may appear to be non-negligible obstacles to some project developers or investors.

b. Initial Exploration Stages and Preparation for Establishment on the Market

Implementation in a new market requires a certain degree of preparation and prospecting done beforehand. This preparation includes, amongst other tasks, examining the current legal framework of the target country. Indeed, certain difficulties unique to that particular country must be evaluated a priori, in particular when it comes to the construction of renewable energy installations.[23]

The main legal source regulating investments in Tunisia is the Investment Incentive Code of 1993, defining the regulatory framework for investment projects, and currently under reform. According to this code, foreign participation in certain service activities that must still be confirmed by decree, is subject to approval of the Commission Supérieure d'Investissement (Higher Commission for Investment). Moreover, the reform of the Code should result in modifications to the regulation associated with special tax regimes for foreign investors. (Cessac 2014) Beyond provisions of the Investment Incentive Code, property rights must be taken into account when land is acquired for the construction of solar plants. Reference regulation remains the Tunisian Property Code of 1965. The purchase and rental of goods and property by foreign private individuals or legal entities are subject to prior authorisation from the regional governor, except in the industry sector and tourist areas. Agricultural lands are however treated much more restrictively. (Cessac 2014)

Beyond analysing the legal framework, the following steps remain useful when it comes to the Tunisian market:

- Out-posting of francophone business personnel qualified to be set up on the Tunisian market.
- Obtaining current information on the photovoltaic market in Tunisia. The best way to obtain information is to contact the secretariat of the Tunisian-German Energy Partnership[24] or BSW-Solar. [25]
- Participating in activities from the Initiative à l'Export des Energies Renouvelables (Renewable energy export initiative) promoted by the German Federal Ministry for Economic Affairs and Energy (BMWi).[26]
- Evaluating the market for the relevant photovoltaic installation sector, with the help of a profitability study, and an estimate of resources necessary to complete administrative procedures.
- Presenting the company and the project to the Tunisian National Agency for Energy Management (ANME) in order to raise awareness of the agency to the needs of the company and prepare necessary agreements for the planned activities of the company.
- Collecting information on the eligibility of components and equipments depending on the norms and standards applied in Tunisia. This information is available through the ANME and consigned in a specific bill of specifications for the eligibility of installations.[27] For reference, eligible photovoltaic installations must currently meet the following requirements:
  - The photovoltaic models must meet the following international standards:
    - CEI-61215: Ground-mounted crystalline silicon photovoltaic modules
    - CEI-61646: Ground-mounted thin-layered photovoltaic modules
  - Photovoltaic modules must be tested by a licensed laboratory and must present certificates. Currently in Tunisia, there is no accredited laboratory to complete tests relating to requirements regarding those two standards. Certificates must then be issued elsewhere, in Europe for example.

[23] *In the case of Tunisia, existing obstacles have been identified and analysed from a legal point of view in a recent study led by Cécile Belet Cessac, entitled «Analyse du cadre réglementaire de l'accès au réseau des producteurs d'électricité à partir d'énergies renouvelables en Tunisie» (Analysis of the legal framework regulating the access to the grid for electricity producers using renewable energies in Tunisia). Cécile Belet Cessac's study is freely available on the Internet at the following link: https://energypedia.info/images/2/2a/GIZ_Legal_Framework_fr_web.pdf*

[24] *Contact information for the German-Tunisian Energy Partnership is available in the following chapter on useful contacts.*

[25] *The German solar industry association BSW-Solar regularly publishes information on global photovoltaic markets: http://www.solarwirtschaft.de/*

[26] *For more information on the activities of the Renewable Energy Export Initiative, please refer to the Initiative site at the following address: http://www.export-erneuerbare.de/EEE/Navigation/DE/Home/home.html*

[27] *The bill of specifications regulating technical requirements of eligibility for photovoltaic installations can be found in the Annex*

– Other specific requirements on electric wiring for direct current as well as supports exist.
– Inverters must meet requirements specified by the DIN VDE 0126-1-1 Standard, and a test certificate must be issued by a recognized third party.

- Collecting information on securing tax privileges for the import of equipment and components of photo voltaic systems to Tunisia. These privileges concern custom duties and the right of exemption from value added tax. Tax privileges given for equip ments and products during importation are set by decree.[28] The list of equipment and products is constantly updated. Fiscal privilege is reviewed before each importation of equipment or component. A file must be submitted to the ANME to apply for an authorisation to receive such privileges.
- Taking into consideration a potential membership of the company to a solar industry association in Tunisia, that could facilitate communication with companies that are active in the photovoltaic sector. Membership to an association representing the interests of the company is a recommendation made by the GIZ and the Tunisian-German Chamber of Commerce.
- Identifying a business representative in the field, who could participate in the market evaluation, the creation of a network of contacts and the implemen tation of a distribution channel.
- Contacting a local legal consultant, in order to guaranty the drafting of contracts that meet local legal requirements.
- Acquiring installation authorisations from the ANME and certifications for the components of the installation according to applicable standards for the eligibility of the installations for the PRO SOL ELEC programme.
- Choosing suppliers and service providers, in particu lar for logistic purposes (carriers, freight forwarders).

Categories of Companies Active in the Energy Sector

Activities of companies belonging to the energy sector can be categorised in three different categories:

1. Installation companies: A bill of specifications defines all requirements regulating conditions and procedures enabling installers to appear on the list of installers eligible to operate within the PROSOL ELEC programme. Eligibility of an installer for the PROSOL programme remains dependent on a favourable opinion from the ANME, after review of an application submitted by the company. The main criteria to meet in order to obtain eligibility as an installing company are as follows[29]:
   – The installer has completed a minimum of three recent PV installations within the three years prior to the file application.
   – The installing company has, amongst it permanent personnel, an engineer or high-level technician who has received qualifying training given by a specialised institution on the aspects relating to the completion of photovoltaic projects.
   – The agents of the installer have attended a prac- tical workshop, organised by the PV equipment manufacturer or their representatives in Tunisia, and relating to the installation and maintenance of these equipments.
   – The installer will be supervised during the first three installations connected to the grid by a Tuni- sian or foreign company who has solid experience in this sector (having completed at least five pho- tovoltaic installations connected to the grid during the previous three years).

Moreover, it is preferable that the company submits a general electricity company certification (B2 type) to the Ministry of Equipment and Environment. Indeed,

[28] *Currently, these products and equipments are subject to Decree n° 2012-2773 of 19 November 2012, modifying and completing Decree n° 95-744 of 24 April 1995, implementing Articles 88 and 89 of Law n° 94-127 of 29 December 1994 regulating the Finance Act for the 1995 financial year, concerning the setting of a list of raw materials and semi-finished products required to the manufacture of equipments used in energy management or in the sector of renewable energies and equipments used in energy manage-ment or in the sector of renewable energies. This decree can be found at the following address: http://www.legislation.tn/fr/detailtexte/D%C3%A9cret-num-2012-2773-du-19-11-2012-jort-2012-093__2012093027733*

[29] *For more information concerning the eligibility requirements of installers to take part in the PROSOL ELEC programme, please refer to the Annex*

this certification brings about a better legal cover for the company, as well as access to public markets. The bill of specification of the Ministry of Equipment and Environment divides the market according to the amount of work. The same division is recognized by the STEG as well as insurance companies offering insurance policies of different types, "Tous Risques Chantiers" (Contractor's all-risk insurance), "Tous Risques Montage" (All-risk erection insurance) and "Responsabilité Civile Décennale" (Decennial Civil Liability).

2. Les Entreprises de Services Energétiques (ESE) (Energy Service Companies): These companies are subject to a specific bill of specifications that enables them to finance investments and complete installations for third parties by signing a performance bond contract.[30] The Tunisian state guarantees, through the Tunisian Guarantee Company (Sotugar), investments and loans issued by international and/or local financial operators. Very few companies have seen the light of day up to now, despite the fact that a bill of specifications exists since 2004. The price decrease of photovoltaic panels on the international market constitutes an opportunity to give a new impetus to this type of companies. Companies wishing to penetrate the Tunisian market as an ESE company must submit an eligibility file to the ANME. This file must deal with the human and material capacities of the company and includes the following:
   - A description of the legal form/social reason/nature of activities/headquarters/identity of the legal representative of the company.
   - CVs of the members of the company as well as a copy of their diplomas.
   - A copy of the insurance policy covering risks linked to guaranteed energy savings.
   - Proof of employment of the required qualified personnel: thermal engineers, electricians and economists. (contract, certification of membership to one of the social security funds)
   - References of the company at the national or international level.

3. Business venture: Company active in the importation of equipment and components of photovoltaic installations. This category of companies may have a residential or non-residential status. Business companies can benefit from legal benefits as well as other benefits such as exemption from income tax for a period of three to ten years (depending on the policy), the payment by the State of social security contributions of employees during a period ranging from three to five years and hiring of foreign personnel. This category of companies would allow a presence on the local market without having to commit to the contractor's market sector, which would require a more significant presence and highly-qualified personnel in order to meet contractual and legal requirements for this type of market.

[30] *The decision of the Minister of Industry, Energy and Small and Medium-Sized Businesses of 4 December 2004, approving the bill of specifications relating to the organisation of the activities of energy service institutions (Jort n°99 published on 10 December 2004) as supplemented by the decision of 15 September 2005 (Jort n° 76 published on 23 September 2005) can be found on the ANME website at the following address: http://www.anme.nat.tn/index.php?id=121*

c. Useful Contacts in Tunisia and Germany

Table 12: Contact details of useful organisations in Tunisia and Germany

Country	Organisation	Contact Person
Tunisia	Secretariat of the Tunisian-German Energy Partnership implemented by the German Federal Agency for International Cooperation (GIZ)	**Martin Baltes** Secretariat of the Tunisian-German Energy Partnership Energy Division, Ministry of Industry 40 avenue du Japon, 3ème étage 1073 Tunis (Montplaisir), Tunisie Tel: +216 71 902 603 Fax: +216 71 905 011 Email: Martin.baltes@giz.de
Tunisia	Tunisian-German Chamber of Commerce and Industry (AHK) – within the Tunisian-German Energy Partnership	**Andrea Ben Mahmoud** Immeuble «Le Dôme», 1er étage Rue du Lac Léman 1053 Les Berges du Lac, Tunisie Tel: + 216 71 965 280 Fax: +216 70 014 179 Email: info@ahktunis.org Internet site: www.ahktunis.org
Tunisia	Confederation of Tunisian Citizen Enterprises (CONECT)	**Douja Ben Mahmoud Gharbi, Vice-President** 8 rue Imem Ibn Hanbal Menzah 1004 Tunis, Tunisie Tel: +216 71 23 14 22 / 71 23 14 02 Fax: +216 71 23 10 59 Email: douja@topnet.tn Internet site: http://conect.org.tn/
Germany	German Solar Industry Association (BSW-Solar)	**Jörg Mayer, Director** BSW - Bundesverband Solarwirtschaft e.V. Quartier 207 Friedrichstraße 78 10117 Berlin Tel: +49 (0) 30 29 777 88 51 Fax: +49 (0) 30 29 777 88 99 Email: mayer@bsw-solar.de Internet site: www.solarwirtschaft.de
Germany	Renewable Energy Export Initiative – German Federal Ministry of Economy and Energy (BMWi)	**Secretariat** Exportinitiative Erneuerbare Energien Scharnhorststr. 34-37 10115 Berlin Tel: +49 (0)30 18615-7386 Fax: +49 (0)30 18615-5400 Internet site: www.export-erneuerbare.de

Moreover, the ecopark initiative (www.ecopark.tn) has published a directory of active businesses in the photovoltaic sector in Tunisia, which can be found at the following address: http://bsw.li/1rlvtHS.

d. Political Recommendations

Numerous national efforts have been undertaken so far to support the development of the photovoltaic sector. Today in Tunisia, progress in the sector is not only a positive example to numerous countries in the region, but also an important basis to reach the 30% renewable energies goal in electricity production by 2030.

Amongst the numerous measures encouraging the development of the photovoltaic sector, implementation of incentive measures such as the PROSOL ELEC programme has an economical as well as social interest. In the context of the phasing-out of fossil fuel subsidies resulting in an increase of electricity prices, financial support for photovoltaics helps to strengthen public acceptance of solar technologies. Economically, the PROSOL ELEC programme has generated positive repercussions, in particular by promoting the creation of a network of installing companies.

Policy-makers play a decisive role in ensuring lasting growth in the photovoltaic sector in Tunisia. Policy recommendations formulated below aim at activating efficient leverage in order to reinforce the development of the sector.

Optimising the PROSOL ELEC Programme

Since its inception in 2010, the PROSOL ELEC programme has contributed significantly to the development of the photovoltaic sector in Tunisia. Today however, several aspects of the programme could be adapted in order to support the development of the sector more efficiently:

- Allocating bank credit for installations of a capacity superior to 2 kWp, in order to target larger electricity consumers.
- Broadening eligibility for the programme to renters, in order to facilitate participation of low-income consumers to the development of photovoltaics. This measure would imply modifying the eligibility conditions to the PROSOL ELEC programme that currently require that the owner of the PV installation also be the owner of the propertyty.
- Introduction of a legal framework enabling the enforcement of a new type of contracts regarding electricity supply, allowing the photovoltaic producer to provide its electricity to the occupants of the property where the installation is located. The occupants would have the possibility to consume that electricity, as needed.
- Implementation of a system of regression as regards to investment subsidies, in order to avoid a windfall effect for larger electricity consumers whose bills benefit the most from savings resulting from photovoltaic electricity production.
- Higher media coverage of the PROSOL ELEC programme on the national level, in order to promote the benefits of the support system and increase its attractiveness. Between 5 to 10% of the budget allocated to the PROSOL ELEC programme should be used for marketing purposes.

Beyond the optimisation of the PROSOL ELEC programme, it would be important to clarify the range of subsidies available in the photovoltaic sector. There is a lack of clarity about the types of subsidies likely to be allocated to low-voltage installations. Indeed, certain subsidies such as that for self-generation in low-voltage are not or are rarely requested, to the benefit of other subsidies (subsidies for the solar buildings programme or for self-generation in medium-voltage), depending on the size of the installation and the level of voltage to which it is connected.

Operation of New Market Segments

Beyond the success of the PROSOL ELEC programme intended for small installations, the photovoltaic sector requires the development of market segments for installations of a capacity of more than 2 kWp. This development is conditioned by the guaranty of stable and perennial investment conditions. To this end, the government must guaranty immediate payment of subsidies. Indeed, delayed payment harms the whole distribution chain and destabilises the Tunisian market in the long term.

Publishing tenders intended for the completion of large photovoltaic projects remains an interesting alternative for the exploitation of the larger installations market segment. Such tenders would enable a quick increase in photovoltaic capacities installed on the grid. The development of the photovoltaic sector through tenders should however not be done to the detriment of small residential and commercial installations. Indeed, the sustainability of the Tunisian photovoltaic market depends on the existence of a wide range of players.

Strengthening of the Legal Framework

The legal framework in favour of self-generation of energy generated from renewable energy installations should supervise more closely the discretionary power of the competent authorities and grid operators. For example, the legal framework should define more clearly the deadlines allocated to each party when it comes to the authorisation process.

Moreover, the government should implement a clearing-house allowed to resolve amicable disputes concerning grid connections that cannot be invoked before a court.

Strengthening of the Electricity Grid

In the long term, the sustained development of the sector is dependent on the existence of an electricity grid able to welcome significant photovoltaic capacities. In this respect, the implementation of a system allowing to finance the strengthening of the Tunisian electricity grid is necessary. Currently, the financial contributions for the maintenance of the Tunisian grid, to which the self-producers are subjected, are not sufficient.

Strengthening of Expertise

In order to establish a powerful and efficient Tunisian solar industry, measures intended for the strengthening of professional expertise of the sector players must be implemented. One can imagine the creation of research programmes within public-private partnerships or else the integration of specialised training in educational institutions such as universities or chambers of commerce. Moreover, the exemplary role of the public authorities through the financing of innovative pilot projects on public buildings would encourage the development of new skills as well as increase the public's acceptance of photovoltaic technologies.

Removing Trade Restrictions

The economic added value on the national and regional levels can be generated without trade restrictions. Indeed, the economic benefit of renewable energy projects is in part generated by the fact that renewable energies are available at very reasonable cost, so that renewable energy can be produced at low cost and low externalities. Several arguments justify this hypothesis:

1. Mass production, research and development as well as work experience in production and installation lead to a decrease in price for products used in the production of renewable energies, such as photovoltaic panels. On top of that, a decrease in the price of electrical and electronic components leads to the international decrease of the value added part of industrial products. Consequently, the value chain located downstream gains in significance. That is why it is particularly important for decentralised technologies using primary energy such as solar energy to have at their local disposal engineers and qualified installers able to complete the installation and the maintenance of the installations.
2. As production costs of renewable energy products decrease, the relative share of transport and logistic costs increases until it reaches a disproportionate level with the final sales price of the product. This situation increases the chances of attracting companies located close to the market, as long as the available infrastructure in the target market remains attractive.
3. As positive results of industrial production, training and research must be considered as goals for industrial policy programmes. The potential of research in the renewable energy sector resides in fundamental and applied research. For example, one of the objects of applied research could be the adaptation of renewable energies to the local conditions of electricity production. Companies planning to penetrate the market in the long term are likely to train their personnel in the field and direct themselves towards local training institutions. That is why helping these local institutions is necessary in order to insure an easier transfer of knowledge.
4. The existence of decentralised projects and developed distribution infrastructures increases the chances of attracting foreign companies to settle in the long term, as well as the development of local training establishments. The more attractive the market, the more companies will want to settle locally and invest in the local workforce.

6. Business Outlook

a. New Law on Renewable Energies

In November 2013, the first version of the draft bill on electricity production using renewable energies was submitted to the National Constituent Assembly. The text aims at regulating the Tunisian electricity market by opening the market to private players. The law therefore allows for the emergence of independent electricity producers and regulates the feed-in price of this electricity through the STEG.

The new law opens the photovoltaic market to larger scale, MW-class systems. It therefore represents the main legal tool enabling Tunisia to reach its national energy goals, namely 30% of renewable energies in the Tunisia electricity mix by 2030. Amongst these 30%, a third will be produced through photovoltaics. These national targets not yet being present in the current legislation, it would be valuable to stipulate them in this new law, in order to confer it a regulatory value. (Cessac 2014) From a technical point of view, Cessac's technical analysis of the draft bill underlines that the "access to information on the electricity grid and its state is not mentioned […], whereas it is essential in order to appreciate it connection capacity and costs pertaining to its potential future strengthening." (Cessac 2014)

The revised version of the text provides, moreover, the creation of a regulatory energy commission, which would act as an independent authority and could issue laws and decrees. The regulatory commission would thus be in charge of implementing regulation for the electricity market. It would define grid codes and contracts for the purchase of electricity produced by photovoltaic installations connected to the grid. Its role would also be to define clear and precise procedures to the decentralised grid integration of electricity generated by renewable energy installations. However, it is regrettable that in this revised legal text, "the contemplated commission does not contain in its DNA all the characteristics of independence for this type of institution, since it would be placed under the supervision of the Minister who would appoint its members". (Cessac 2014).

Currently, the law is in its parliamentary phase and should be adopted at the earliest in Autumn 2014. Once the law adopted, numerous implementing decrees will be published. These decrees should be in effect at the earliest a year after the publication of the law. The publication of these decrees fall within the jurisdiction of the Ministry of Energy. They should define the grid code as well as the new STEG feed-in tariffs for electricity produced by independent producers. These feed-in tariffs should first be set by the regulatory commission, before being approved by the Ministry of Energy.

Finally, the photovoltaic sector is also awaiting promulgation of two other legal texts whose contents remain little known until now, namely the Investment incentive code and the law on public-private partnerships. Restrictions concerning market access to foreign companies are however not expected. Foreign investors should indeed be considered in the same way as local investors.

b. Feed-in Contract for Electricity Produced by PV Installations Connected to the MV Grid

At the beginning of September 2014, the contract regarding feed-in tariffs for the electricity produced by self-generation photovoltaic installations connected to the MV grid was published on the website of the STEG. The contract stipulates that the remuneration of PV producers shall be made according to the tariff structure with time slots. However, the tariffs applicable for PV installations within this contract were not officially published yet. Pending their official publication on the website of the STEG, the tariffs can be obtained by contacting the STEG.[31] According to information obtained in July 2014, these tariffs should be in effect starting in September 2014.

[31] *The "contract for the supply to the STEG of electrical energy produced by a renewable energy installation" can be found on the website of the STEG under the following link: https://www.steg.com.tn/dwl/tarifs/Contrat_d_achat_de_l_excedent%20(Pages%201_9%20_%20remplir)%20.pdf*

7. Conclusions

The ENABLING PV project was able to provide an assessment of the photovoltaic market in Tunisia, through a series of interviews of players in the sector, as well as the profitability analysis of business models currently applied to photovoltaics.

The contextual analysis of Tunisia reveals that the country enjoys numerous conditions favourable to the development of photovoltaics. On the one hand, geographic conditions are excellent, with a sunshine rate enabling installations to produce electricity at a rate of more than 1.700 kWh/kWp/year. On the other hand, Tunisia shows an increasing energy deficit since 2000, due to the increase of national energy consumption combined with the decline of hydrocarbon deposits. Moreover, the government's determination to eliminate public subsidies for fossil fuels, also resulting in an increase of electricity tariffs, constitutes a competitive advantage for the photovoltaic sector. Finally, the national target of 30% of renewable energies in its electricity mix by 2030 opens the way to the reinforced use of photovoltaics. This target combines with an adaptation of the current legal framework in favour of renewable energies that should come into effect in the next few months and thus enable the large-scale development of renewable energies.

Currently, the legal framework constitutes one of the main difficulties against the implementation of larger-scale photovoltaic projects in Tunisia. Current legislation only allows photovoltaic electricity production for personal consumption. Moreover, self-generation in medium voltage is only possible for companies in the industrial, service and agricultural sectors. Finally, companies wishing to develop larger photovoltaic projects in Tunisia are faced with the difficulty of securing bank financing, owing chiefly to the lack of confidence of banks regarding this type of projects.

However, while waiting for pending legislation enabling the opening of the market to independent electricity producers, several business models already show particular promise for investors and project developers. Indeed, simulations for these four installation types have shown a high rate of attractiveness of some of the business models applied to photovoltaics in Tunisia. The small photovoltaic systems for commercial use of a capacity of 15 kWp and eligible to the "Solar Buildings" programme are by far the most attractive. With an internal rate of return (IRR) of 38% and an amortization period of only 3.5 years, these projects are a profitable alternative for investors. PV installations of a capacity of 2 kWp, intended for private individuals and eligible for the PROSOL ELEC programme have an internal rate of return of 13% and an amortization period of 9.5 years. Despite modest results from a purely economic point of view, these installations nevertheless represent a very attractive alternative for households. Finally, PV installations of a capacity of 150 kWp used in the industrial or agricultural sectors as well as installations of a capacity of 500 kWp used in the industrial sector show IRRs of respectively 23% and 18% with an amortization period between 6 and 8 years. Even if these projects do not currently constitute a particularly attractive alternative for investors, numerous signs mentioned above show that the economic conditions of this type of projects could be evolving positively.

With a high sunshine rate and a political determination favourable to renewable energies, Tunisia offers advantageous conditions for the development of photovoltaic projects. The implementation of a reformed legal framework adapted to the specificities of renewable energies promises to pave the way for new attractive business models for investors.

8. Annexes

a. Methodology

Development Process of the Project

One of the aims of the "ENABLING PV" project was to initiate a close collaboration with the solar energy companies and solar industry associations of Jordan and Tunisia. To this end, the implementation of the project planned for two trips to be undertaken in each country. The first trip, from 6-10 April 2014, was intended for meeting the players in the public and private photovoltaic sector in order to gather their perspectives and experiences of the sector during bilateral interviews. The information thus obtained on the existing business models was then analysed and submitted in a report addressed to national and international investors and project developers, as well as policy-makers. Once the report drafted, a second trip was undertaken from 11-13 June, to present and discuss results thus obtained in a seminar attended by all the players interviewed during the first trip. Observations of the players and conclusions reached during this seminar were then taken into consideration during the finalisation of the report. The participation of local players of the private as well as the public sectors was paramount, as it enabled the project team to acquire a detailed understanding of the development process of photovoltaic solar energy in Tunisia and Jordan, and to identify specific needs that could be met with the "ENABLING PV" project.

Graph 37: Calendar and stages of the "ENABLING PV in the MENA region" project

PREPARATORY STAGE IN BERLIN	Collection of comprehensive background information	Compilation of existing business models in Jordan and in Tunisia	MARCH 2014
PROJECT TRIP TO JORDAN AND TUNISIA	Contact with local stakeholders and project presentation	Identification of process flows for business models and related barriers	APRIL 2014
CONSOLIDATION AND ANALYSIS OF INFORMATION	Briefing of the input from local experts, especially local industry associations	Analysis of barriers and identification of viable business models	MAY 2014
PROJECT WORKSHOP IN JORDAN AND TUNISIA	Presentation of the project results and collection of feedback	Formulation of recommendations for the removal of barriers	JUNE 2014
ELABORATION OF FINAL REPORTS	Process description of viable business models and recommendations for the removal of barriers	Availability of project results for national and international stakeholders	JUNE 2014

b. General Situation of the PV Sector in Tunisia

Fundamentals

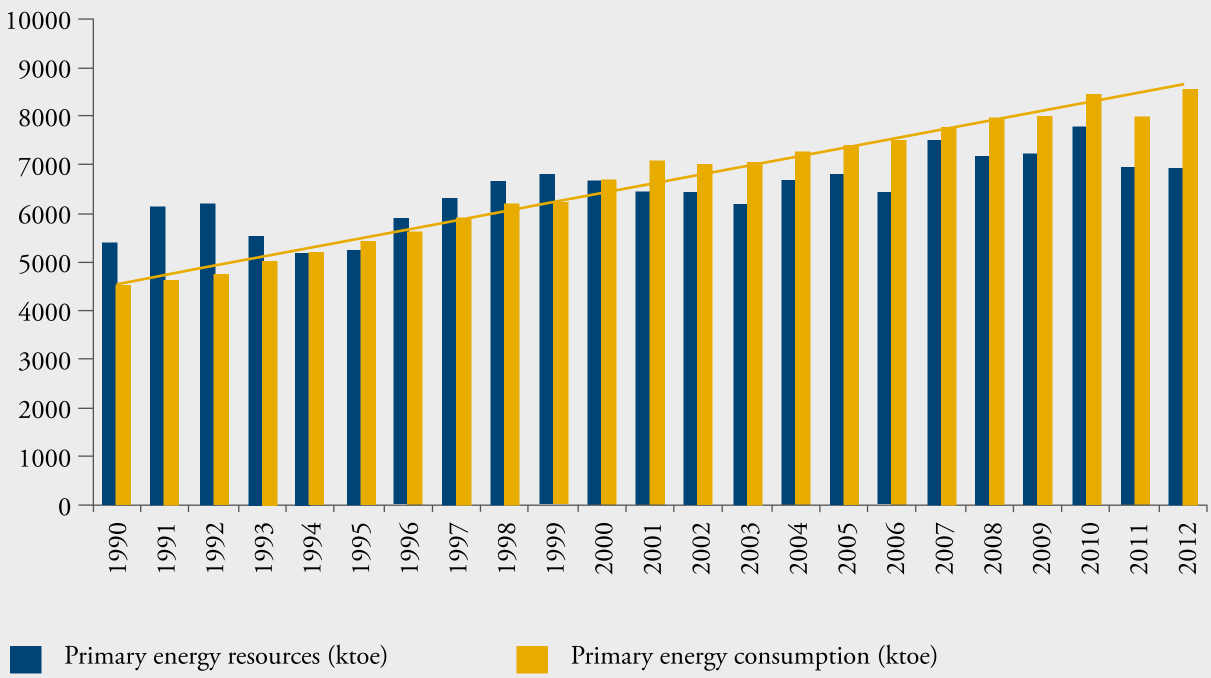
- Growing deficit of the global energy balance
- Constantly increasing electricity demand, especially during the summer peak months
- Heavy dependence on oil
- Low penetration of renewable energies in the electricity mix
- Deficit in the state budget, continually growing
- High public subsidies for fossil fuels

Energy Situation and Existing Resources

Historically, Tunisia has never been endowed with substantial hydrocarbon natural resources able to cover its national primary energy needs. The country's fossil energy resources have played an important part in the economic and social development of the country without however representing a substantial part of the gross domestic product (GDP). This contribution was chiefly linked to the availability of energy resources at interesting prices for economic operators as well as citizens.

The graph below illustrates the evolution of the exploitation of energy resources and of primary energy consumption in Tunisia between 1990 and 2012. The orange curve corresponds to the average annual increase of primary energy consumption, about 1.6% over the 1990-2012 period. In the year 2000, the country's primary energy consumption remained higher than available resources, reaching 8,544 kilotons of oil equivalent (ktoe) in 2012. This energy deficit is explained in part by the economic growth of Tunisia, that has led to an increase in the energy consumption of the economic sectors, as well as non-productive sectors, in particular the residential sector. Furthermore, this increasing demand is accompanied by stagnation in the discovery of hydrocarbon reserves. Consequently, Tunisia remains highly dependent on international energy markets, in particular that of oil products. However, these markets are subjected to significant fluctuations, not without economic and social consequences for Tunisia.

Graph 38: Evolution of energy resource exploitation and primary energy consumption in Tunisia (ANME, 2012)

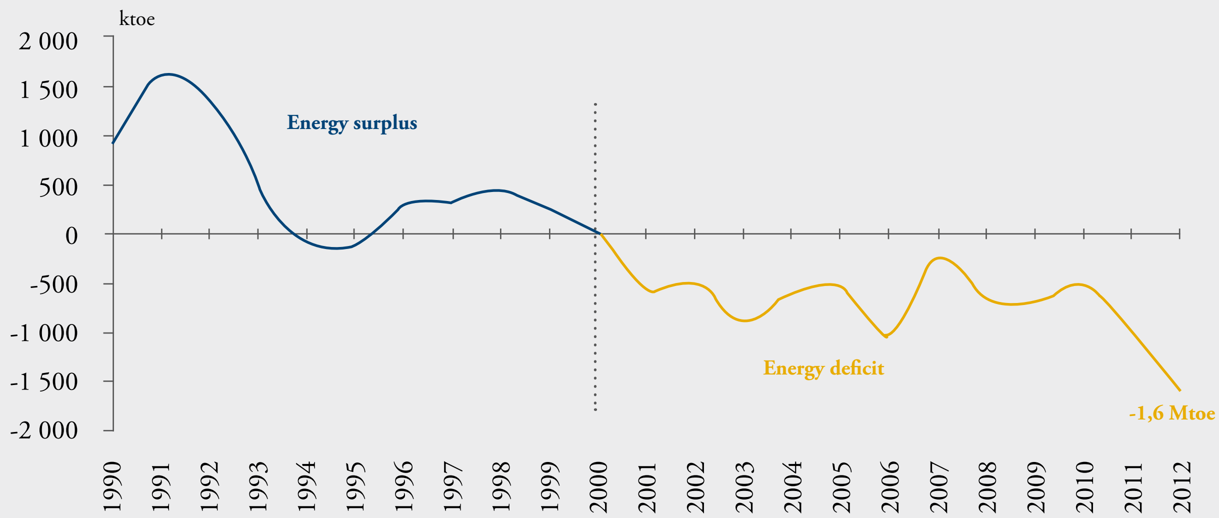


Natural gas represents 55% of the primary energy consumption in 2012, whereas it only represented 34% in 1990. This increase is the result of a substitution policy carried out by the Tunisian government in the '90s in order to diversify energy sources and mitigate oil prices fluctuations on the international market.

The evolution of the national energy consumption from 1990 to 2012 is illustrated by the graph below. Tunisia has gone from a surplus situation between 1990 and 1994 to a balance situation between 1994-2000. The transition to a situation of deficit is clearly visible since 2000.

The Electricity Sector

Graph 39: Evolution of the Tunisian energy balance in ktoe (ANME, 2013)



A growing part of energy consumption

The electricity sector covers a more and more important part of primary energy consumption. Primary energy consumption attached to electricity generation has evolved from 2,318 kilotons of oil equivalent (ktoe) in 2000 to 3,550 in 2010. Its total primary energy consumption share went from 34% in 2000 to 45% in 2010.

Electricity production in Tunisia corresponded to about 15.8 terawatthour (TWh) in 2010, as opposed to 10 TWh in 2000 and 5.5 in 1990. Thus, the electricity part in the total final energy consumption went from 14% in 2000 to 20% in 2010.

The evolution of electricity demands was essentially driven by households, a sector that does not significantly contribute to economic growth. In 2013, the Tunisian Electricity and Gas Company (STEG) had over 3.5 million customers connected to the national grid, among which 99.5% were connected to low-voltage. The table below shows the evolution of the number of STEG customers since 2008.

Table 13: Number of STEG customers since 2008 (STEG, 2014)

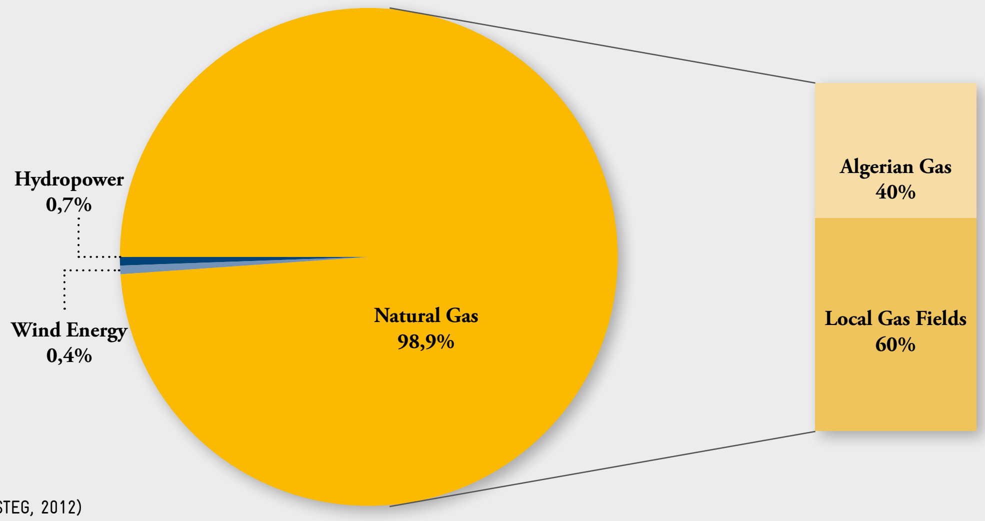
	2008	2009	2010	2011	2012	2013
High voltage	18	18	18	20	20	21
Medium voltage	14476	15106	15653	16688	16500	16761
Low voltage	2949001	3041233	3145392	3285746	3461405	3485308

Heavy dependency on natural gas in the energy mix

The Tunisian energy mix presents very little diversity, with a very low penetration of renewable energies. The part of renewable energies in the energy produced in 2010 only represented 1.1% with a strong predominance of hydraulic electricity and wind turbines. The rest is essentially produced from natural gas, 62% coming from national gas fields and 38% from the Algerian gas pipeline.

This heavy dependency on natural gas is likely to be a serious security problem for electricity production, knowing that forecasts indicate a gas deficit from 2020 on.

Graph 40: Electricity mix in 2011 in Tunisia (source: STEG, 2012)



(Source: STEG, 2012)

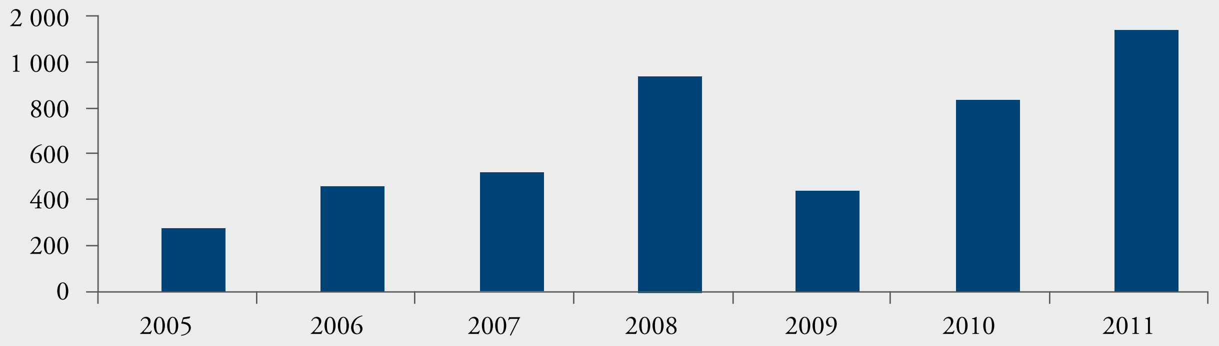
High public subsidy

Public subsidy of natural gas is rather complex in Tunisia, as it operates on two levels:

- The Entreprise Tunisienne des Activités Pétrolières (ETAP, Tunisian Petroleum Enterprise) supplies Algerian natural gas to the STEG at a fixed price of about 90 TND/toe.
- The State grants, every year, a direct subsidy to the STEG as compensation for the cost variation of natural gas acquired directly by the STEG on local fields in relation to the reference price that establishes final tariffs of electricity and natural gas.

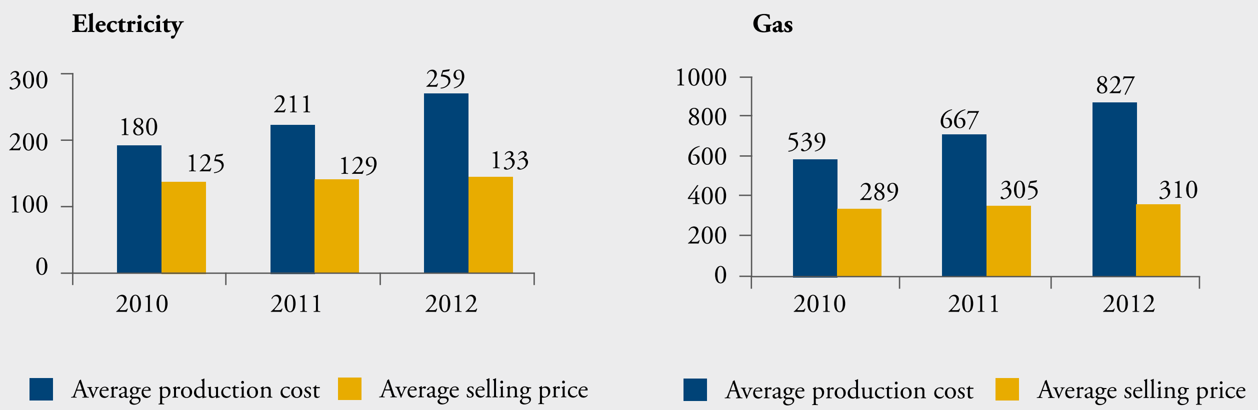
The amount of these subsidies therefore varies according to the international natural gas price (estimated at the importation rate in Tunisia). In 2011, this amount reached about 1.1 billion dinars, exclusively in the electricity sector, as illustrated by the following graph:

Graph 41: Subsidies granted to the electricity sector for fuel in million of Tunisian dinars (MTND) (DGE, STEG, 2012)



The increasing deficit between energy revenues of the STEG and energy sales revenues shows how expensive subsidies are to Tunisia. The current goal is then to reduce subsidies and increase energy sales prices.

Graph 42: Energy and gas cost prices vs. costs of sales in millions of Tunisian Dinars (MTND)



c. Legal Framework Concerning Electricity Produced with Renewable Energies

Fundamentals

- An energy policy aiming at reducing the country's energy dependency
- The intention to diversify the electricity mix with the use of renewable energies, encouraged by a policy to support self-generation, based on a subsidy system
- A photovoltaic capacity goal of 540 MW in 2020 and 1,510 MW in 2030
- The authorisation to produce electricity using renewable energies for private direct consumption
- For companies or business corporations in the industrial, agricultural or service sectors, the right to transport produced electricity through the national grid to points of consumption
- For companies or business corporations in the industrial, agricultural or service sector, the right to sell surplus electricity solely to the STEG and limited to 30% of the annual energy produced
- The sale and transport of surplus energy to the STEG through a model-contract approved by a supervisory authority
- Setting of the sales price of surplus electricity sold to the STEG to a price equivalent to the sales price, exclusive of value added tax, with 4 different tariffs depending on time of production, and the setting of a right to transport electricity to pay for the use of the transport network at 0.005 TND/kWh
- Obligations at the charge of the self-producer of renewable energy electricity:
  - The connection of the installation to the STEG grid, including measuring, control, monitoring and safety tools
  - The strengthening of the STEG grid, if necessary, for electricity feed-in
- The possibility to benefit from subsidies granted by the National Energy Management Commission (FNME)

Energy Goals for the Tunisian Government

The energy policy of the Tunisian government has been defined in order to reduce its energy dependency. Consequently, it rests on two main areas:

- Development of local resources exploitation:
  - Implementation of a legal and fiscal framework favourable to oil and especially gas exploration, in order to attract investors and exploit potential deposits.
  - Implementation of an institutional and regulatory framework in order to promote renewable energies as energy alternatives to conventional energies.

- Management of electricity demands:
  - Tunisia has been committed to energy management for more than three decades. It has thus set a regulatory framework that forces larger energy consumers to draft action plans regarding a decrease in energy consumption and the improvement of their energy performance.
  - Decrease of energy precariousness and regional disparities through the launch of a rural electrification programme offering photovoltaic systems to impoverished families living in areas that do not have access to the electricity grid.

As part of this strategy, the will to diversify the Tunisian electricity mix and to reduce dependency on fossil energies has resulted in the implementation of measures supporting renewable energies:

- The launch of the PROSOL ELEC programme enabling residential customers of the STEG to install small photovoltaic system in order to reduce their energy bills.
- The opening of electricity production via renewable energies for self-generation and the quota offered to self-producers for the exclusive sales of their production to the STEG.

Tunisia has published, in September 2013, its national plan of action for the development of renewable energies[32] , established taking in consideration energy policy goals and the Tunisian Solar Plan[33] , providing for a share of renewable energies in the Tunisian electricity production of 20% in 2020 and 30% in 2030. The plan of action intends for a photovoltaic capacity target of 140 MW in 2016, 540 MW in 2020 and 1,510 MW in 2030. The Tunisian government hopes to reach, thanks to the PROSOL ELEC programme, a photovoltaic capacity of 60 MW in 2016, 190MW in 2020 and 590 MW in 2030.

Current Legal Framework with Respect to Photovoltaics

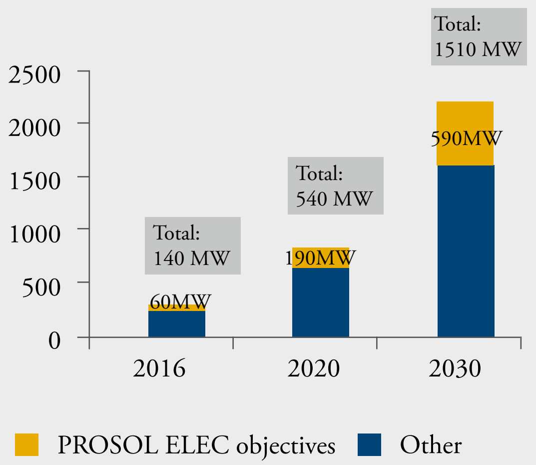
The gradual increase of energy prices since 2003 has prompted decision-makers to consolidate the existing regulatory framework relating to energy management, in order to mitigate the effects of this increase on the national economy, as well as its repercussions on final consumers. This consolidation has led to the drafting of new regulatory texts organising the renewable energy sector in Tunisia. Among these main texts:

The Law n° 2009-7 of 9 February 2009, regarding energy management, constitutes the main legal basis regulating the production of decentralised electricity produced from renewable energies in Tunisia. From Articles 14bis and 14ter stems the authorisation to produce electricity using renewable energy for one's own consumption and to sell the surplus of electricity exclusively to the STEG. The STEG agrees to buy surplus electricity as part of a model contract. Moreover, companies or business corporations in the industrial, agricultural or service sectors have the right to transport the electricity produced, through the national electricity grid up to its consumption points. Finally, the law specifies that electricity production projects using renewable energies connected to the medium and high-voltage grid must be approved by decision of the Ministry of Energy, after consultation of a technical advisory committee.

The Decree n° 2009-2773 of 28 September 2009 stipulates transport and sales conditions of electricity produced from renewable energies. The company or business corporation in the industrial, agricultural and service sectors who produces electricity using renewable energies can sell its electricity surplus, within the limits of 30% of it annual electricity production. In the case of producers connected to the low-voltage grid, the installed electricity capacity of its electricity production equipment must not exceed the electric capacity indicated in the producer's contract with the STEG. In any case, the STEG remains the exclusive buyer of the surplus electricity produced by renewable energy producers. The tariffs of transport and sale of surplus are set by decision of the Ministry of Energy. Moreover, the decree specifies that the self-producer is responsible for any connection charges to the installation on the grid and those relating to the strengthening of the grid, if necessary. The connection and evacuation of energy conditions are specified by a bill of specifications.

The Decree n° 2009-362 of 9 February 2009 sets the rates and amounts of premiums relating to projects promoting the development of renewable energies. Thus, photovoltaic installations connected to the grid receive a 30% of the investment cost premium, limited to 15,000 TND (this subsidy corresponds to the PROSOL ELEC programme, mainly intended for the residential sector).

Graph 43: PV (connected to the grid) capacity targets according to the national action plan (ANME 2013)



[32] *The plan of action for the development of renewable energies can be found on the ANME site: http://www.anme.nat.tn/*

[33] *A new version of the Tunisian Solar Plan was published in June 2014. It can be found on the ANME site: http://www.anme.nat.tn/index.php?id=117*

Moreover, rural lighting and water pumping projects using solar energy for farming and rural projects benefit from a 40% of the investment cost premium, limited to 20,000 TND.

Finally, photovoltaic installations may be eligible for subsidies intended for investments in the energy management area, equivalent to 20% of the material investment costs and limited to:

- 100,000 TND for institutions whose global annual energy consumption does not exceed 4,000 tons of oil equivalent. (toe)
- 200,000 TND for institutions whose global annual energy consumption varies between 4,000 toe and 7,000 toe.
- 250,000 TND for institutions whose global annual energy consumption exceeds 7,000 toe.

A law on electricity production using renewable energies is currently being drafted, and its adoption is expected at the earliest in Autumn 2014. Please refer to the Business Outlook chapter for more information regarding this bill.

d. Eligibility Conditions for Instalers for the PROSOL ELEC Programme

Programme de Promotion de l'Energie

Solaire Photovoltaïque pour l'Electrification et le

Pompage de l'Eau

PRO VOLT

Conditions d'éligibilité des installateurs

Société Signataire :

………………………………………………………………….

Janvier 2009

ARTICLE PREMIER
PREAMBULE

Dans le cadre de son plan quadriennal de maîtrise de l'énergie 2008-2011, l'Etat tunisien a décidé de lancer un programme visant la promotion de l'utilisation de l'énergie solaire photovoltaïque pour l'Electrification et le Pompage d'Eau. Ce programme, dénommé PRO VOLT, se compose de trois projets, à savoir :

– POMPAGE PV qui concerne le pompage d'eau destinée à l'irrigation dans les fermes agricoles.
– Elec Fermes qui concerne l'électrification des fermes agricoles et petits projets dans le milieu rural.
– Bât Sol qui concerne l'utilisation de l'énergie solaire photovoltaïque pour couvrir partiellement les besoins en électricité des bâtiments connectés au réseau de la Société Tunisienne d'Electricité et du Gaz.

Le programme PRO VOLT bénéficie d'incitations financières accordées dans le cadre des actions financées par le Fonds National de Maîtrise de l'Energie, à savoir :

– Une prime de 40% du coût de l'investissement, avec un plafond de vingt mille dinars (20 000 D) pour les projets d'éclairage rural et le pompage de l'eau par énergie solaire photovoltaïque ;
– Une prime de 30% du coût de l'investissement avec un plafond de trois mille dinars (3 000 D) par kilowatt crête et de quinze mille dinars (15 000 D) par bâtiment solaire.

Il est à noter que les établissements, souhaitant s'équiper par des installations photovoltaïques pour l'autoproduction de l'électricité et qui ne peuvent pas être admissibles au projet Bât Sol (connectés au réseau MT ou HT de la STEG), pourraient bénéficier des avantages accordées aux investissements dans le domaine de la maîtrise de l'énergie (20% de la subvention).

Afin de bénéficier de ces incitations, les opérations effectuées dans le cadre du programme PRO VOLT doivent être réalisées par des installateurs qui figurent sur la liste des installateurs éligibles au programme, en utilisant des produits répondant aux exigences des cahiers des Spécifications Techniques d'admissibilité des différents projets du programme, en respectant les règles d'installation mentionnées dans ces cahiers et les normes et textes réglementaires applicables.

ARTICLE PREMIER
OBJET DU CAHIER DES CHARGES

Le présent cahier définit l'ensemble des dispositions qui régissent les conditions et procédures permettant aux installateurs de figurer sur la liste des installateurs éligibles pour opérer dans le cadre du programme PRO VOLT.
L'éligibilité de l'installateur au programme PRO VOLT est tributaire de l'avis favorable de l'ANME, après examen du dossier déposé par les soins de l'établissement concerné conformément aux dispositions définies ci-après.

ARTICLE 2
CONDITIONS D'ELIGIBILITE DE L'INSTALLATEUR

2.1. Installateurs habilités à déposer un dossier :
Toute entreprise établie en société de droit tunisien, active dans le domaine des énergies renouvelables ou ayant un agrément B2 (spécialité Electricité) octroyé par le Ministère de l'Equipement, de l'Habitat et l'Aménagement du Territoire, peut déposer un dossier de qualification pour se faire inscrire sur la liste des installateurs éligibles au programme PRO VOLT.

2.2. Conditions d'éligibilité des installateurs :
Pour pouvoir figurer sur la liste des installateurs éligibles, les installateurs concernés doivent avoir suffisamment de connaissances relatives à la sécurité des installations connectées au réseau et satisfaire au moins l'une des conditions suivantes :

– L'installateur a réalisé au minimum trois références récentes d'installations photovoltaïques au cours de la période des trois années écoulées avant le dépôt du dossier.
– Avoir parmi son effectif permanent, un ingénieur ou technicien supérieur ayant reçu une formation qualifiante dispensée par un établissement spécialisé sur les aspects relatifs à la réalisation des installations photovoltaïques.
– La participation des agents de l'installateur à un stage pratique, organisé par le fabriquant des équipements photovoltaïques ou son représentant en Tunisie et portant sur les prestations d'installation et de maintenance de ces équipements.
– L'installateur sera accompagné lors de la réalisation des trois premières installations connectées au réseau par une entreprise, tunisienne ou étrangère, ayant une bonne expérience dans le domaine (pas moins que cinq installations photovoltaïques connectées au réseau durant les trois dernières années).

2.3. Dépôt du dossier :
Tout installateur, tel que défini dans l'article 2.1., souhaitant figurer sur la liste des installateurs éligibles pour le programme PRO VOLT, doit présenter à l'ANME un dossier composé obligatoirement des pièces suivantes :
– Le présent cahier des charges et ses annexes, remplis et paraphés à toutes les pages. L'engagement du respect des dispositions du cahier des charges devra être daté, signé (signature légalisée) et cacheté par l'installateur;
– Une demande formelle d'admissibilité de l'installateur ;
– Un engagement de respect des mesures et règles de sécurité relatives aux installations photovoltaïques, annexées au présent cahier des charges ;
– Une copie de la carte d'identification fiscale ;
– Un certificat d'affiliation à la Caisse Nationale de Sécurité Sociale ;
– Une copie de l'agrément du MEHAT pour la spécialité B2 pour les entreprises spécialistes en travaux d'électricité,
– La composition de l'équipe de personnel permanent et la liste de matériels dont dispose l'installateur;
– Liste des projets réalisés durant les 3 dernières années, indiquant les références des projets (maître d'ouvrage, intitulé du projet, lieu, travaux réalisés et montant des travaux). Joindre obligatoirement une copie des PV de réception définitive (ou provisoire) de chaque projet.
– les Justificatifs concernant la qualification du personnel pour les aspects relatifs à la réalisation des installations photovoltaïques et éoliennes:
  i. Certificats concernant les stages de formation,
  ii. Conventions de partenariat et les justificatifs concernant l'expérience du partenaire dans la réalisation d'installations photovoltaïques connectées au réseau.

2.4. Décision concernant l'éligibilité de l'installateur :
Après étude du dossier, l'ANME émet, par écrit, un avis favorable ou non favorable et le transmet à l'installateur. En cas d'avis favorable, l'installateur sera inscrit sur la liste des installateurs éligibles au programme PRO VOLT.

2.5. Validité de l'éligibilité de l'installateur :
L'éligibilité de l'installateur reste valable durant trois ans, sauf dans le cas où elle serait interrompue pour des raisons de fautes professionnelles graves, d'un nombre important de complaintes de la part des clients ou d'une défaillance en termes de respect des engagements.

ARTICLE 3
QUALITE DES PRESTATIONS

Dans le but d'assurer la bonne qualité des services rendus aux clients, l'installateur s'engage à :

1. Assurer auprès du client un rôle de conseil et d'assistance dans le choix des solutions les mieux adaptées à son contexte ;
2. Informer le client sur les démarches nécessaires, relatives en particulier aux demandes d'autorisation de raccordement et de production d'électricité ainsi qu'aux conditions d'octroi des subventions ;
3. Après visite sur site, soumettre au client un devis descriptif écrit, détaillé et complet, de l'installation proposé, en fixant un délai de réalisation, des termes de paiement et des conditions de garantie légale ;
4. Opter pour les matériels et équipements conformes aux exigences réglementaires ;
5. Réaliser l'installation commandée dans le respect des règles professionnelles, normes et textes réglementaires applicables, selon les prescriptions prévues. Lors des travaux d'installation, il est demandé à respecter les exigences du présent cahier de charges et ses annexes ainsi que les instructions des fournisseurs des équipements;
6. Afficher les consignes de sécurité sur les organes de manœuvre et les équipements ;
7. Mettre en service l'installation, puis procéder à la réception des travaux en présence du client. Lui remettre les notices et tous documents relatifs aux conditions de garantie et d'entretien/maintenance de l'installation ;
8. Remettre au client les instructions de sécurité et le former d'une façon adéquate sur les procédures d'intervention et la sécurité de l'installation ;
9. Proposer au bénéficiaire un contrat de maintenance au-delà de la période de la garantie totale de l'installation ;
10. Remettre au client une facture descriptive détaillée et complète de la prestation, conforme au devis. Cette facture devra indiquer le montant de la subvention (qui sera débloquée directement par l'ANME au profit du fournisseur) et le montant net à payer par le client ;
11. En cas d'anomalies ou d'incidents de fonctionnement de l'installation signalés par le client, s'engager à intervenir sur le site dans les délais convenus dans le contrat de fourniture et d'installation, et procéder aux vérifications et remises en état nécessaires, dans

le cadre des obligations d'intervention attachées à la garantie biennale ;

12. Etre à la disposition de l'ANME pour des visites aux installations aux fins d'examiner les conditions de mise en œuvre et de réalisation des prestations.
13. Etre à la disposition de la STEG, pour les installations raccordées au réseau, aux fins d'examiner le raccordement, le comptage et le dispositif de découplage.

ARTICLE 4
RESPONSABILITES :

L'installateur sera responsable, vis à vis des tiers de tous les dommages ou dégradations qui auraient lieu du fait du fonctionnement des chantiers. Il sera également responsable des dommages éventuels pouvant résulter du transport de ses matériaux et de la traversée des propriétés privées. Les indemnités à payer en cas d'accidents sont dues par l'installateur, sauf recours contre l'auteur de l'accident.

ARTICLE 5
ASSURANCES

L'installateur devra souscrire :

- Une assurance de responsabilité civile aux tiers, couvrant tous dommages corporels et matériels pouvant survenir à des tiers ou à leurs propriétés (cultures, exploitations agricoles, etc.) pendant l'exécution des travaux, la police devra spécifier que le personnel du maître d'ouvrage, ainsi que celui d'autres établissements se trouvant sur le chantier, sont considérés comme des tiers vis à vis des assureurs.
- Une assurance couvrant tous les risques d'accidents du travail vis à vis de son propre personnel.
- Une assurance de responsabilité professionnelle couvrant les travaux réalisés pour la garantie décennale et ce conformément aux lois N° 94-9 et 94-10 du 31 Janvier 1994.

L'installateur remettra au client un exemplaire des polices d'assurances souscrites avant tout commencement des travaux. Ces polices devront comporter une clause interdisant leur résiliation sans avis préalable de la Compagnie d'Assurances au maître d'ouvrage.

ARTICLE 6
MOYENS HUMAINS ET MATERIELS

L'installateur doit posséder les moyens (potentiel humain et matériel) suffisants pour assurer l'installation et le Service Après-vente.

En particulier, il doit disposer d'au moins d'un ingénieur (en génie électrique, énergétique ou électromécanique) ou d'un technicien supérieur en électricité.

D'autre part et afin de réaliser l'installation dans les meilleures conditions et de vérifier son bon fonctionnement tout en respectant les mesures de sécurité, l'installateur doit disposer de matériel de manutention approprié, des instruments de mesure et des équipements de sécurité adéquats.

ARTICLE 7
LA GARANTIE ET LE SERVICE APRES VENTE DES EQUIPEMENTS ET DES TRAVAUX

a. Garantie totale de l'installation : La période minimale de garantie totale de l'installation est fixée à 24 mois à partir de la date de la réception provisoire. Pendant cette période, l'installateur devra procéder à ses frais, à la remise en état de toutes les parties qui deviendraient défectueuses, et à tous les travaux d'entretien et de maintenance périodique nécessaires.
b. Garantie des équipements : L'installateur garantit que tous les équipements installés n'auront aucune défectuosité due à leur conception, aux matériaux utilisés ou à leur fonctionnement survenant pendant l'utilisation normale des équipements livrés dans les conditions prévalant en Tunisie.
   Les durées minimales de garantie des équipements sont détaillées dans les cahiers des Spécifications Techniques d'admissibilité des différents projets du programme PRO VOLT. Il est à noter que ces garanties prendront effet à partir de la date de réception provisoire des installations.
c. Contrat de maintenance : Pour chaque installation à réaliser dans le cadre du programme PRO VOLT, l'installateur doit impérativement inclure dans son offre un projet de contrat détaillée de maintenance pour une durée de trois (3) ans, à compter de la date de la fin de garantie totale de l'installation.

d. Service Après Vente :
– Délais d'intervention : L'installateur s'engage à fournir un service après-vente de qualité, avec des délais d'intervention acceptables par les bénéficiaires.
– Pièces de rechange : L'installateur s'engage à maintenir un stock de pièces de rechange jugé indispensable pour assurer le fonctionnement normal des installations.

ARTICLE 8
CONTROLE EFFECTUE PAR L'ANME

– Droit de contrôle : L'ANME a le droit de procéder, à sa convenance ou à l'issue de plaintes des bénéficiaires, à toute opération de contrôle qu'elle juge nécessaire en vue de s'assurer de l'authenticité des informations et données inscrites dans les dossiers relatifs à la demande de subvention ou pour vérifier les aspects relatifs à la qualité des équipements et des travaux de l'installation et leur conformité aux exigences des cahiers des Spécifications Techniques d'admissibilité présentés en annexes.
– Collaboration de l'installateur : L'installateur s'engage à se soumettre à toute opération de contrôle que l'ANME souhaiterait effectuer et de faciliter la tâche aux contrôleurs désignés par l'ANME pour cette opération, qu'ils soient du personnel interne de l'ANME ou indépendants commandités par elle. Il s'engage en particulier à fournir aux contrôleurs toutes les informations de nature administrative, technique où financière, nécessaires pour l'exercice du contrôle.
– Confidentialité : L'ANME est tenue strictement à la confidentialité des informations, des données et des résultats issus des opérations de contrôle.

ARTICLE 9
SANCTIONS EN CAS DE NON RESPECT DU CAHIER DES CHARGES

a. Actes frauduleux : Si, suite à un contrôle, l'une quelconque des installations visitées par l'ANME, il s'avère que l'installateur se sera livré à des actes frauduleux (non-conformité des informations indiquées dans le dossier de la demande de subvention par exemple), l'ANME se réservera le droit de :
– Demander à l'installateur le remboursement de la subvention à l'ANME, assorties des pénalités découlant des poursuites légales prévues par la loi tunisienne.
– Suspendre momentanément ou définitivement l'éligibilité de l'installateur aux avantages du programme.
b. Non-conformité technique des installations : Si, suite à un contrôle auprès des clients, l'une quelconque des installations visitées par l'ANME se révèle non conforme aux spécifications techniques minimales d'installation établies par l'ANME, celle-ci se réservera le droit d'astreindre l'installateur à réparer ou remplacer le matériel à ses frais (sans indemnités), dans un délai fixé conjointement avec l'ANME.
De même, en cas de manquements répétés aux exigences minimales d'installation établies par l'ANME, celle-ci se réservera le droit de suspendre momentanément ou définitivement l'éligibilité de l'installateur aux avantages du programme.
c. Conditions d'application des sanctions : Préalablement à l'application des sanctions énoncées dans les sections a et b du présent article, l'ANME demandera des explications à l'installateur, ou le convoquera pour obtenir des clarifications sur le dossier en question. En cas de refus de la part de l'installateur, ou de justifications peu convaincantes, les sanctions peuvent être prononcées huit (8) jours après une mise en demeure envoyée par lettre recommandée et restée sans effet.

ARTICLE 10
FORCE MAJEURE

a. L'installateur ne sera pas exposé aux sanctions indiquées dans l'article 9, si, et dans la mesure où les manquements constatées sont dus à la force majeure.
b. Aux fins de la présente clause, le terme «FORCE MAJEURE» désigne un événement imprévisible échappant au contrôle de l'installateur et qui n'est pas attribuable à sa faute ou à sa négligence.
c. En cas de force majeure, l'installateur notifiera rapidement par écrit à l'ANME l'existence de la force majeure et ses motifs.

ARTICLE 11
MODIFICATION DU CAHIER DES CHARGES

L'ANME peut, à tout moment, par écrit transmis à l'installateur, spécifier son intention de modifier les termes du présent cahier des charges. Afin que l'installateur puisse bénéficier des avantages liés au programme, celui-ci devra alors nécessairement signer le nouveau cahier des charges, reconnaissant ainsi satisfaire à ses conditions et règles.

Engagement

Je soussigné Mr : ....
Agissant en qualité de : ....
Au nom et pour le compte de la société : ....
Faisant élection du domicile au :....................................
....
Inscrit au registre du commerce du :...............................
Sous le numéro :..

Après avoir pris connaissance du présent cahier des charges et ses annexes, me soumet et m'engage à se conformer à toutes ses préconisations, en vertu de quoi, la société ………………………………………………… devient éligible aux avantages de programme PRO VOLT.

Cachet :...

Signature légalisée :..

Fait à ……………………….. le
……………………………………………………..

e. Technical Eligibility Conditions for Photovoltaic Installations Connected to the Grid

PRO VOLT

ANNEXE

Spécifications Techniques d'admissibilité des installations photovoltaïques raccordées au réseau

Projet Bât Sol

Janvier 2009

1- Admissibilité au projet Bât Sol

Pour être admis au projet Bât Sol dans le cadre du programme PRO VOLT, toute installation photovoltaïque raccordée au réseau basse tension devra se conformer aux :

– Règles d'admission énoncées dans la présente annexe ;
– Conditions techniques d'accès au réseau fixées par la Société Tunisienne d'Electricité et du Gaz (STEG) ;
– Procédures administratives fixées par l'ANME et la STEG.

2- Composants des installations photovoltaïques

Un système photovoltaïque raccordé au réseau comprend les composants suivants :

– Un générateur photovoltaïque produisant du courant continu et composé d'un ensemble de panneaux photovoltaïques. Chaque panneau est formé d'un assemblage en parallèle et série de modules photovoltaïques ;
– Un onduleur (ou plusieurs) transformant le courant continu fourni par le champ photovoltaïque en un courant alternatif ayant toutes les caractéristiques du courant électrique fourni par le réseau ;
– Des organes de coupure, de sécurité et de raccordement assurant des fonctions de protection vis-à-vis de l'utilisateur, de l'installation photovoltaïque et du réseau ;
– Un système de comptage permettant de mesurer l'énergie électrique totale produite par le système et celle injectée au réseau électrique.

3- Auto-producteurs admissibles au projet Bât Sol

Est admissible au projet Bât Sol, tout propriétaire ou exploitant (personne morale ou physique) d'un bâtiment, client de la STEG, souhaitant s'équiper d'une installation solaire photovoltaïque pour couvrir partiellement ou totalement ses besoins en électricité.

4- Installateurs admissibles

Seules les entreprises inscrites sur la liste des installateurs éligibles au programme PRO VOLT, sont autorisées à réaliser les travaux d'installation dans le cadre du projet Bat Sol.

5- Puissances admissibles des systèmes photovoltaïques

La puissance d'une installation photovoltaïque raccordée au réseau, à réaliser chez un bénéficiaire dans le cadre du projet Bât Sol, ne doit pas dépasser la puissance souscrite de celui-ci auprès de la STEG. Toute fois, la puissance de l'installation photovoltaïque devra:

– Se limiter à 36kVA en triphasé (soit 12 kVA par phase) ;
– Se conformer aux conditions techniques de raccordement et d'évacuation des installations de production sur le réseau national HT et MT.

6- Dimensionnement du générateur photovoltaïque

6.1 Critères de dimensionnement

Tout en respectant les puissances admissibles définies ci-haut, le dimensionnement du générateur photovoltaïque peut se faire selon l'un des critères suivants :

– La consommation d'électricité du bâtiment : la taille du générateur photovoltaïque est choisie de façon à ce que le productible annuel de l'installation soit équivalent à la totalité ou une partie, convenue à l'avance avec le bénéficiaire, de la consommation annuelle d'électricité. Dans ce cas, la société installatrice devra se référer à :
  • la consommation électrique annuelle, ou,
  • l'estimation de la consommation annuelle en se basant sur les puissances électriques des équipements et les durées moyennes de leur utilisation.
– La surface disponible pour l'implantation des modules photovoltaïques : le nombre de modules (et par conséquent la puissance du générateur) équipant un bâtiment dépend de l'existence d'une surface « bien ensoleillée » pour leur emplacement. A titre indicatif, l'installation d'un champ photovoltaïque d'une puissance de 1 kWc nécessite une superficie d'environ 8 m² .

6.2 Estimation du productible

La production annuelle d'électricité d'une installation solaire est calculée en tenant compte;

– De l'ensoleillement annuel du site (en se référant aux moyennes du rayonnement quotidien global sur un plan horizontal, enregistrées dans la station météorologique la plus proche au site. Les données météo de référence sont annexées au présent document) ;
– Des tailles et performances techniques des modules photovoltaïques et de l'onduleur (rendement et disponibilité) ;
– De l'orientation et l'inclinaison des modules photovoltaïques.

7- Exigences techniques

Il est à noter que tous les équipements constituant les installations photovoltaïques doivent être neufs, convenablement étiquetés et fournis au bénéficiaire de l'installation avec la documentation technique nécessaire.
Les équipements et les travaux d'installation devront obligatoirement répondre aux exigences suivantes :

7.1. Champ photovoltaïque

– Les modules photovoltaïques doivent être conformes aux normes internationales :
  • CEI-61215 : Modules photovoltaïques (PV) au silicium cristallin pour application terrestre- Qualification de la conception et homologation.
  • CEI-61646 : Modules photovoltaïques (PV) en couches minces à usage terrestre- Qualification de la conception et homologation.
– Les modules photovoltaïques doivent être testés, certificats à l'appui, par un laboratoire agrée ;
– L'ensemble des modules du générateur photovoltaïque doivent avoir des caractéristiques identiques avec une tolérance de +/- 5% sur la valeur de la puissance crête.
– Le module devra comporter :
  • Une boite de connexion ou des connecteurs appropriés au moins IP 54 ;
  • Des diodes by-pass.
– Les modules devront être garantis pour une période minimale de 5 ans. De plus, les performances des modules devront être garanties à 90% de rendement garanti après 10 ans de fonctionnement et à 80% de rendement garanti après 20 ans.
– L'installateur devra veiller à bien choisir, en accord avec le client, l'endroit pour placer les modules photovoltaïques. Cet endroit doit avoir une surface suffisante, orientée le plus possible vers le Sud, sans obstacle masquant la course du soleil en toute saison. De plus, il doit être capable de supporter le poids des modules.
– L'inclinaison optimale des modules photovoltaïques est de 30° par rapport à l'horizontale. Toutefois, l'installateur pourrait choisir d'autres inclinaisons pour favoriser la production d'électricité durant certaines saisons (en accord avec le client).
– Les rangées de modules photovoltaïques ne devront pas faire d'ombre les unes aux autres.
– Lors de la fixation de la structure supportant les modules, l'installateur doit préserver l'étanchéité de la toiture (pas de percement) tout en assurant un bon ancrage.
– Les supports doivent résister sans dégât aux vents puissants ainsi qu'à la corrosion.

7.2. Câblage de la partie courant continu

– L'interconnexion électrique entre les modules photovoltaïques devra se faire conformément aux instructions du fabricant.
– Tous les composants du câblage courant continu (câbles, interrupteurs, connecteurs ….) doivent être choisis en fonction de la valeur de courant et de tension maximum des modules connectés en série/parallèle constituant le champ photovoltaïque.
– Les câbles utilisés devront être de type simple conducteur avec double isolation.
– Les sections des câbles seront déterminées de façon à minimiser les pertes en ligne entre le champ photovoltaïque et l'onduler (inférieures ou égales à 3%).
– Les câbles extérieurs doivent être flexibles, stables aux UV et résistant aux intempéries.
– Les connecteurs doivent être spécifiés pour le courant continu, de classe II, résistants aux conditions extérieures, assurant une protection contre les contacts directs et dimensionnés pour des valeurs de tensions et courant identiques ou supérieures à celles des câbles qui en sont équipés.
– Les boîtes de jonction utilisées pour la mise en parallèle des chaînes (une chaîne est circuit dans lequel les modules PV sont connectés en série) devront être implantées en un lieu accessible pour les exploitants et comportant des étiquettes de repérage et de signalisation du danger.
– Chaque chaîne du champ photovoltaïque doit pouvoir être déconnectée et isolée individuellement par le biais de porte fusible ou d'autres liaisons dé connectables mais sans risque pour l'opérateur. Un interrupteur général CC sera de préférence intégré dans chaque boite de jonction sur le départ de la liaison principale.
– Lorsque la protection par fusibles s'impose, ils doivent être appropriés pour le courant continu et installés à la fois sur la polarité positive et négative de chaque chaîne.
– Un interrupteur/sectionneur spécifié pour le courant électrique, remplissant à la fois la fonction de coupure en charge et de sectionnement, devra être mis en place sur la liaison principale champ photovoltaïque – onduleur . L'interrupteur, dimensionné pour la tension et courant maximum, doit être étiqueté avec un repérage clair des positions. Le coffret comportant l'interrupteur/sectionneur doit être étiqueté « danger, conducteurs actifs sous-tension durant la journée ».
– The DC connector mounting box must be able to withstand the temperature range expected (-20°C up to

+85°C), it must be UV-resistant and take the expectable voltage and current according to CEI 60439-1. There must be a weather, ozone resistance and UV resistance according to ISO 4892-2 method A). It must be suitable for ouDToor use according to EN 60529 (IP 54) and protected against touch. It must be non-flammable according to DIN EN 60692-2-11. Further its must be double or enforced insulated according to (CEI 60335-1/ CEI 61140) with clear labelling of polarities. Mechanical connectors must be in accordance to (EN 60999) and (EN 50262) for cables.

7.3. Onduleurs

- Ils doivent être de type onduleurs pour installations solaires compatibles avec les caractéristiques du réseau électrique de distribution et permettant :
  - Une bonne synchronisation avec le réseau, ce qui inclue de délivrer un signal proche de la sinusoïde, un déphasage faible et peu d'harmoniques par rapport à la phase du réseau, de faibles perturbations électromagnétiques ;
  - Un déclenchement automatique en cas de coupure du réseau et une qualité de courant qui correspond aux valeurs maximales admissibles pour le réseau ;
  - Une isolation galvanique entre le champ et le réseau ;
  - Un rendement de conversion du courant photovoltaïque le plus élevé possible sur la plage de tension la plus large possible ;
  - Une plage d'entrée en tension importante car elle conditionne le nombre de panneaux à connecter en série dans le champ.
  - Un bon comportement à puissance maximale.

- Les onduleurs de puissance inférieure à 5 KVA devront être équipés d'un système de protection de découplage intégré conformément aux spécifications de la norme allemande DIN VDE 0126 (certificat d'essais de type à l'appui).
- L'onduleur doit être capable d'accepter le courant et la tension maximum du champ photovoltaïque.
- Si l'onduleur, de part sa technologie de fabrication, génère une composante continue sur le réseau, sa valeur ne doit pas dépasser celle précisée par la CEI 61000-3-2.
- Le dimensionnement de l'onduleur doit être réalisé en adéquation avec la puissance du champ photovoltaïque et doit être compris entre 0,7 et 1 fois la puissance du champ photovoltaïque.
- Afin de limiter les pertes, l'onduleur doit être placé le plus près possible des panneaux photovoltaïques.
- Le Rendement maximum de l'onduleur devra être supérieur ou égal à 95%. Son rendement pour une charge égale à 10% de sa charge nominale devra être supérieur ou égal à 90%. The measurement for this value has to take place in accordance to CEI 61683 and the European performance ration must be calculated with the following formula:

$$\text{Euro } \eta = 0{,}03 * \eta_{@5\%} + 0{,}06 * \eta_{@10\%} + 0{,}13 * \eta_{@20\%} + 0{,}13 * \eta_{@39\%} + 0{,}48 * \eta_{@50\%} + 0{,}20 * \eta_{@100\%}$$

- L'onduleur devra être garanti pour une période minimale de 5 ans.
- L'onduleur doit disposer d'un certificat de test établi par un organisme spécifié.
- Si la protection de découplage est incorporée à l'onduleur, il faut fournir le procès verbal délivré par un laboratoire d'essai agrée mentionnant sa conformité à la norme allemande DIN VDE 0126.
- L'onduleur doit être installé dans un local ventilé et facile d'accès
- Compliance with the CEI-62093 for all parts of the inverter, conpliance with safety reulation DIN EN 50178 for all parts of the inverter, further compliance with the European regulation DIN EN 60146-1-1 and DIN EN 60146-1-3 (for semi conducting inverters) as well as the European regulation EWG 89/336/EWG for electromagnetic protection and the European low voltage regulation 73/23/EWG

7.4. Câblage de la partie courant alternatif

- L'onduleur doit être connecté au tableau de distribution interne du bénéficiaire et protégé par un disjoncteur différentiel 30 mA (au minimum).
- Le câble de liaison entre l'onduleur et le disjoncteur doit être dimensionné pour limiter la chute de tension à une valeur inférieure à 3% en BT.
- Deux points de coupure doivent être fournis entre l'onduleur et le point de connexion au réseau : un disjoncteur doit être installé à proximité de l'onduleur et le second à proximité du disjoncteur différentiel.
- The AC connector mounting box must be able to withstand the temperature range expected (-20°C up to +85°C), it must be UV-resistant and take the expectable voltage and current according to CEI 60439-1. There must be a weather, ozone resistance and UV resistance according to ISO 4892-2 method A). It must be suitable for outdoor use according to EN 60529 (IP 54) and protected against touch. It must be non-flam-

mable according to DIN EN 60692-2-11. Further its must be double or enforced insulated according to (CEI 60335-1/ CEI 61140) with clear labelling of polarities. Mechanical connectors must be in accordance to (EN 60999) and (EN 50262) for cables.

7.5. Système de découplage

– Les installations photovoltaïques raccordés au réseau doivent comporter un système de découplage permettant de déconnecter instantanément le générateur photovoltaïque pour :
  - Permettre le fonctionnement normal des protections et automatismes installés par la STEG ;
  - Eviter le maintien sous tension de l'installation après séparation du réseau ;
  - Eviter des découplages intempestifs préjudiciables aux équipements domestiques ;
  - Séparer le générateur en cas de défaillance interne.

– L'équipement de découplage du générateur photovoltaïque devra obligatoirement être conforme aux exigences techniques de la STEG.

7.6. Comptage

– Toute installation photovoltaïque devra être équipée en sortie du (ou des) onduleur (s) d'un compteur électrique accessible par l'usager afin de pouvoir disposer d'une estimation cumulée de la production électrique photovoltaïque.

– Toute installation photovoltaïque devra être équipée d'un système de comptage de l'énergie électrique injectée sur le réseau conformément aux exigences de la STEG.

7.7. Mise à la terre et protection contre la foudre

– Les installations raccordées au réseau électrique sont classées en risque moyen, ce qui impose la mise en place des dispositions suivantes :
  - Interconnexion des masses par conducteur cuivre 25 mm² ;
  - Mise à la terre des masses uniques ;
  - Interconnexion avec dispositifs d'écoulement lors d'impacts directs (si existant) tels que descentes de paratonnerre, fils tendus… ;
  - Câblage modules photovoltaïques flottant (non relié à la terre) ;
  - Contrôleur permanent d'isolement (généralement intégré à l'onduleur) ;
  - Liaison renforcée entre modules photovoltaïques et onduleur ;
  - Limitation des surfaces offertes des boucles de câblage au rayonnement électromagnétique ;
  - Protection par parafoudres bipolaires sur circuit courant continu (type varistances à oxyde de zinc avec déconnexion thermique intégrée, entre polarités et terre) au niveau de la boite de jonction (si le câble de liaison dépasse 10 mètres) et à l'entrée de l'onduleur ;
  - Protection par parafoudres sur circuit courant alternatif entre phases et terre (type modulaire pour régime TT à fort pouvoir d'écoulement sur réseau de distribution) en sortie du courant alternatif onduleur et au tableau de distribution intérieure.

8- Documents à fournir au bénéficiaire

L'installateur devra fournir au bénéficiaire de l'installation photovoltaïque les documents suivants :

oLes plans et schémas électriques détaillées de l'installation ;

– Le repérage sur plans de l'implantation des différents composants et modules photovoltaïques ainsi que des liaisons correspondantes ;
– Les notices d'utilisation et d'exploitation du système PV ;
– Les notices des constructeurs des équipements fournis ;
– Une notice de maintenance préventive de l'installation avec et une proposition de contrat de maintenance ;
– Les certificats de garantie des équipements et de l'installation ;
– Une description de la procédure d'intervention sur le système et consignes de sécurité.
– Technical data sheets of all components signed and verified by date so they become a document.
– Full wiring diagram with all installation places
– Measuring protocols of the first operation of the system signed by the installer
– Serial numbers of photovoltaic panels and inverters
– All certificates and warranty guidelines
– Insurance policy forms if present
– Declaration of conformity to the requirements of STEG and ANME signed by the installer with date and place to become a document
– Service and emergency phone numbers
– All instruction books for all pieces of equipement
– Form sheet for the meter readings and system performance indications (monthly or weekly meter readings)

Further there should be a certificate of the education of the customer issued by Anme and STEG and signed by the installer and the customer:

Content of the customer education form sheet:

– Instruction of the components and their mounting places and functions has taken place (Yes/No)
– Handed over the instruction manuals to the customer (Yes/No)
– Education session on functions and failure detection (Yes/No)
– Handed over service and emergency numbers (Yes/No)
– Explained relevant operation modes (day, night, standby, etc) (Yes/No)
– Explanation on shading possibilites and avoidance (Yes/No)
– Explanation on cleaning instructions of the modules (Yes/No)
– Explanation of simple structure integrity checks, mounting system, cables, modules etc, (Yes/No)
– Signature of both installer and customer

9. Bibliography

Studies and Reports

Arab Future Energy Index - AFEX (2013): Report on the Arab Future Energy Index – Renewable Energies. Regional Centre for Renewable Energy and Energy Efficiency (RCREEE). Can be found in English online at: http://www.rcreee.org/sites/default/files/reportsstudies_afex_re_report_2012_en.pdf

Cessac, Cécile B. (2014): Analyse du cadre règlementaire de l'accès au réseau des producteurs d'électricité à partir d'énergies renouvelables en Tunisie - Etude de préfaisabilité sur les axes de développement. (Analysis of the legal framework relating to the grid access of electricity producers using renewable energies in Tunisia – Pre-feasibility on the axis of development.) Can be found online at: https://energypedia.info/images/2/2a/GIZ_Legal_Framework_fr_web.pdf

Renewable Energy Division - DER (2014): Report on the activities of the DER presented to members of the Technical Advisory Committee in February 2014.

Tunisian National Agency for Energy Management - ANME (2013): Plan d'action de développement des énergies renouvelables en Tunisie. (Action plan for the development of renewable energies in Tunisia) September 2013.

Interviews

The drafting of the report would not have been possible without the active participation of stakeholders from the photovoltaic sector in Tunisia. This is why we would like to sincerely thank all the participants for their contribution to this report on the Tunisian photovoltaic market. The interviews were carried out with several players of the private and public sectors.

Private sector Stakeholders:

- 9 interviews with photovoltaic installers
- 2 interviews with representatives of the Syndicate of Corporate Citizens (CONECT) as well as with a representative of Cluster Énergies Renouvelables
- 3 interviews with representatives of a project development company
- 3 interviews with representatives of Attijari bank

Public sector Stakeholders:

- Interview with the Sales Management department at the STEG
- Interview with the Distribution Management department at the STEG
- Interview with the management of the Renewable Energies Department at the ANME

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