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Cooperating across borders in the Mediterranean

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MAIA-TAQA

MAIA-TAQA Resources Efficiency Market Assessment Report

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Website	http://www.enicbcmed.eu/projects/maia-taqa

About the Programme

The 2014-2020 ENI CBC Mediterranean Sea Basin Programme is a multilateral Cross-Border Cooperation (CBC) initiative funded by the European Neighborhood Instrument (ENI). The Programme objective is to foster fair, equitable and sustainable economic, social and territorial development, which may advance cross-border integration and valorise participating countries' territories and values. The following 13 countries participate in the Programme: Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Malta, Palestine, Portugal, Spain, Tunisia. The Managing Authority (JMA) is the Autonomous Region of Sardinia (Italy). Official Programme languages are Arabic, English and French. For more information, please visit: www.enicbcmed.eu.

The European Union is made up of 28 Member States who have decided to gradually link together their know-how, resources and destinies. Together, during a period of enlargement of 50 years, they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms. The European Union is committed to sharing its achievements and its values with countries and peoples beyond its borders.

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Executive Summary

Despite the fact that in the Southern Mediterranean countries there is a growing need for resource efficiency (RE) services (consulting, engineering and operations)to deal with the pressure on the environment, the RE supply persists at low levels.This is essentially due to the lack of a proper innovation process that would be ableto identify the needs, structure the creative solutions and commercialise them. MAIA-TAQA (Mobilizing new Areas of Investments And Together Aiming to increase Quality of life for All) will deal with these issues by setting up demonstrators in 3 Mediterranean pilot areas where innovative services will be applied: they will be related to micro-grids, photovoltaics, energy storage, solar thermal technologies and water sanitation and purification. Partners will develop solutions for each identified barrier: capacity building programme (for lack of skills); innovation desk (for lack of information); guidelines (for lack of regulation); voucher (for lack of finance) and targeted B2B events (for lack of specific matchmaking). The main final beneficiaries are SMEs (especially from environment/utility/building sector) that can have a set of supporting instruments to overcome the existing barriers and reduce the risks to innovation. The resources efficiency market assessment reportpresents the status of RE services in the three pilot countries: Egypt, Jordan and Lebanon. This report provides a comprehensive overview on the selected REservices in each pilot country, the RE market situation, the RE production state, thedistribution methods, the incentive and financing methods, the challenges and barriers facing the RE services implementation and the RE prospects in each pilot country. The data collected and analyzed show that there are significant opportunities in the three pilot countries for the development of RE services. The study also shows the governments' efforts in supporting the RE services through different incentives and financing mechanisms. In addition to the challenges and barriers that need to be taken into consideration to develop a well-established RE eco-system.

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1.Introduction

The ENI CBC MED project, MAIA-TAQA (Mobilizing new Areas of Investments And Together Aiming to increase Quality of life for All), with the thematic objective of *A.2 Support to education, research, technological development and innovation,* priority A.2.2*SMEs access to research and innovation*, involves six partner countries: Greece, Egypt, Italy, Jordan, Lebanon and Spain. Due to the growing need for resource efficiency (RE) services in the Southern Mediterranean countries, which include consulting, engineering and operations, MAIA-TAQA focuses on setting up demonstrators in 3 Mediterranean pilot areas where innovative services will be applied: micro-grids, photovoltaics, energy storage, solar thermal technologies and water sanitation and purification. Partners will develop solutions for each identified barrier: capacity building programme (for lack of skills); innovation desk (for lack of information); guidelines (for lack of regulation); voucher (for lack of finance) and targeted B2B events (for lack of specific matchmaking). The main final beneficiaries are SMEs (especially from environment/utility/building sector) that can have a set of supporting instruments to overcome the existing barriers and reduce the risks to innovation.

The resources efficiency market assessment report presents the status of RE services in the three pilot countries: Egypt, Jordan, and Lebanon. This report provides a comprehensive overview on the selected RE services in each pilot country, the RE marketsituation, the RE production state, the distribution methods, the incentive and financing methods, the challenges and barriers facing the RE services implementation and the RE prospects in each pilot country. The data collected for this report included primary data through an online survey that targeted RE services suppliers and users in each pilot country in addition to published studies and reports and a few interviews with experts. The report is divided into four main sections. Section one presents the case of Egypt (PV system design and storage), section two presents the case of Jordan (solar cooling), section three presents the case of Lebanon (wastewater treatment), and the final section is a conclusion of the main findings.

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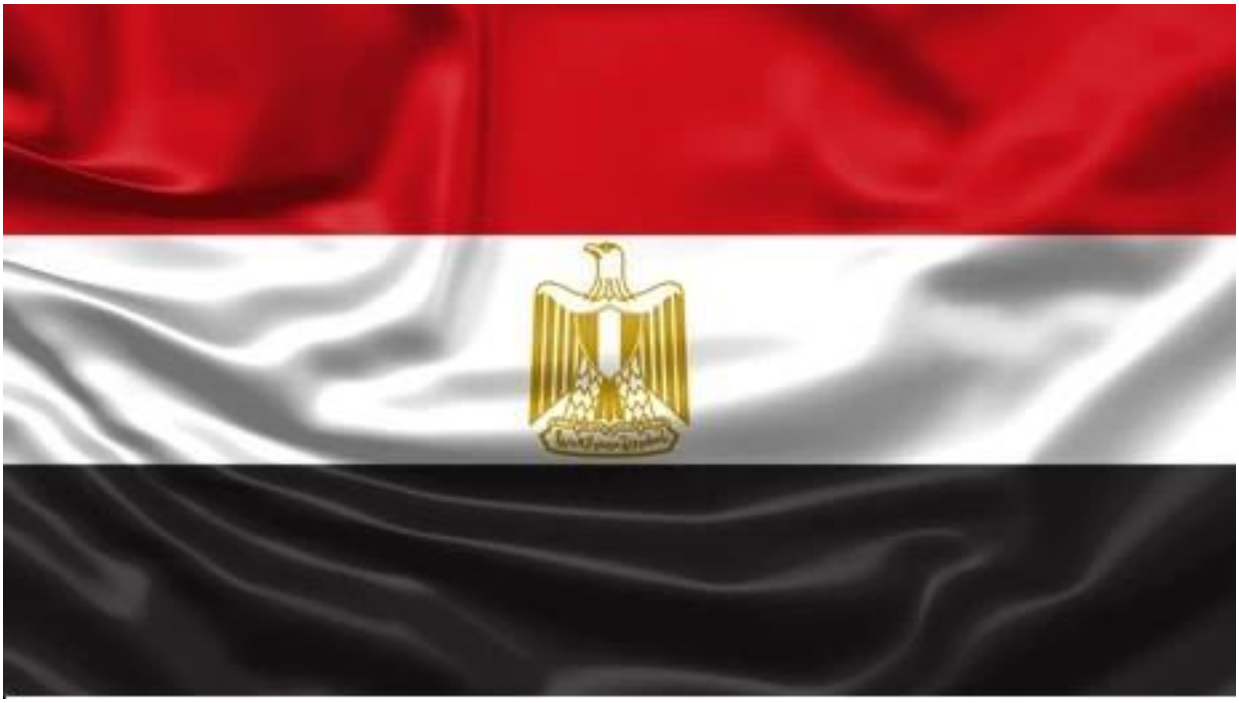

EGYPT

2. Egypt

2.1 Introduction

The Arab Republic of Egypt is a transcontinental and Mediterranean country spanning the north-eastern corner of Africa and Southwestern corner of Asia. The 1 million km^2 land area is home to a large number of natural energy sources, including solar, wind, biomass and hydro resources spread throughout the nation. Egypt is one of the most industrialized countries in the MENA region with a population growth rate of 1.94% in 2019 (United Nations, World Population Prospects). As of mid-year 2020, the population of Egypt has reached 102,334,404 people.

Accordingly, its energy demand has increased steadily, by an average 5% yearly since 1995 (BP statistical Review of World Energy 2018). The majority of energy is used in thetransport sector with 29.5% of all energy consumption, 28.7% are being used by the industrial sector, 23% of energy is directed to the residential sector and 5% are consumed by commercial and public services (IIA 2020, World Energy Balances, Factsheet Egypt). Egypt's energy mix traditionally was constituted of oil, natural gas (90%) and hydroelectric power (9%) generated from the large dam projects over the Nile.

Within the MENA region, Egypt is leading in regard to the deployment of renewable energies.). According to an interview with the Minister of Egyptian Renewable Energy the target of 2022 with 20% electricity production capacity from clean energy (including Hydropower) has already been reached. The Minister also recently announced that Egypt plans to generate 60% of its electricity by renewable energies by 2035. This announcement sets a target even abovethe current target of the integrated sustainable energy plan of the country and can only be achieved with efforts promoting large scale and small-scale resource efficiency (RE) investment. Figure 1 shows the estimated Egypt Energy Mix by 2035.

Source	Percentage
PV	21.3
Wind	14.04
CSP	5.52
Hydro	1.98
Conventional + Nuclear	57.33
100 %	

Renewable Energy 42.7 %

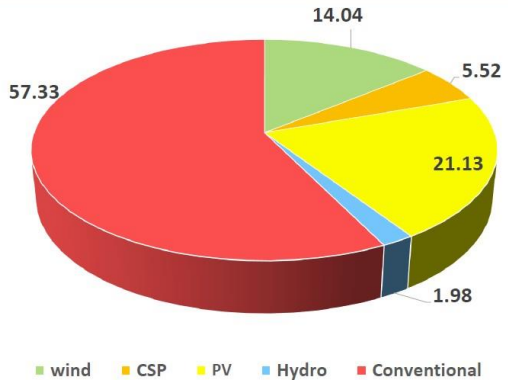

Figure 1 – Egypt Energy Mix 2035 Production Capacity
Source: Extracts of a PP of Dr. Mohamed El-Khayat, Exec. Chairman NREA held in December 2020

The electricity from renewable sources in 2019/2020 is estimated to be around 11% of the total electricity generation in Egypt. The integrated sustainable energy plan of the Egyptian governments has set a goal of 20% and 42% renewable energy targets in the electric energy mix by years 2022 and 2035, respectively. The electricity from renewable sources in 2018/2019 year amounted to 4543 GWh, over a total installed capacity of 58.353 MW, which is around 11% (EEHC Report 2019).

Egypt currently experiences an overcapacity of electricity supply, but with a yearly expected increase in demand of around 6-7% minimum, this overcapacity is expected to disappear within the next couple of years. By 2030 conservative estimates figure a lack in electricity supply of 18% if the current generation capacity would not be fortified. Taking into consideration the expected rise of e-mobility in Egypt, the increase in

demand could grow by 30% within the coming 10 years, according to Prof. Dr. Hafez el Salmawy, Former Executive Chairman Egypt ERA.

The government's 2035 Integrated Sustainable Energy Strategy underlines the importance of renewable energy and aims to increase the supply of electricity generatedfrom renewable sources to 20% by 2022 and 45% by 2035, with wind providing 14%, hydro power 2%, and solar 25% by 2035. The aim shall be achieved by encouraging theprivate sector to invest in renewable energy projects for wind generation and solar energy projects based on BOO modus (Build-Own-Operate) and donor funded EPC contracts (Engineering-Procurement-Construction).

In fact, Egypt has adopted several incentive mechanisms to encourage the establishment of generation plants from renewable sources, such as Competitive bids for large plants issued by the Egyptian Electricity Transmission Company (the national TSO) up to feed-in tariff and net-metering schemes for small-scale projects. Figure 2 shows the capacity of solar and wind energy projects in Egypt.

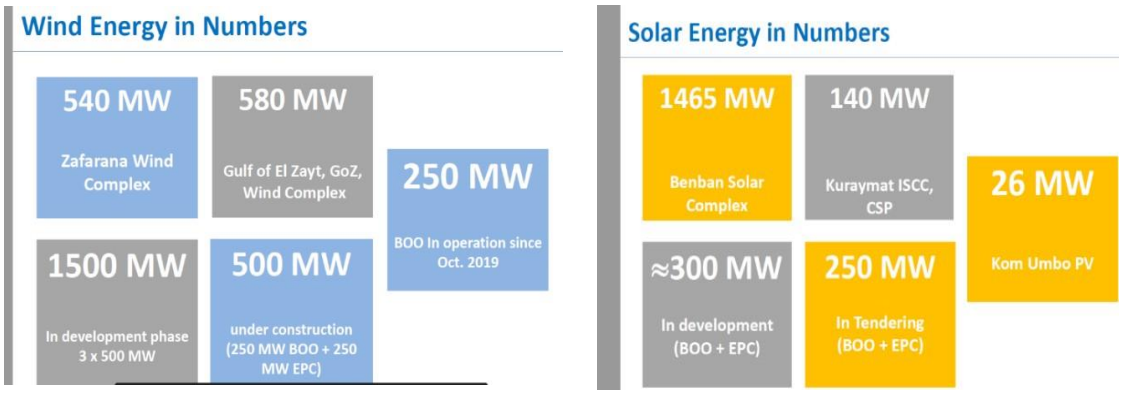

Figure 2 - The Capacity of Solar and Wind Energy Projects in Egypt

Source: Extracts of a PP of Dr. Mohamed El-Khayat, Exec. Chairman NREA held in December 2020

While utility scale investment has progressed quite well, investment in small scale RE is limited, despite its considerable potential to make Egypt reach its renewable energy goals. A recent legislation, circular 2/2020 of the Egyptian Energy Consumer Protection Authority (EgyptERA) of May 2020 limits the volume and total amount of renewable energy projects under the net metering scheme, reducing the potential for renewable energy projects to a maximum of 300 MW for the whole country. Finance for small scale photovoltaic (PV) is usually offered commercial loans that are partly supported by International Finance Institutions providing preferential rates and conditions for renewable energy projects through local banks.

Egypt has a well-established market of PV system providers. Especially in recent years, due to the decline of prices for solar panels, many new companies entered the market, next to well established older companies. Not all of them have sufficient knowledge and experience in design and installation, as there are no standards or codes of practice required by law. The main sales channel for the commercial and industrial applications is still direct sales, while the residential sector is targeted mostly through social media channels. As worldwide, also in Egypt 90% of panels are imported from China, research and development in solar technologies in Egypt is rather low.

Therefore, this report attempts to assess the situation of the RE services in Egypt, explore the potentials in market supply and demand, and analyse the challenges and barriers of RE services implementation in Egypt. The research team used desk research in addition to interviews and surveys with expertise to provide a holistic view on the supply and demand for RE services in the Egyptian market.

2.2 MAIA- TAQA pilot in Egypt: El-Ameria Wholesale Market in Alexandria

The city of Alexandria, where the MAIA-TAQA pilot project will be implemented throughthe introduction of PV system design and storage, holds around 5% of the total population in Egypt with 5,280,664 inhabitants. The Ameria neighborhood alone is home to around 1 million locals and potential direct beneficiaries of the project's futuresuccess.

For the implementation of the MAIA-TAQA project, El-Ameria, vegetable and fruit wholesale market located in the densely populated El-Ameria neighborhood in Alexandria, Egypt has been chosen for its high level of replicability and suitability to theproject's objectives and targets. With around 200 shops benefiting from the implementation, the project will bring significant advantages to the local shop owners and suppliers. Numerous markets around the country have similar characteristics, whichonly adds to the high level of replicability of the intended action plan and project.

The pilot of El-Ameria Wholesale Market will bring positive outcomes for the market aswell as for the national power system. As for the positive outcomes for the market, thepilot will achieve a primary energy consumption reduction derived from oil or gas with the related environmental benefits; less congestion on the distribution networks and therefore less network losses; and finally, a cost reduction of the electricity service to the extent that 'parity grid' RES solutions are used.

As for the benefits of the national power system:

- lower fossil fuel consumption: assuming an average efficiency of 46% of the Egyptian power plants (94,7% fuelled by natural gas) for each kWh from renewable sources the avoided consumption of natural gas amounts to 0.206 Nm3 (38MJ/ Nm3); taking into account the 169 GWh of electricity generated by the PV plant it can be estimated a yearly saving of 34814 NM3 of natural gas;

- avoided carbon dioxide emission equal to 74 t/year in connection with the avoided natural gas (56 t CO2/TJ natural gas);
- technical losses in transmission and distribution network: assuming these losses are equal to 10% of the purchased electricity, the pilot allows less losses equal to 16,9 GWh/year.

These benefits for the national energy system justify the granting of incentives for the pilot, such as net metering or net billing. Considering of similar wholesale markets in each city, the designed pilot presents a wide possibility of replication. The expected number of replicabilities for such project might exceed 1000 replications with a total capacity estimated to exceed 100 MW. Each city in Egypt does have several markets such as El-Ameria Wholesale Market. The largest city in Egypt is Cairo, which boasts a population of close to 8 million. The next largest city, Alexandria, has about half of thatnumber, with 5 million inhabitants. Thirty-four cities in the country have populations that are a bit smaller but still contribute significantly to the high population. These cities have populations that exceed 100,000,including Port Said which has over 500,000 and several cities that are approaching the half-million inhabitant milestone. Eighty-five cities are even smaller, but still haverespectable populations that have surpassed 100,000. Of course, there are other smallercities and towns that round out the country's total population.

In this perspective, it seemed more appropriate to direct the pilot towards solutions favouring highly replicable applications of renewable sources for local generation (i.e. close to consumption) capable of replacing electricity coming from fossil fueled power plants through the transmission and distribution network.

2.3 Market Situation

To understand the market situation in Egypt, the research team conducted desk research, interviews, and surveys with expertise in order to provide a holistic view of themarket situation for RE services in Egypt. The research team designed two surveys; oneto assess the demand for the RE services in Egypt (26 respondents) and the other one for the RE supply market (24 respondents). The surveys targeted decision makers and top management levels as demonstrated in Figures 3 and 4.

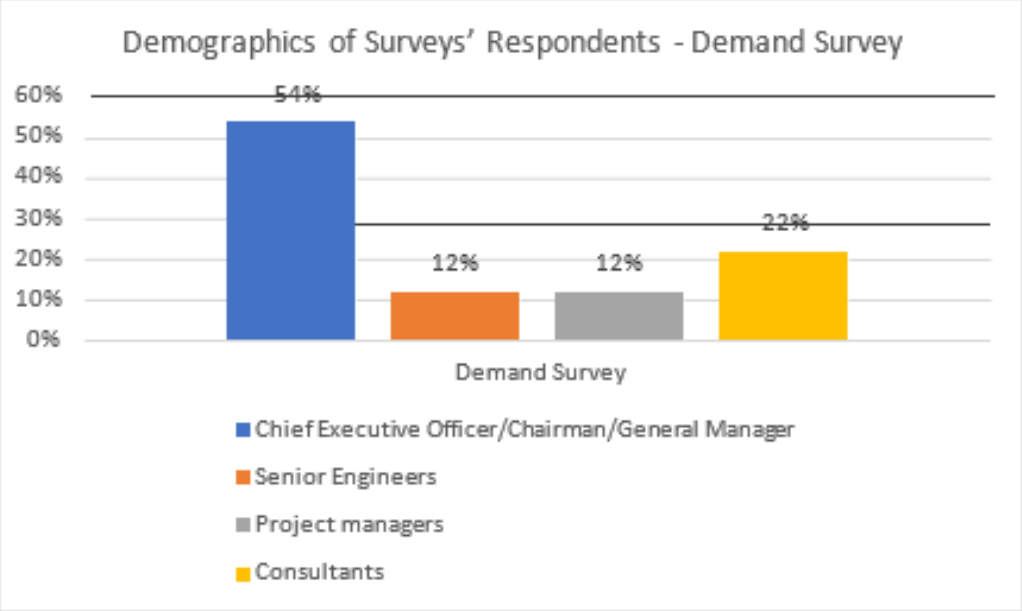

Figure 3 – Respondents' Demographics of the Demand Survey Egypt

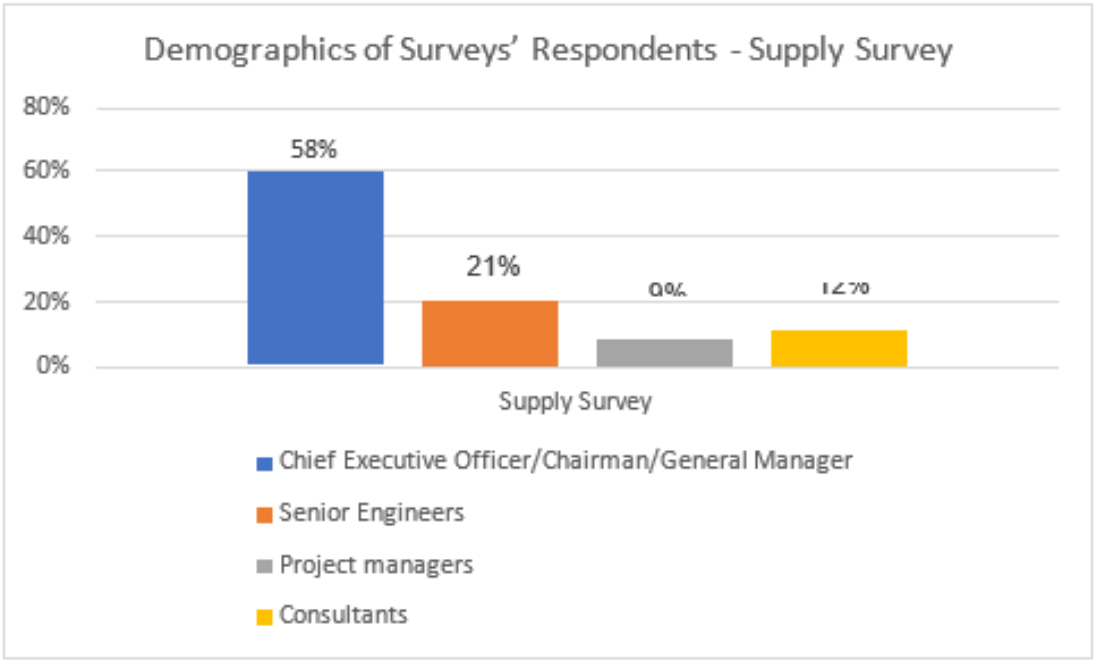

Figure 4 – Respondents' Demographics of the Supply Survey Egypt

The majority for the respondents in both surveys belonged to the private sector except for only 3 entities in the demand survey representing the public sector in Egypt. For the demand survey, 60% of the respondents represented local companies/organizations while the remaining 40% represented international companies. For the supply survey, 80% of the respondents were local companies and 20% presented international companies. Figures 5 and 6 show the types of organizations/companies of the respondents in both surveys, and Figures 7 and 8 show the years of experience in supplying or implementing RE services in Egypt.

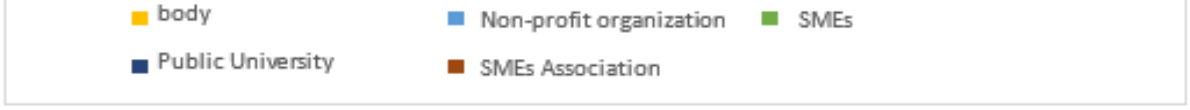

Figure 5 – Types of Organizations/Companies of the Respondents - Demand Survey

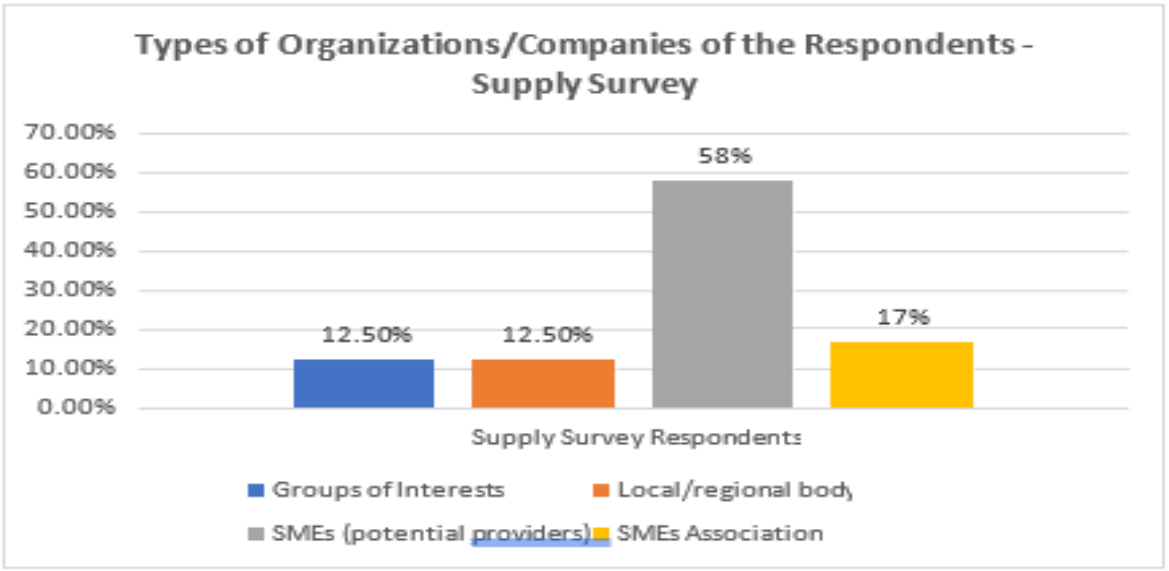

Figure 6 – Types of Organizations/Companies of the Respondents - Demand Survey

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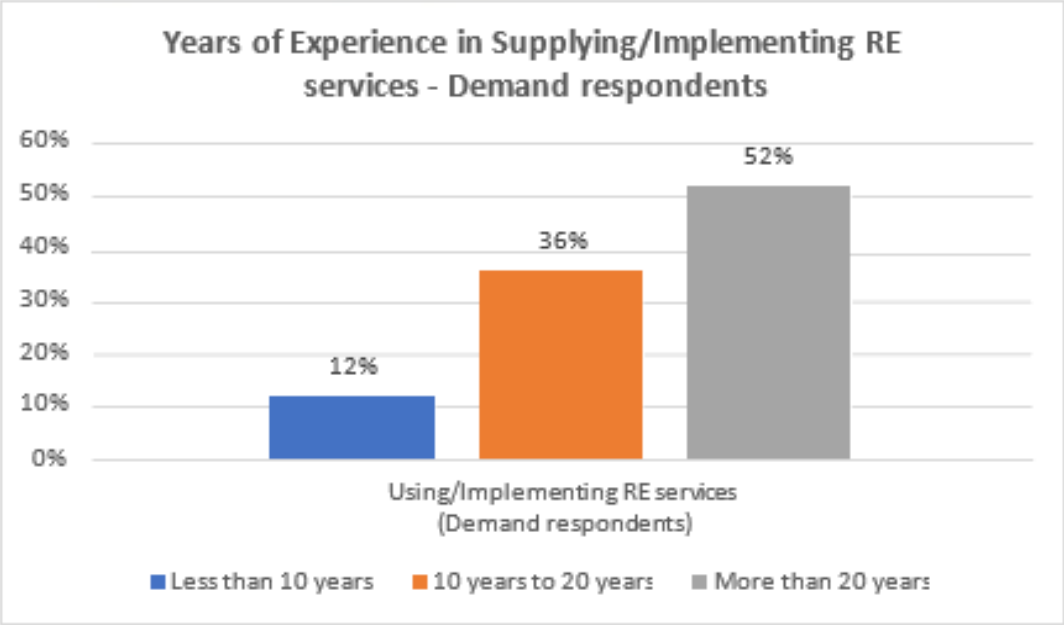

Figure 7 - Years of Experience in Supplying/Implementing RE services - Demandrespondents

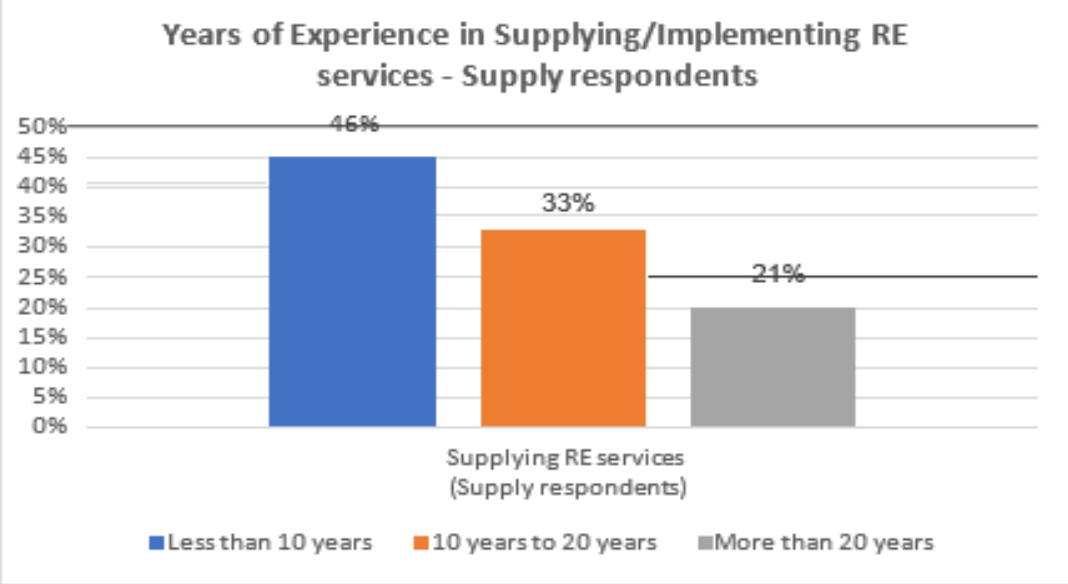

Figure 8 - Years of Experience in Supplying/Implementing RE services - Supply respondents

2.3.1 Potential of the market of the RE Services in Egypt

Since the late 1970s, the Egyptian government has proposed programmes for demonstrating, testing and evaluating various renewable energy applications and technology systems in co-operation with different countries and international bodies, including France, Germany, Italy, Spain, Denmark, Japan, the European Union and the United States. The co-operation between these entities translated into the installation of the first wind farms in Zaafarana in the early 2000.

For many years the focus of renewable energies investment was brought on wind energy, with only smaller PV applications being used in the form of solar industrial process heat systems (SIPHS), solar water heaters (SWHs), and photovoltaic (PV) applications in water pumping, cold stores and desalination plants, as well as biogas digesters in rural areas. PV systems were considered one of the most appropriate applications for remote areas, off the national grid. According to NREA, PV technologiesare used for lighting, commercial advertisements, wireless communication and cell phone networks, in rural electrification, refrigeration and in water pumping for irrigationin newly reclaimed lands, etc.

After launching the feed-in tariff in 2014, Egypt experienced a rapid growth in the investment in renewable energies applications. By end of 2019, the installed capacity ofrenewables in Egypt reached 1 491 MW solar PV of which 1465 MW are installed in the Benban Solar Park, 1375 MW wind power and 140 MW CSP as shown in Figure 9.

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Signed PPA	32
Total Installed Capacity	1465 MW
Total Area for Solar Park	37.1 Km Square
Total Investment	2 Billion $
Workers and Job Creation	More than 10000

Figure 9 – Benban Solar Park

Source: PP slide by Dr. Mohamed El-Khayat, Exec. Chairman of NREA

The Benban Solar Park is considered the world's biggest solar park with a capacity to produce 1.8 GW electricity from solar power. The national project was supported by the EU and the Green Climate fund. It succeeded to gather 32 solar plant investors; the majority of the private investments was financed by the EBRD.

Along with the success of such mega projects, the supply survey showed that the RE suppliers examined approximately serve 2,930 facilities/households in Egypt and there are potentials for growth. Figures 10 and 11 show the approximate amount of capital invested by both the suppliers and users of RE services surveyed.

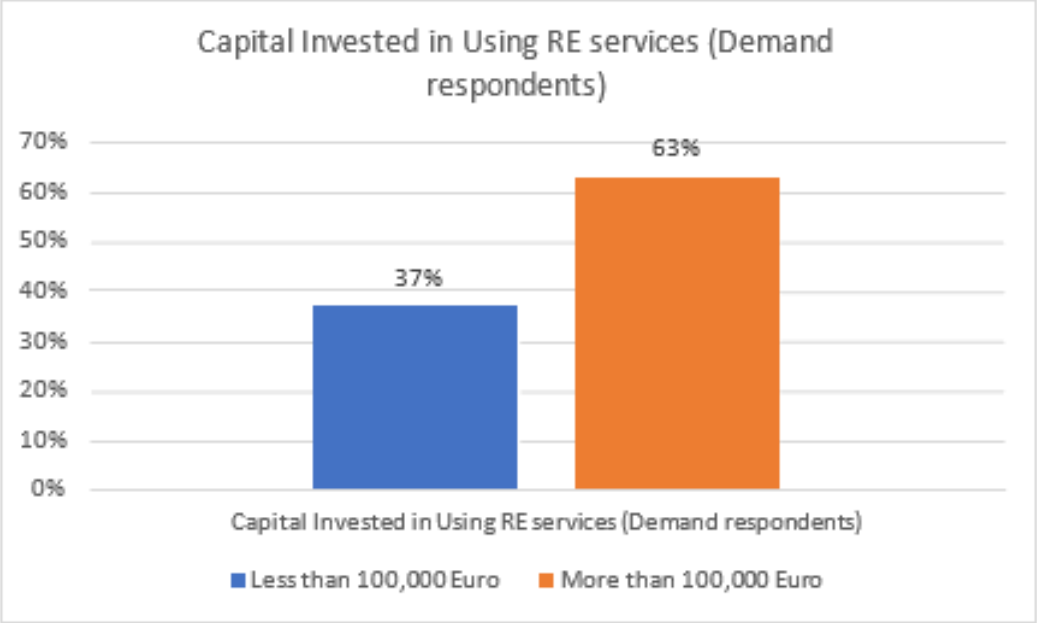

Figure 10 - Capital Invested in Using RE services (Demand respondents)

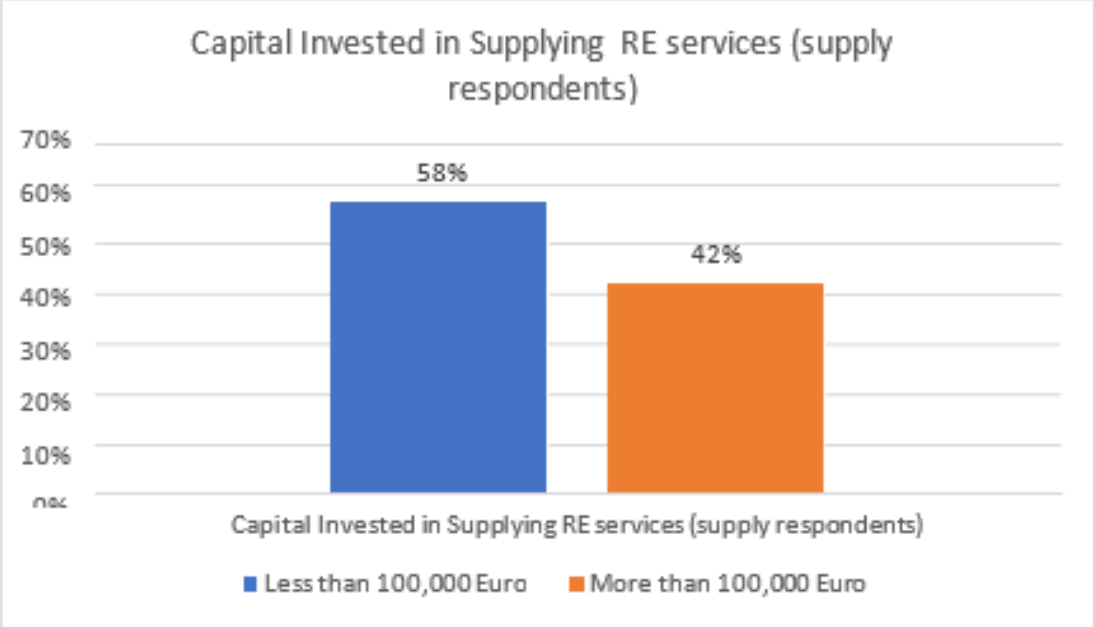

Figure 11 - Capital Invested in Supplying RE services (supply respondents)

While these utility scale renewable energy generation has progressed well in Egypt, thechallenge remains in fostering small scale PV and wind benefiting from FIT and net metering opportunities for small scale.

Small scale solutions for the public and SMEs can contribute majorly to an increase of RE in the energy and electricity mix, especially considering that households consume nearly half of the country's electricity (EEHC 2019). Besides some rural electrification projects using PV applications, no targets seem to exist for small-scale RE applications (e.g. on household level or in the commercial sector).

Currently, net metering is only applicable to solar PV technology with a limit of 20 MW installations. Owners of a small renewable energy power plant with a capacity up to 500 KW are exempted from having to get a license from the regulator. Instead, investors who comply with the regulation rules, need to apply directly to the off-taker and sign acontract with him. The government has released a limit for installing solar plants underthe net metering scheme of a maximum of 300 MW installed capacity in total. Approximately half of the capacity is reserved for instalments less than 500 KW and 100MW is foreseen above 500 KW and up to 20 MW capacity installations.

Despite the large potential market and improved economics, limiting the total allowed output for net-metering projects had a negative effect on investments in small solar projects in general and solar irrigation, especially as the new circular does not foresee a timeframe for re-evaluating the decree after reaching the maximum allowed output.

2.3.2 Product types and applications (for the selected RE services)

The prevailing product types of PV panels in Egypt are mono- and polycrystalline panels. Monocrystalline panels are considered more efficient in regard to their output, but due totheir sensitivity of high temperature changes, that can occur in the Egyptian desert, theyare also considered less durable. The third option, PV films, that are used on glass surfaces, are considered of lower efficiency and shorter life team than the two first mentioned technologies. Additionally, they are also more expensive in Egypt. Figure 12 shows the percentages of RE services used/implemented by the respondents.

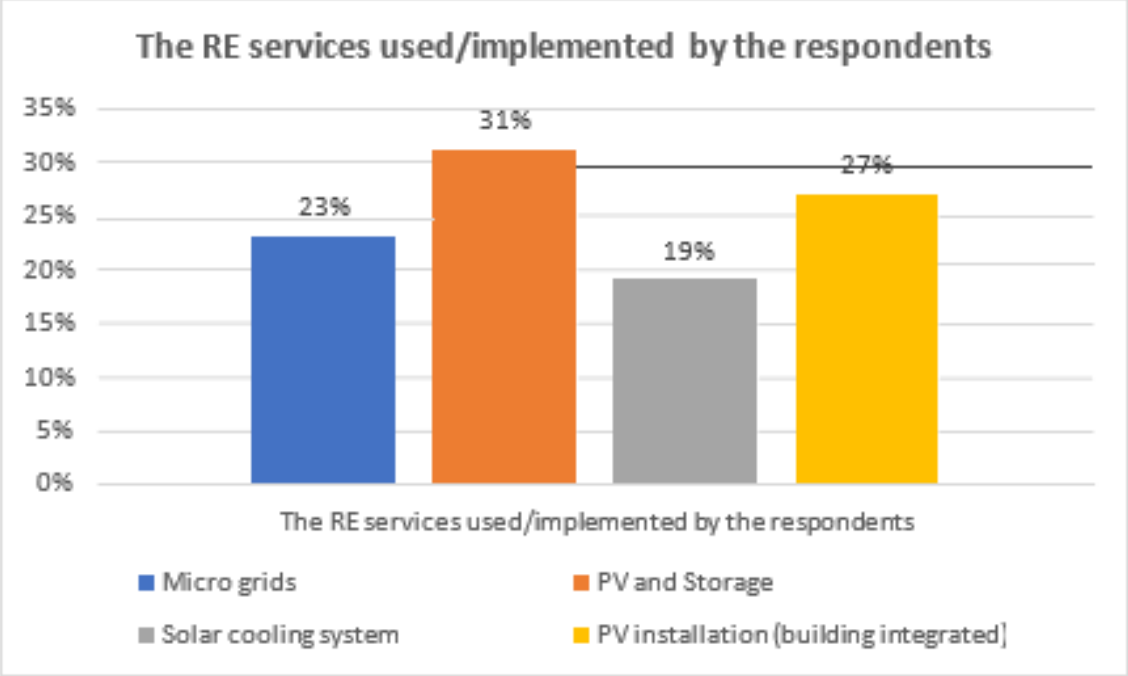

Figure 12 - The RE services used/implemented by the respondents

As it is shown in the previous figure the mostly used RE services is the PV and storage. Itis worth noting that the majority of the respondents have only used the RE services recently over the past five years. Figure 13 presents the number of years for which RE services have been implemented in the surveyed sample.

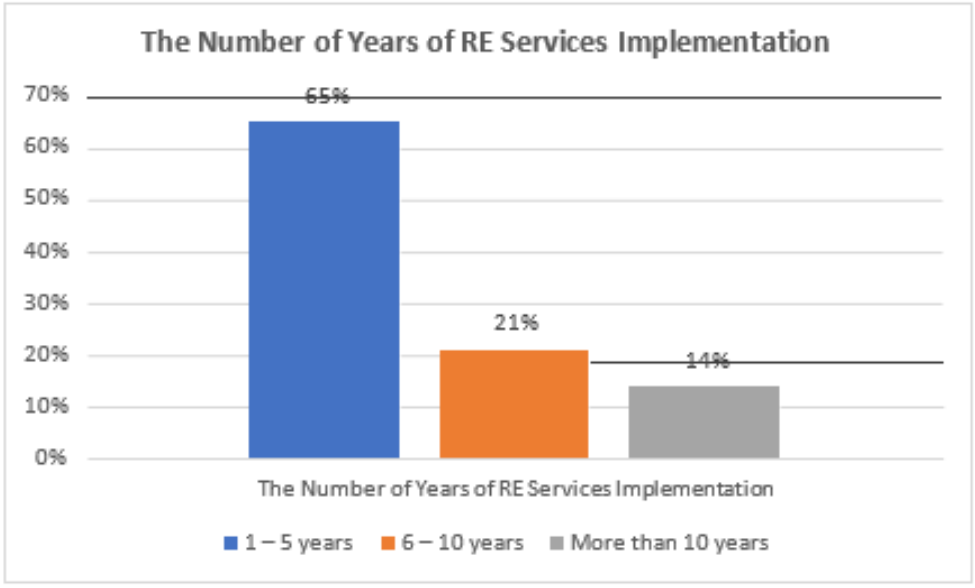

Figure 13 - The Number of Years of RE Services Implementation

With the RE services implementation came various benefits to the organizations/companies. Table 1 shows the advantages that users acquired from implementing and using RE services.

Table 1 – Advantages of Using/Implementing RE Services

Advantages	No response	Not as beneficial asexpected	Beneficial	Very beneficial	Highly beneficial
Reduced Energy Cost	4%	4%	12%	16%	64%
Producing own energy	8%	8%	16%	36%	32%
Available good infrastructures /goodsector management	4%	12%	32%	16%	36%
Ease of maintenance	4%	12%	20%	24%	40%
Reduced carbon footprint	4%	4%	12%	20%	60%
Using clean/renew ableenergy	8%	4%	4%	28%	56%
Increased awarenessof energy usage	4%	4%	20%	24%	48%
Improved organization reputation/pu blicimage	12%	4%	28%	20%	36%

As demonstrated in the previous table, it is clear that the RE users witnessed many advantages from using RE services with the majority of them rating the stated advantages as very beneficial and highly beneficial which is above the average rating.

To further investigate the potential demand in the RE market, the RE users were asked to indicate the RE services they are most likely to implement within the next 5 years. Microgrid presented the majority with 30%, followed by PV and storage 25%, solar cooling system 20%, PV installation building integrated 15% and reuse of treated water 10%.

2.3.3 Segmentation of the potential market between the different type of suppliers

Egypt has a well-established range of companies for PV system design and technology contracting that for a big part are well established in the market for many years. Due to the rising popularity of solar PV systems due to lower costs in the past years, many new companies are now importing solar panels and offering PV designs.

The 1st and only company that plans to manufacture PV panels in Egypt was only recently established (https://www.al-monitor.com/pulse/originals/2021/02/egypt-china-local- manufacture-sand-solar-panels-energy.html). This Egyptian company will produce in a joint venture with a Chinese company solar panels and PV applications for water pumping. The start of the production is expected to be in 2022.

Up to now, more than 90% of all PV panels are imported from China and the rest is imported from Europe. According to Prof. Dr. Sobki, Former Chairman of the New & Renewable Energy Authority in Egypt and Eng. Wael ElNashar, Chairman Onera, the segmentation for PV plants providers in Egypt is manifold, but the majority of players are EPC contractors, who are also project developers and importers of PV technologies. Smaller companies that are focusing on residential applications also work with importers and installation companies. Project and system developers work mainly the contracts with the government on utility scale.

Many of the providers of PV systems relevant for our project are companies that are working in the medium sized segment of a minimum of 50 kw to 2-5 MW, are importers and at the same time EPC contractors as it was also shown from the survey results. According to an estimation by Eng. Wael el Nashaar, around 70% belong to this category. An exact breakdown is not available.

2.4 Overview of the production state in Egypt

2.4.1. Potential market shares covered by existing players

Egypt has a relatively well-established market for suppliers and installers of PV systems. Most of them are officially licensed and accredited by the New and Renewable Energy Authority of Egypt to fulfil a set of criteria in regard to financial and technical capacities. The license is a precondition in order to work with a feed-in-tariff. Apart from the licensed companies, others offer their service to customers without having a license and fulfilling the minimum requirements.

The New and Renewable Energy Authority has issued licenses to the following PV installation companies:

- 20 companies are enlisted and accredited for installing capacities of less than 500 KW.
- 188 companies have been certified for PV projects between 500 kW and 20 MW.

It is estimated, that 40 of the most established players cover around 80% of the market of small and medium sized projects, as stated by Prof. Dr. Sobki (2021). Figure 14 shows the type of RE providers in the Egyptian market according to the survey results.

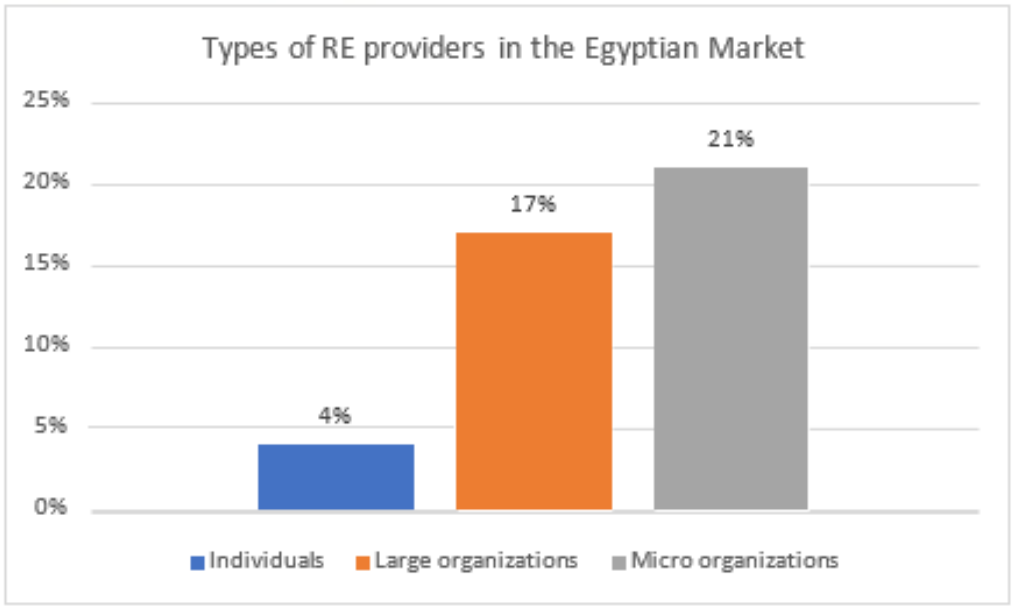

Figure 14 - Types of RE providers in the Egyptian Market

According to the survey conducted for the RE suppliers, the majority of the market sharein the RE services market belongs to the RE installers. The survey results showed that the competition in the RE market is very high and this is due to the high demand on theexamined RE services in Egypt as expressed by 75% of the respondents. Added to the high competition is the high prices of the RE services, 57% of the respondents clearly stated that the RE prices are not affordable. In return, the Return on Assets (ROA) or the provided RE services had split opinions among respondents, with 50% stating that it is rewarding while the other 50% do not agree.

Respondents were also asked to express their opinion on the presence of a guarantee for small producers that their energy would be purchased. As shown in Figure 15 the majority of opinions disagreed, which confirm the strong competition in the market.

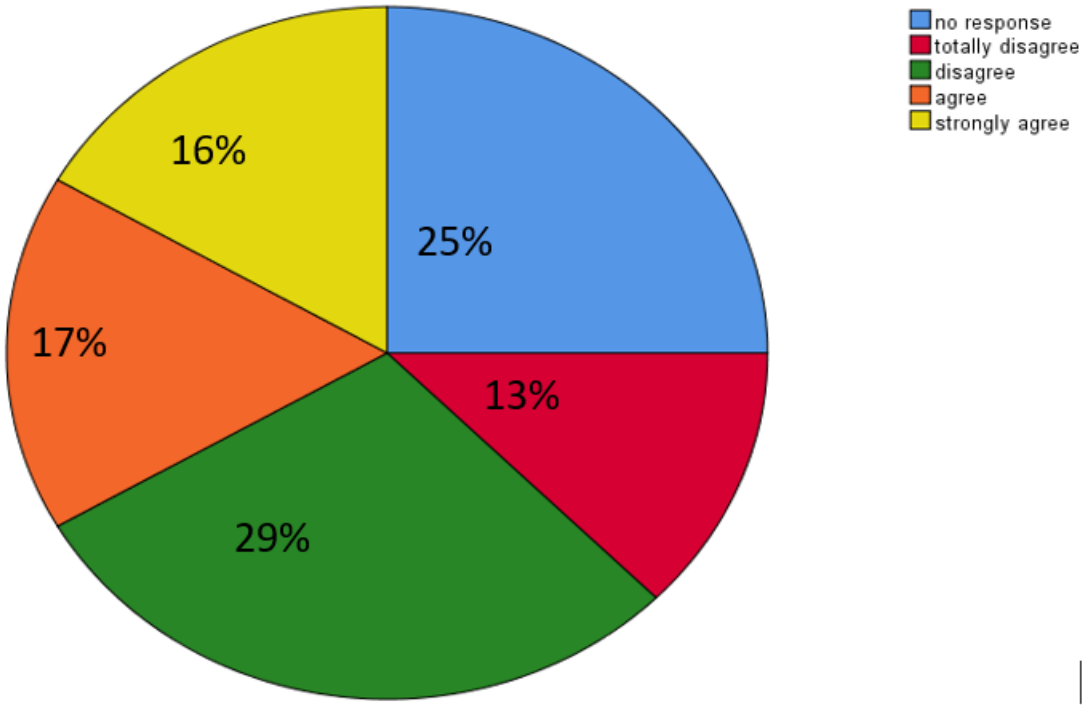

Figure 15 – Small producers energy purchase

Moreover, the RE suppliers were asked if competitive bidding for the production of renewable energy is usually practiced, and the majority of respondents also disagreed.

2.4.2 *Standards and codes of practice*

There are no binding standards for PV technology and its installation. As mentioned above, NREA though has developed a licensing scheme that shall guarantee to the end-consumers and clients the technical and financial capacity of the provider. A proposal has been developed by the EU funded project: “Support to the technical and financial sustainability of the RE and EE sectors in Egypt’ to improve the certification system. This was also shown in the results of the survey when respondents were asked about their opinion on ‘describing the standards and codes of practice for RE services in Egypt’. The majority of respondents (79%) stated that it was not strong nor solid. However, the majority of RE suppliers (67% of respondents) agreed that grid connections are regulated, while 62% disagreed that transmission access is regulated and facilitated.

In order to get more insights into the status of standards and codes of practice in Egypt, the RE suppliers were asked to express their opinions on the statements shown in Table 2.

Table 2– The Status of Standards and Codes of Practice in Egypt

Statement	No response	Totally disagree	Disagree	Agree	Totally agree
Administrative Licensing is simple and speedy	25%	43%	13%	9%	10%
Existing licensing scheme guarantees the technical and financial capacity of the provider	4%	42%	38%	4%	12%
The procedure is complicated for small-scale producers	0%	13%	20%	38%	29%
Building policies in place promotes applying renewable energy, e.g. solar panels on rooftops	8%	17%	33%	37%	5%
Renewable energy equipment characteristics are sufficiently standardized	12%	20%	26%	25%	17%
In general, the administrative framework facilitates small renewable energy producers	8%	29%	38%	21%	4%
There is a renewable portfolio standard in place (i.e. a quota for renewable sources among all electricitysources)	4%	13%	42%	29%	12%

The results shown in Table 2 confirms that the standards and code of practice in Egypt are still underdeveloped. The research team also asked the RE users' opinions on the status of standards of code of practice in Egypt to get a holistic view. The majority of REusers 66% stated that the standards and code of practice is present but need improvement, 22% stated that they are strong and solid, while the remainder was divided between the lack of knowledge 8% and lack of presence 4%.

2.4.3 Level of Research and Technology innovation demand

The technology used for PV systems are imported international technology, that is assembled in Egypt. The majority of PV panels (estimated over 90%, according to Prof. Dr. Mohamed ElSobki) are imported from China. The rest is imported mainly from Europe (Greece, Germany, etc). The mounting systems are produced in Egypt, sometimes also imported from China.

As the PV panels worldwide are exported mainly by China, most research is implemented by Chinese research institutes and universities. The research in Egyptian Universities on PV and solar energy is very limited focusing on increasing the efficiencyof solar/PV panels. This fact was confirmed by the survey results as the majority of respondents (74%) stated that they do not find the technology innovation needed to develop the RE services in national research centres and universities. Moreover, the majority of respondents (58%) expressed that it is highly challenging to find training institutions available to transfer technical skills to workers.

In addition, there is a gap between the number of specialized graduates from Egyptian universities and the market needs. The majority of RE suppliers indicated that it is somewhat challenging to find the specialized graduates who would meet the RE market size. As for the easy access to the technical expertise by small producers who wants to start generating RE services, the majority of the RE suppliers (38%) were neutral.

Furthermore, the RE users were asked to express their opinions on the state of research and technology innovation in Egypt. The results show that 48% of the respondents stated that there is a significant development in the RE services technologies in Egypt, in addition to the easy access to information on new RE technologies, and the availability of local experts in RE technologies to provide consultations. The RE users also pointed that public and private events are frequently organized in Egypt to promote RE services/technologies which proved to be beneficial. Moreover, 77% of the RE users indicated that there are training programs available locally/regionally to train their technical staff on RE services implementation/maintenance.

There is no clear estimation for the potential of the selected RE services. The government has set a target of 300 MW of small-scale solar under its FIT program, but quantified targets for distributed solar at both a national level and within certain key sectors, such as agriculture or tourism, have not been developed yet.

As described above the expected number of replicabilities for our pilot project might exceed 1000 replications with a total capacity estimated to exceed 100 MW.

2.5 Distribution and marketing methods

2.5.1 Channels of distribution

The PV systems are usually directed sold and installed by EPC contractors, that offer design, engineering, procurement and installation. For smaller PV systems, there is also importers that sell PV technology to EPCs. (Interview with Prof. Dr. Hend Farouh). The RE suppliers' respondents stated that they directly distribute the RES to the final client and work with a list of accredited local installers.

The distribution mainly is organized through the main company. Most companies do nothave branches in other cities than Cairo or Alexandria. Bigger companies work with sales representatives in all governorates of the country. The RE suppliers' respondents statedthat if they were direct importers, they sell directly to EPC contractors.

2.5.2 Marketing methods

Providers of small and medium sized PV solutions mostly tackle the commercial and industrial markets through direct sales to possible clients for (eg. governmental hospitals etc.). Residential sector/private households are nowadays mostly reached by Social Media channels, where Facebook plays a major role. The major companies in the sectoralso participate in Egypt's main energy exhibition Egypt-Energy (former Electric exhibition) but the participation is mainly used for branding purpose and sales results are rather low (Interviews with private sector).

Provider of micro-PV solutions, which are often young entrepreneurs, advertise their services mostly in social media. Their clients are households living in compounds aroundCairo and Alexandria.

In order to get more insights into the status of marketing and awareness of RE services in Egypt, the RE suppliers' respondents were asked to express their opinions in the statements shown in Table 3.

Table 3 – The Status of Marketing and Awareness of RE services in Egypt

Statement	No response	Totally disagree	Disagree	Agree	Totally Agree
There are enough marketing campaigns promoting the production of renewable energy by small producers and citizens	12%	41%	28%	16%	3%
Newspapers and press reflect the essential role of renewable energy to public	24%	32%	24%	15%	5%
Media reflects a political willingness that supports green renewable energy usage	12%	33%	20%	29%	6%
Keeping clean environment for coming generations is a responsibility of each one of the citizens	8%	12%	21%	14%	45%

As it is clear from Table 3, the status of RE services marketing and awareness in Egypt isnot strong. The media, in addition to the main stakeholders have a vital role to play in the promotion of green energy.

To get a complete view of the RE services marketing and awareness, the research teamasked the RE users about how they learned about the technology sold by the RE serviceprovider. The majority of RE users 48% learned about the technology through direct sales, followed by exhibition events 31% and social media 21%.

2.6 Incentive and financing methods

2.6.1 Incentives

The following laws and regulations determine the framework for private sector investment in renewable energy in Egypt:

The Renewable Energy Law 203 from the year 2014 identifies the mechanism for developing renewable energy projects in Egypt: competitive bidding for stated-owned projects, competitive bidding for BOO contracts, the feed-in tariff and a IPPA scheme for bilateral contracts to sell power directly to consumers (Wheeling and grid-access charges to be paid to grid operator).
Electricity Law no 87/2015 and its executive regulations from 2016 encourage the generation of electricity from renewable energy sources as well as energy efficiency measures and the rule of independence of the sectors for generation, distribution and transmission of electricity with the target of a levelled and competitive electricity marketA Prime Minister Decree from 2019 fixes the feed-in-tariff for electricity generation from biomass. In a circular from 2020, the Egyptian Electricity and Consumer Protection Regulatory Authority limited the metering systems for the solar power generation.

The general framework for electricity production from renewable energies has been characterized by legislations with many characteristics and challenges, among which:

1. The possibility of simultaneous application of a number of modern and old implementation mechanisms. Egypt has adopted several mechanisms to encourage the establishment of electricity production plants from renewable energies in various capacities of small, medium and large; those mechanisms are:

    - Competitive bidding / bidding
    - Design, Supply and Implementation (EPC + Financing)
    - Build, Ownership and Operation (BOO)
    - Independent producers and direct bilateral contracts (IPP)

- Feeding tariff for different project sizes (FiT)
- Mandatory ratios (quota).
- Net metering

2. The participation of many entities representing several government agencies (New & Renewable Energy Authority, Egyptian Electric Utility and Consumer Protection Regulatory Agency, Electricity Holding Company etc) and the private sector at levels of production and use. This highlights, in a way, a positive approach, yet might cause confusion.
3. The need to prepare more organizing documents that reflect the relationships between the various parties in terms of funding, contractual, technical and commercial. Furthermore, these documents should take into consideration any of the technical and commercial limitations and requirements.
4. Different costs and price signals for providing electricity through renewable energies, from the national, regional and global markets according to: Type of source/location, timing of application, and cost of funding. The prices for providing electricity from RE sources over the last ten years are different due to:
    - Type of detailed technology intended to be used and the capacity size of the project.
    - The scheme under which the application is planned to be carried on under (FiT, IPP, EPC, Boo); and under which market conditions such as standalone or grid connected as well as its intended type of use, self-consumption or feeding the grid or using the grid for wheeling.
    - The region where the application is taking place, hence the condition of financing differs from countries with high financial risk to countries with low financial risks.
    - Furthermore, the level of state involvement and guarantees.

Just as an example of the above was in 2014 & 2016 when Egypt announced its FiT for rounds one and two at values 0,142 & 0,087 US $ cents per kWh , there were other projects in the Gulf and south America areas at the range of 0,05 US $ cents per kWh under different schemes such as BOO and IPP. Clear explanations of these differences could have been better explained to the media as well as the public.

5. The prevailing tariff which reflects the average cost (weighted average) of all traditionaland renewable sources without distinction. In this regard, the details for average cost ofelectricity (weighted average) are not yet publicly announced as the activities to reach cost reflective tariff, even-though well announced, is still going on. It is planned to reachthese cost reflective tariffs by year 2025. On the other hand, tariffs to be applied up toyear 2024/2025 are announced. Figure 16 shows a summary of the development of theaverage tariffs and the average cost of electricity.

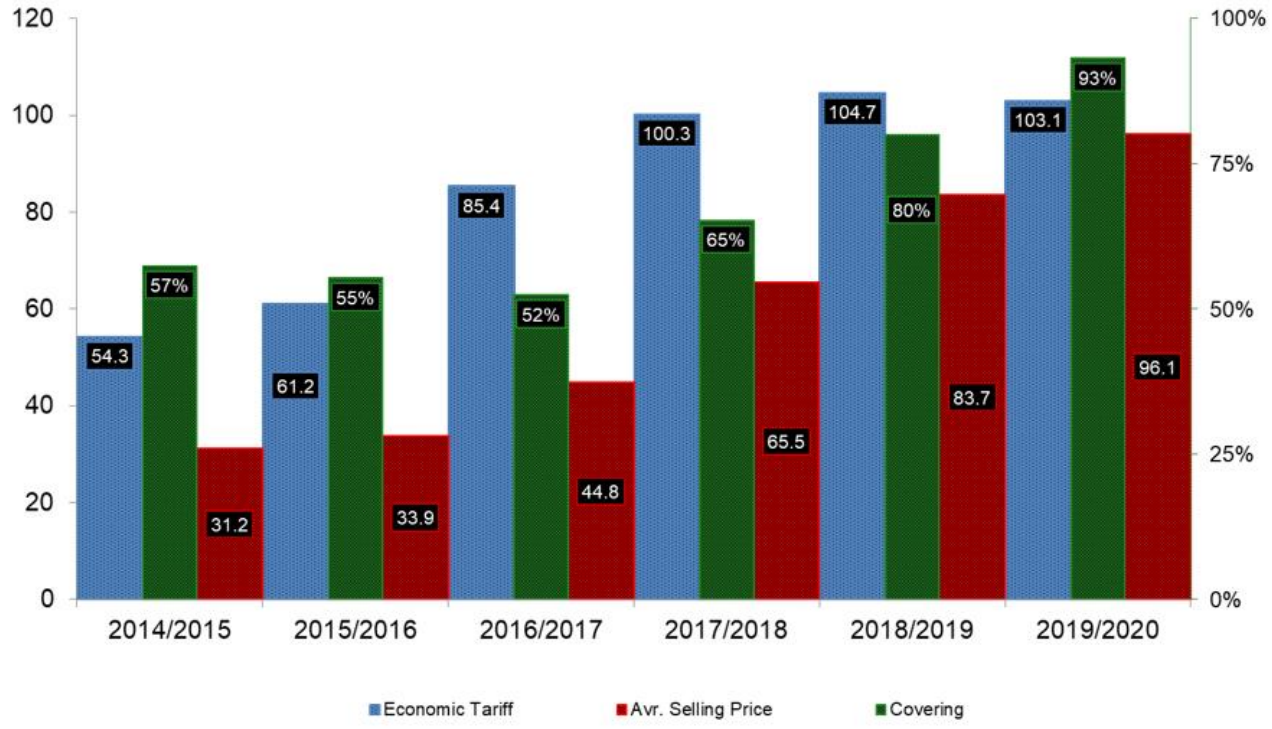

Figure 16 – Development of the Average Tariffs and the Average Cost of Electricity in Egypt

6. Coordination with the gradual change of the rules of the electricity market in accordancewith the provisions of the Electricity Law, especially with regard to the transition from the single buyer's model to a competitive market in which direct bilateral relations between users and producers prevails. Where also, the exchange of electricity is done through the transmission or distribution networks against a tariff determined by the electricity regulatory agency (wheeling charges).

In light of the above, it is clear that what is being applied so far to produce electricity through the use of renewable energies available in Egypt from wind and sun, although not very little, is a partial application of the existing mechanisms stipulated in the legislation (primarily law number 203/2014) which:

- Encourages and pushes for electricity production activities from renewable energies and places an obligation on electricity utilities to buy or exchange electrical energy, althoughthis is applied in many countries, but electricity utilities in Egypt are yet not used to that.
- Do not directly push for the use of renewable energies and do not place any obligation or incentive on the end user to do so.

In order to get more insights on the incentives and financing issues from the market, the REsuppliers' respondents expressed their opinions in the statement shown in Table 17.

Table 17 – The Status of RE Incentives and Financing Methods

Statement	No Response	Totally Disagree	Disagree	Agree	Totally Agree
National subsidies and grants are available for investments in renewable energy production, particularly to small renewable energy producers and citizens	8%	45%	17%	12%	17%
Credit at low interest rates is readily available to support renewable energy production, particularly to energy producers and citizens	16%	33%	29%	9%	13%
There exists a clear information on financial support	12%	45%	25%	10%	8%
Tax reliefs are offered to smallrenewable energy producers	20%	50%	16%	5%	8%

As it is shown in the previous table, incentives and financing methods for RE services in Egyptare not as developed as it should be. The majority of respondents expressed the lack of national subsidies and grants for RE services, lack of low interest credits, lack of tax reliefs to small RE producers in addition to the unclear information on financial support.

Net metering scheme

In order to promote small scale PV projects, the Egyptian government introduced in 2014 the net-metering system (Renewable Energy Law 203) that targets residential, commercial and industrial PV projects between 5 and 20 MW to feed electricity into the grid.

The generated electricity is credited against the consumers' electricity bill crediting surplus electricity into the consumers into the highest tariff bracket. Consumers participating in thenet-metering scheme receive a compensation in EGP against any excess electricity fed intothe grid.

But in 2020, the regulator introduced new restrictions for small scale PV projects with net- metering scheme:
The energy-generating facility must be located within the premises of the electricity consumer. The total capacity of the net metering solar project must not exceed 1.5% of thepeak load of the distribution's companies registered during the financial year preceding thecontract. The installed capacity of the individual net-metering facility must not exceed the maximum load of the consumer during the year preceding the commercial operation date of the facility. The new regulation also introduced a balancing charge.

The RE users were asked to indicate the incentives provided to encourage the implementation of RE services. Table 4 shows the rank of the incentives offered.

Table 4 – Incentives offered to RE users

Rank	Incentive
1	Grants
2	Corporate income tax incentive
3	Sales or value added tax incentive
4	Green banks
5	Property tax incentive
6	Rebates
7	Subsidized traditional revolving loan
8	Mortgage related loan

The most popular incentive used by RE users are grants, followed by corporate income tax incentive and sales or value added tax incentive.

New Investment Law

The new investment law in no 72/2017 grants new RE projects a 30% deduction of the taxable profits for the first seven years of the project, subject to certain conditions. The newlaw also provides a flat rate of 2% customs duties for all equipment and machinery neededfor the project.

2.6.2 Financing methods

Small scale PV systems are usually financed by commercial loans. This was shown in the results of the RE users surveys, where the majority 73% indicated that the financing methodavailable is through loans by local and international banks. Some local banks have established, supported by international donor finance institutions, funds dedicated tosupport small scale RE projects. Also some IFIs have developed finance mechanism for smalland medium scale RE projects such as:
http://ebsomed.eu/sites/default/files/MEDA%20Finance%20survey%202019.pdf

a. Egypt PV

The Egypt PV project is funded by the Global Environment Facility (GEF), the United Nations Development Programme (UNDP), the Industrial Modernization Center (IMC) and the Ministry of Industry in Egypt and offers financial support for PV technology for industrial projects, residential, commercial and public buildings. Commercial customerscan receive technical support of up to 500 kW with a maximum of 25% financialcontribution, tapped at 20 000 US$.

For more information please visit: https://egypt-pv.org/?lang=en

b. The Green Economy Financing Facility GEFF

GEFF provides attractive finance for your investment in green technologies and solutions through local participating financial institutions. The usual financing criteria and assessment process of the participating financial institutions are applied.

Maximum financing amounts

- up to €253,000 for small and a clearly defined projects that comprise high-performing equipment and materials.
- up to € 4.2 million for larger energy efficiency and renewable energy projects (of up to

  € 12.7 million investment size), where GEFF team can provide advice
- up to € 3.8 million (or up to 30% of eligible construction costs) for commercial building construction projects that meet high standards of energy performance, quality and health and safety standards
- Up to € 1.7 million for supply chain development for energy efficient or renewable energy technologies to help meet growing demand.

c. Eco FEI

The Financial Support Program for industrial facilities offered by the Federation of Egyptian industries grants soft loans through its Revolving Fund. The fund is operated bygranting loans to businesses which, then, pay the loan back into the fund. This enables the fund to grant new loans to new businesses, which explains the name: the RevolvingFund.

ECO provides access to soft loans for funding new industrial equipment serving Environmental Compliance application and energy saving. Loan amounts could reach €
372.000 per enterprise carrying a 3.5% annual interest rate with one-year grace period

and a repayment period of up to five years. The loans can be obtained through theNational Bank of Egypt (NBE) or other cooperating banks.
Eligibility Criteria

a. Membership of the Federation of Egyptian Industries.

b. Facilities subordinate to the following industrial sectors: Engineering, metallurgy, food, textile, readymade garments, chemicals, leather products, leather tanning, wood products, furniture, building materials, printing and packaging, pharmaceuticals, finally, seeds and their products.

c. A private sector facility.

d. Small and medium industrial facilities.

e. Willingness to address sustainable development issues.

f. Creditworthiness

Funding Structure

The funding structure of the project and the value of the funding support shall be asdescribed in Table 5.

Table 5 – Value of Funding Support

Investment value	Owner's share	Loan value
More than 26,600 € up to 106,000 €.	10%	90%
More than 106,000 €. up to 266,000 €.	20%	80%
More than 266,000 €. up to 532,000 €.	30%	70%

Large RE projects are mostly financed through loans by international finance institutions, or through grants for projects managed by NREA. Only few large projects are financed by loans from local commercial banks, as most of the technology is imported with foreign currency, which local banks are not allowed to provide, if the profits generated are not in foreign currency.

2.7 Challenges identification for the sector

To understand the possible barriers that exist in the RE sector, the research team investigated the administrative, economic and technical challenges that the RE suppliers face in the Egyptian market. Table 6 shows the administrative challenges faced by RE suppliers' respondents in Egypt. The challenges are ranked according to their importance whereas 1 is the highest rank.

Table 6 – Administrative Challenges in Egypt

Rank	Challenge
1	Excessive bureaucracy and slowness administrative procedures
2	New eco-green local fees/ tariffs affecting providers and finalclients (fiscal disincentives)
3	Net metering issues
4	Regulatory and market issues
5	Restrictions on foreign RE technologies purchases in dollars

As it is shown in Table 6, the most popular challenge in the RE services sector in Egypt isthe excessive bureaucracy and slowness of administrative procedures. Table 7 shows the economic challenges according to the RE suppliers' respondents.

Table 7 – The Economic Challenges in Egypt

Rank	Challenge
1	Funding
2	The high cost of building from scratch
3	The cost of upgrading legacy equipment and infrastructure foroperation
4	The high cost of components
5	Difficulty in quantifying the benefits
6	Maintenance

As it is shown in Table 7, the highest economic challenge is funding. RE projects have a high cost of capital, and with the lack of financing schemes that would encourage investors, funding will still remain a big challenge. In fact, the majority of the economic challenges are actually cost/capital related which proves the need for competitivefinancing schemes. Table 8 shows the technical challenges that RE suppliers face in the Egyptian market.

Table 8 – The Technical Challenges in Egypt

Rank	Challenge
1	Technology immaturity
2	Addressing complex energy imbalances to ensure optimal control
3	Islanded micro grid protection
4	Systems adaptation to current real-time network demands and interfaces
5	Ensuring cybersecurity needs
6	Upgrading legacy generator controls

As shown in Table 8, the highest technical challenge is technology immaturity, and this could be due to the fact that the RE related technology is not manufactured locally and there is a high reliance on imported materials, in addition to the lack of technical innovation by local universities and research centres as it was shown in the previous sections of the study.

To provide a complete view of the challenges in the RE market, the RE users who represents the demand side were asked to indicate the challenges they might face in implementing/using the RE services. Table 9 presents these challenges.

Table 9 – RE Users Challenges to Implement/Use the RE Services in Egypt

Challenge	Not challenging	Somewhat challenging	Neutral	Very challenging	Highly challenging
High upfront costs	7%	15%	15%	30%	33%
Unclear payback time/ROI	5%	7%	40%	26%	22%
Roof and establishment need repairs/update	10%	14%	30%	33%	13%
Complicated program offerings	4%	7%	41%	33%	15%
Systems integration (with grids)	18%	16%	26%	30%	10%
Finding a contractor	12%	15%	48%	15%	10%
Replacing inefficient systemswill be expensive	9%	10%	22%	44%	15%

2.8 Future prospects

It is important in this study to investigate the future prospects for the RE services marketin Egypt. From the RE suppliers' perspectives, they indicated the sectors which are morelikely to implement the RE services provided. Table 10 shows the sectors.

Table 10 - Sectors more Likely to Implement RE Services in Egypt

Rank	Sectors
1	Factories
2	Schools and Universities
3	Municipalities
4	Hospitals
5	Ministries

The projection of future demand for the RE services is shown in Figure 18. The majorityof RE suppliers stated that there is a high projection for future demand for RE services in the future.

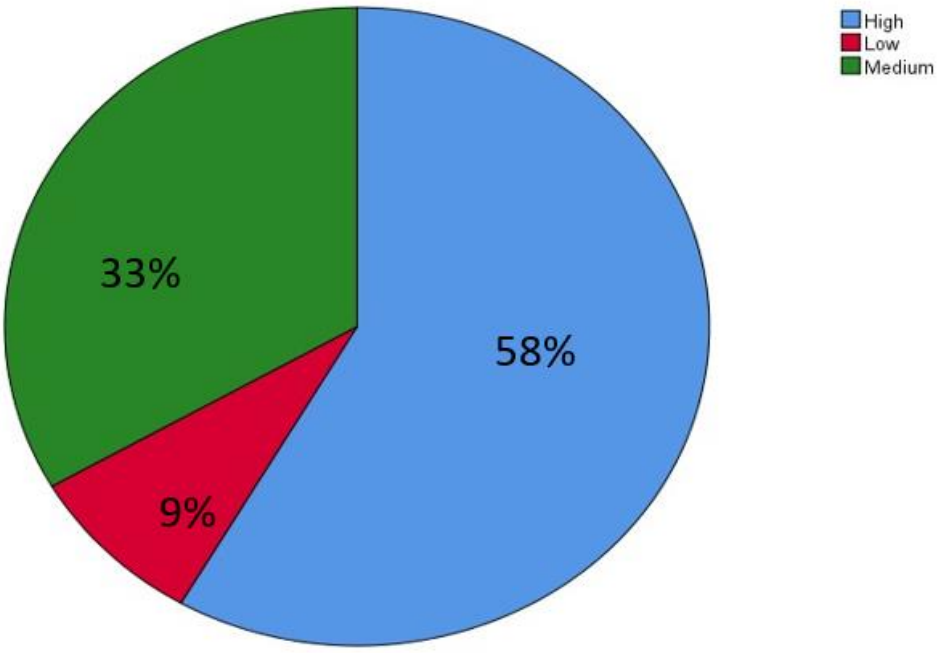

Figure 18 – The Projection for Future RE Demand in Egypt

Lastly, the RE suppliers were asked to indicate the areas which are highly in need for theRE services installations in Figure 19.

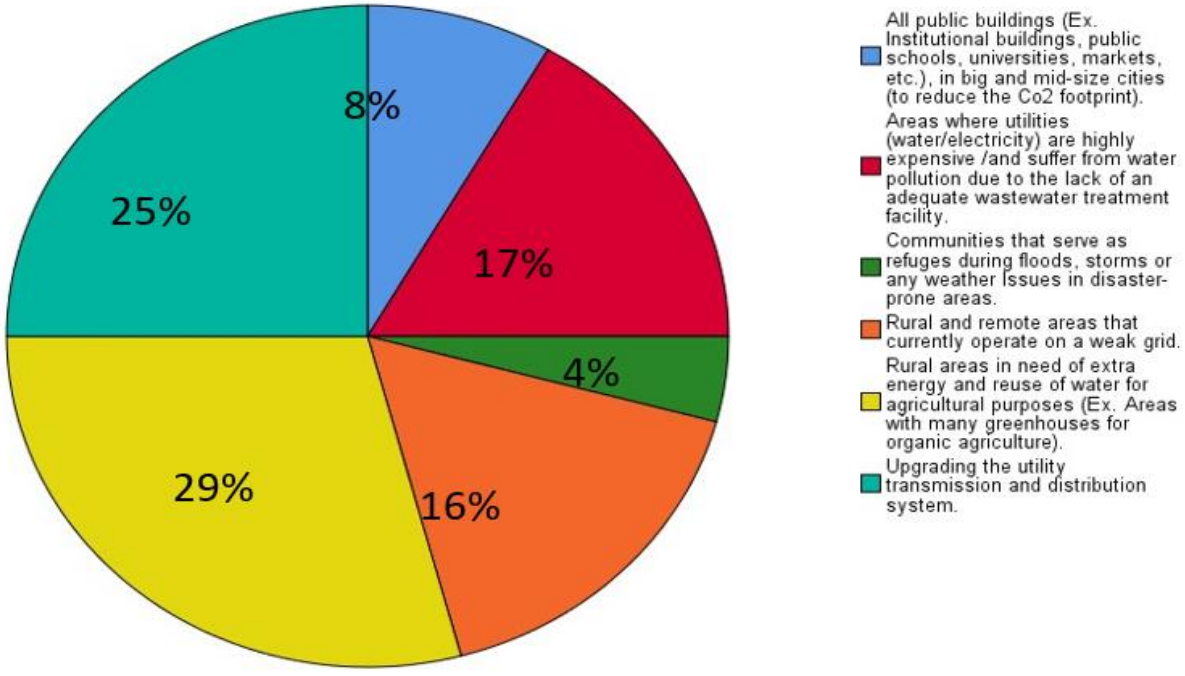

Figure 19 – Areas Highly in Need for RE Installations in Egypt

The RE suppliers indicated that the organic agricultural areas with greenhouses is the area with the high need for RE installation followed by transmission and distribution systems (eg for the telecommunication sector), and areas where utilities are highly expensive.

The RE users were also asked about the extent of importance of the type of information or assistance needed to make decisions regarding the use of RE services. Table 11 showsthe results.

Table 11 – Information Needed to Make Decisions on the Use of RE services in Egypt

Information	Not important at all	Somewhat important	Neutral	Important	Highly Important
Real cost estimates	3%	4%	41%	37%	15%
Ability to talk with people whohave installed solar	2%	11%	37%	30%	20%
System performance guarantees	2%	3%	25%	37%	33%
Contractor reviews	7%	7%	15%	51%	20%
Contractors' recommendations	6%	2%	22%	40%	30%
Referrals to solar loan providers	7%	12%	22%	33%	26%
Visit installation site to see asystem operating in real settings	11%	5%	21%	37%	26%

To increase the efficiency and speed of achieving the target of the contribution ofrenewable energy in the production of electricity to reach the target of 20% by 2022 and42% by 2035, some legislation can be further activated on an urgent basis in addition to what is currently being implemented and follow any of the following:

- Promoting renewable energies applications as the only available or allowed form of applications for example pumping water for agricultural projects, especially in areas away from the electrical grid.
- Commitment to some environmental objectives through the use of electricity produced from renewable energies.
- Activating the commitment to obtain electricity through renewable energies through mandatory percentages in the energy mix supplied to the activity which gradually increase for some or all activities (quota schemes).

The above schemes/mechanism can be classified as a pull mechanism and are complementary to the push mechanisms currently in use. The adoption of these mechanisms will directly increase the growth rate of the use of renewable energies for the production of electricity. Furthermore, this scheme can put a clear commitment onthe end user of electricity, which can either directly contribute to the productionprocesses or to pay investment in this direction and activate the mechanism of direct agreements between producers and users. This can, in accordance with the provisions of the Electricity Law of 2015 (number 87, July 2015) move the electricity market to a competitive form and is in the interests of all parties, starting from the suppliers of the service (producers, carriers and distributors) to the electricity users. It needs to be supported by the commitment of carriers and distributors to allow their networks to pump electricity produced from renewable energies to end users. Implementation of a percentage quota equal to 3% to 5% in the industrial sector would lead to about 7 to 10 GW capacity and 27% to 40% contribution of renewable energies in nine years.

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Cooperating across borders in the Mediterranean
Project funded by the EUROPEAN UNION
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REGIONE AUTONOMA DELLA SARDEGNA
MAIA-TAQA

JORDAN

3. Jordan

3.1 Introduction

The Jordanian government have set a target to obtain 1,800 MWs, or 10% of the country's energy supply, from renewable sources by theyear 2020. According to the Energy Strategy, about 1,200 MWs will come from wind energy, 600 megawatts from solar power, and between 30 and 50 MWs from waste-to- energy facilities The updated Master Strategy for the Energy Sector 2020-2030, calls for a sustainable future energy supply, diversification of the national energy mix and increased dependency on domestic energy resources. The strategy targets a 31% share for renewables in total power generation capacity and 14% of the total energy mix by 2030. PV is the predominant RE system second by wind energy, the PV systems installed is threefold the wind energy as it will be shown in later sections. The fast progress of PV and wind was coupled with the slow pace of other RE like geothermal and solar thermal cooling. It is important to demonstrate the benefits of these slow paced RE systems specially the Solar thermal cooling in this project. The implementation of this project will play an important role in increasing the visibility of these systems and will contribute to a better spread of this system especially Solar Thermal Cooling systems.

Aqaba is a Jordanian port city on the Red Sea's Gulf of Aqaba, located at the south of the Kingdom, inhabited since 4000 B.C., it is home to the Islamic-era Aqaba Fort. Its beach resorts are popular for windsurfing and other water sports, and the area is a top destination for scuba divers, with notable dive sites. The elevation is 6 meters, its area is 375 km², with a temperature of 28°C, Wind N at 23 km/h, 59% Humidity and the population of the pilot location is 200,000.

Jordan is among the highest in the world in dependency on foreign energy sources, with 96% of the country's energy needs coming from imported oil and natural gas from neighboring Middle East countries. This complete reliance on foreign oil imports consumes a significant amount of Jordan's GDP. This led the country to plan investments of $15 billion in renewable and nuclear energy. To further address these problems, the National Energy Strategy for 2007-2020 was created which projects to boost reliance on domestic energy sources from 4 percent to 40 percent by the end of the decade.

Natural gas is increasingly being used to fulfil the country's domestic energy needs, especially with regard to electricity generation. Jordan was estimated to have only modest natural gas reserves (about 6 billion cubic meters in 2002), but new estimates suggest a much higher total. In 2017 the country produced and consumed an estimated 3.6 BCF (Billion Cubic Feet) of natural gas, while in 2020 the figure become 5.3 BCF. The primary source is located in the eastern portion of the country at the Risha gas field. (Ministry of Energy and mineral resources 2021)

In the past, the country imported the bulk of its natural gas via the Arab Gas Pipeline that stretches from the Al Arish terminal in Egypt underwater to Al Aqaba and then to northern Jordan, where it links to two major power stations. This Egypt–Jordan pipeline supplied Jordan with approximately 1 billion cubic meters (BCM) of natural gas per year. Jordan has developed one gas field, at Risha in the eastern desert near the border with Iraq. The current output of around 30 million cubic feet (850 thousand cubic meters) per day from the Risha field is used to fuel one nearby power plant, which generates about 10% of Jordan's electricity.

Oil shale represents a significant potential resource in Jordan. Oil shale deposits underliemore than 60% of Jordanian territory and are estimated at 40 to 70 billion tonnes of oil shale. The deposits include a high quality marinate oil shale of Late Cretaceous to early Tertiary age. The most important and investigated deposits are located in west-central Jordan, where they occur at the surface and close to developed infrastructure.

Although oil shale was utilized in northern Jordan prior to and during World War I, intensive exploration and studies of Jordan's oil shale resource potential started in the 1970s and 1980s, being motivated by higher oil prices, modern technology and better economic potential. As of 2011, no oil shale industry exists in Jordan, but several companies are considering both shale oil extraction and oil shale combustion for thermalpower generation. Till the time of this report the oil shale production used for power generation is still not realized.

Jordan lies within the solar belt of the world with average solar radiation ranging between 5 and 7 kilowatt-hour (kWh) per square meter. Decentralized generation from photovoltaic systems in rural and remote villages is currently used for lighting, water pumping and other social services of up to 1000 kW of peak capacity. In addition, about 15% of all households are equipped with solar water heating systems. In May 2012, a 280 kW solar electricity system was inaugurated to be used at El Hassan Science City.

As per the Energy Master Plan, 30 percent of all households are expected to be equippedwith solar water heating system by the year 2020. The government is hoping to constructthe first concentrated solar power (CSP) demonstration project in the short to medium term and is considering Aqaba and the south-eastern region for this purpose. It is also planning to have solar desalination plant. According to the national strategy the planned

installed capacity will amount to 300–600 MW consisting of CSP, PV and hybrid systems by 2020.

Several projects with a total capacity of 400 MW were already allocated in two 200-megawatt tender rounds. First Solar signed a Build-Operate-Maintain contract with the Jordanian government for the 52.5 MW Shams Ma'an Solar PV power plant, with a 20- year power purchase agreement (PPA). Figures 21, 22 and 23 below show the RE capacityand generation by source in the period 2014-2019.

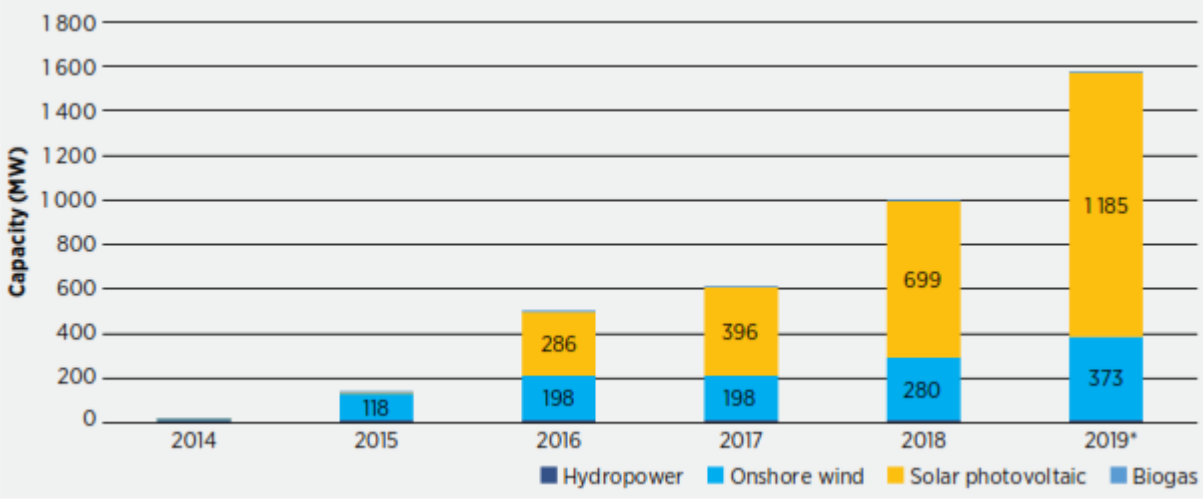

Figure 21 - Renewable energy Capacity by Source (2014- 2019)

Source: IRENA (2021), Renewable Readiness Assessment: The Hashemite Kingdom of Jordan

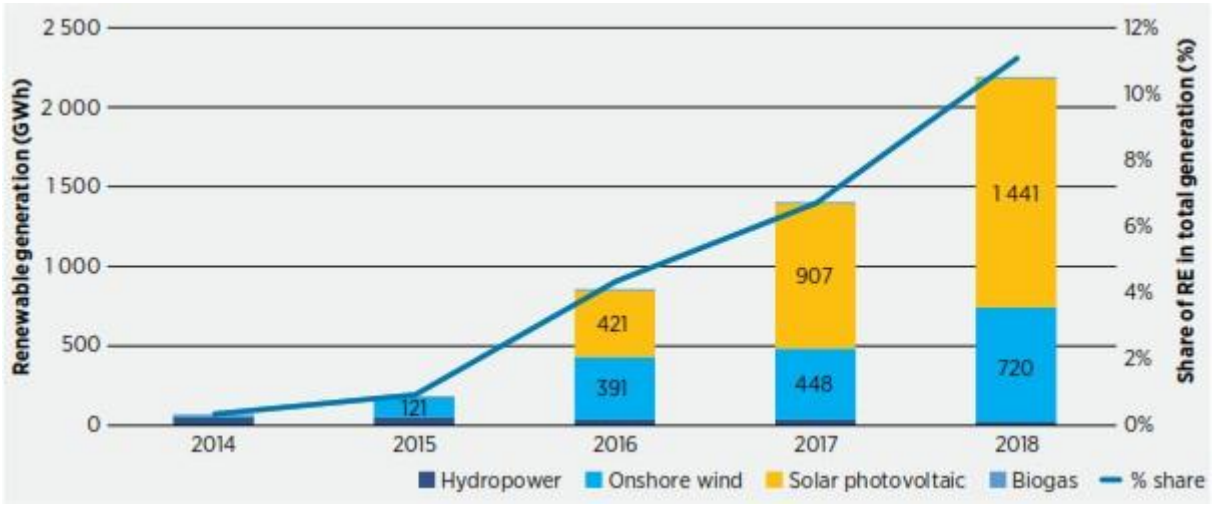

Figure 22 - Renewable energy generation by source (2014-2019)

Source: IRENA (2021), Renewable Readiness Assessment: The Hashemite Kingdom of Jordan

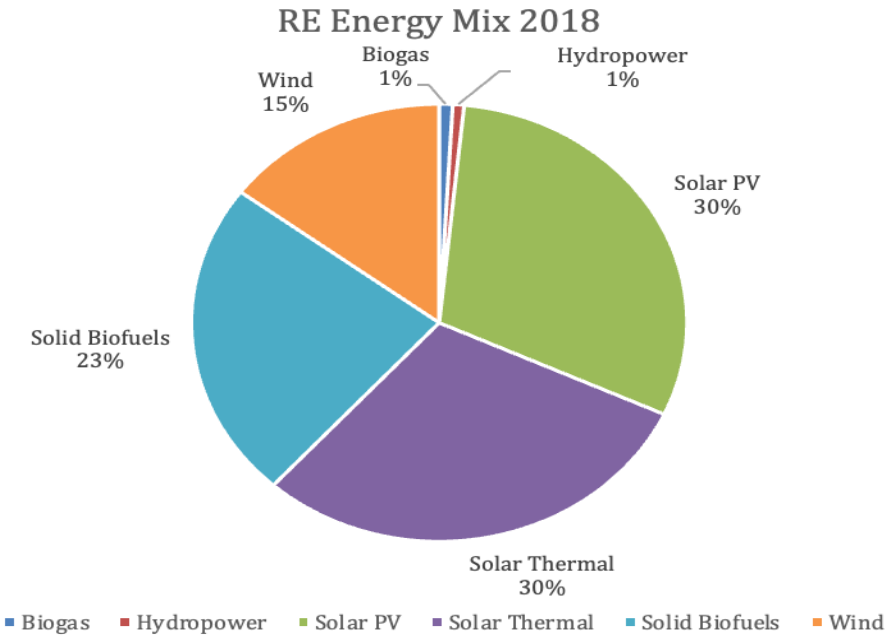

Figure 23 - RE Energy Mix, Jordan 2018, IRENA

3.2 MAIA- TAQA pilot in Jordan: Solar Cooling Systems and PV Installation Building Integrated in Aqaba

The PV systems in Jordan are rapidly spreading. PV are perceived as reliable, cost effective and efficient. At the same time the local infrastructure of the power grid is ready and technical aspects of introducing PV systems is well understood. The national laws, bylaws and regulations and technical specification and requirement for PV systems are in place and thus PV systems are the right choice for Jordan. On the other hand, the selection of Solar Cooling System has been made. This kind of RE solution is very new to Jordan. In an arid country like Jordan, the current use of air conditioning based on PV and high efficiency AC units is starting to increase in adoption in the local market. Grid Connected Solar BIPV (Building Integrated Photovoltaic solar system) in the façade of Jordan Chamber of Commerce building at the southeast and southwest elevations is planned to be installed. This will be an important introduction of BIPV as it is rarely implemented in Jordan and having such system in a public building like JOCC will spread awareness and information about BIPV. With ample sun available and roof space rarely being a limitation the adoption of the more expensive and less efficiency BIPB technology would make less sense for Jordan. On the other hand, direct Solar Cooling System is not well known and many are suspicious about its feasibility. Thus, having a pilot project will show case a good example of using Solar Cooling System and results will be disseminated on the national level.

3.3 Market situation

To understand the market situation in Jordan, the research team conducted desk research, interviews, and surveys with expertise in order to provide a holistic view of the market situation for RE services in Jordan. The research team designed two surveys; one to assess the demand for the RE services in Jordan (20 respondents) and the other one for the RE supply market (18 respondents). The surveys targeted decision makers and top management levels as demonstrated in Figure 24.

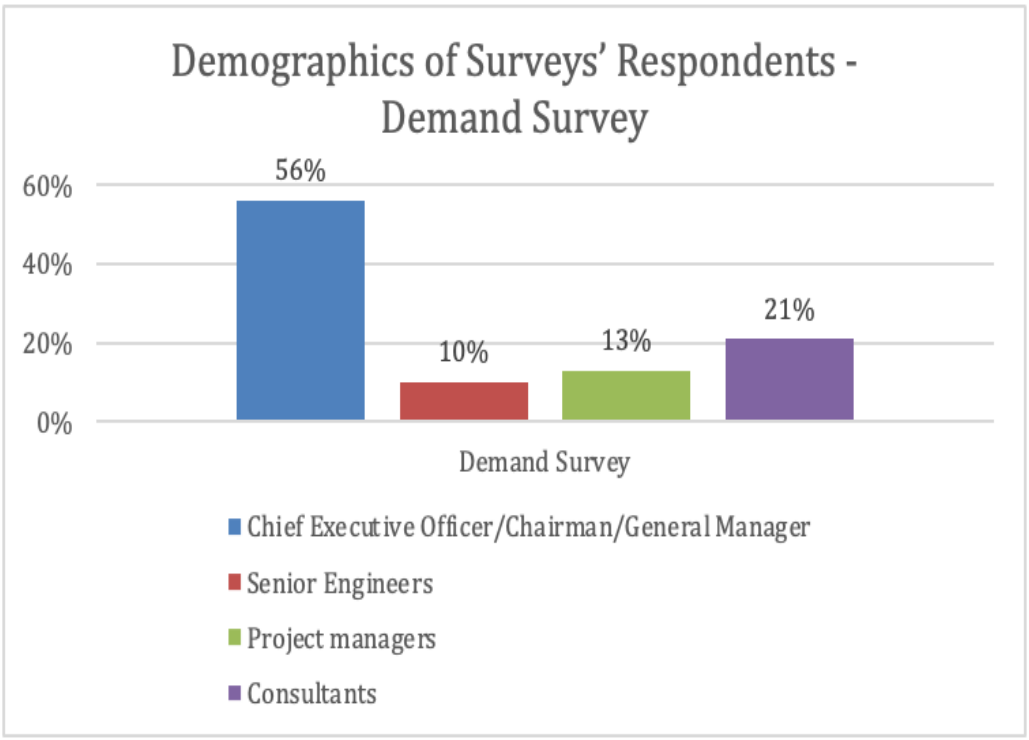

Figure 24 – Demographics of Surveys' Respondents - Demand Survey

The majority for the respondents in both surveys belonged to the private sector with the exception of only 7 entities in the demand survey representing the public sector in Jordan. For the demand survey, 80% of the respondents represented local companies/organizations while the remaining 20% represented international companies. For the supply survey, 94% of the respondents were local companies and 6% presented international companies. Figures 25 and 26 show the types of organizations/companies of the respondents, and Figure 27 and 28 show the years of experience in supplying/implementing RE services.

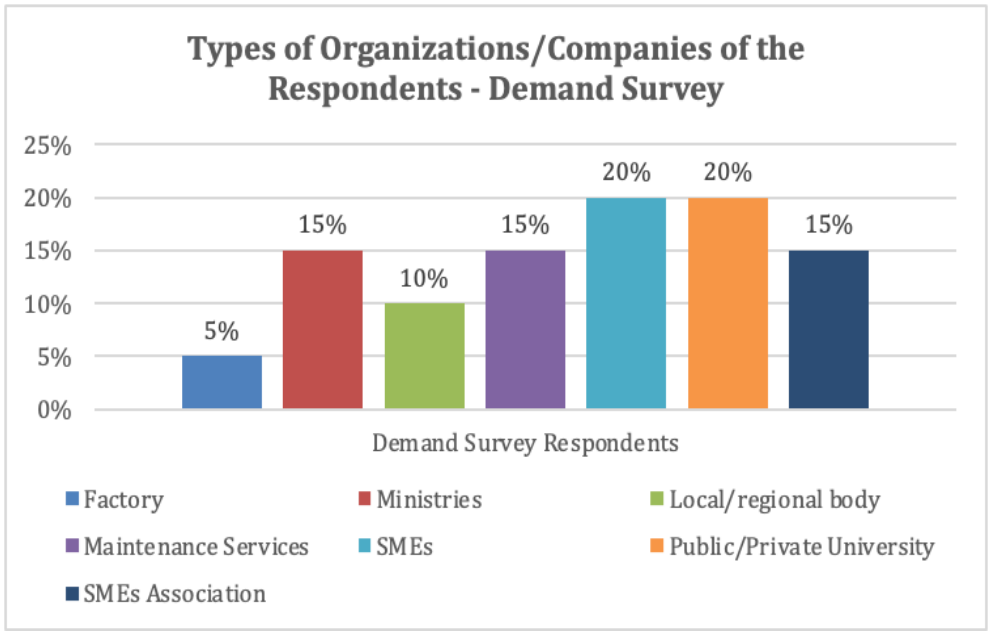

Figure 25 – Types of Organizations/Companies of the Respondents - Demand Survey

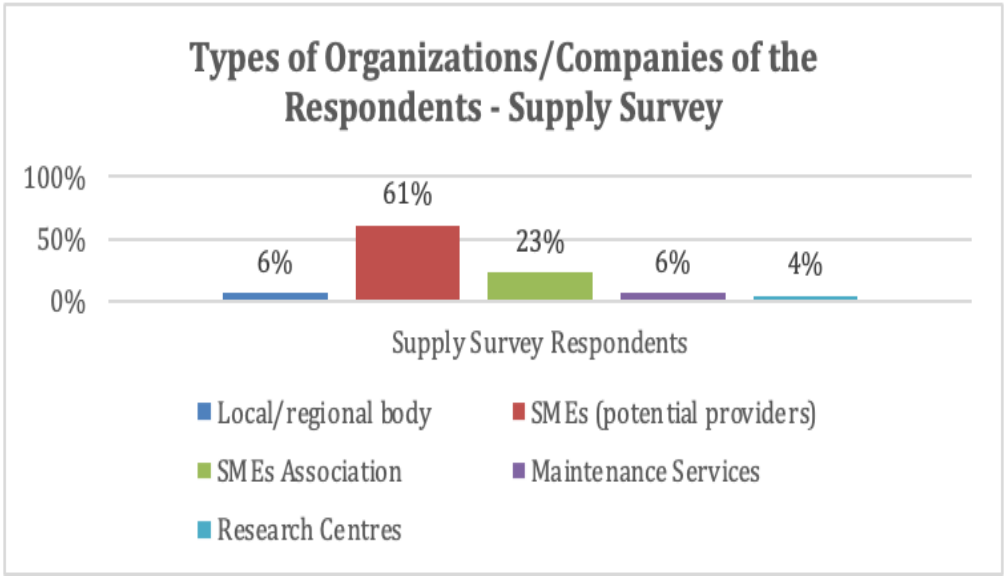

Figure 26 – Types of Organizations/Companies of the Respondents –Supply Survey Jordan

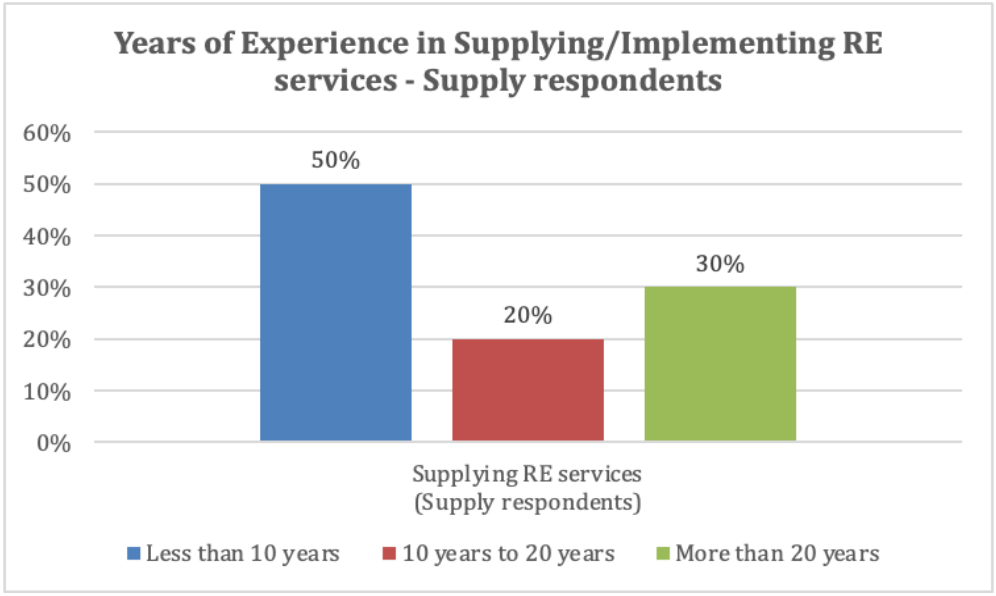

Figure 27 – Years of Experience in Supplying/Implementing RE services –Supply respondents Jordan

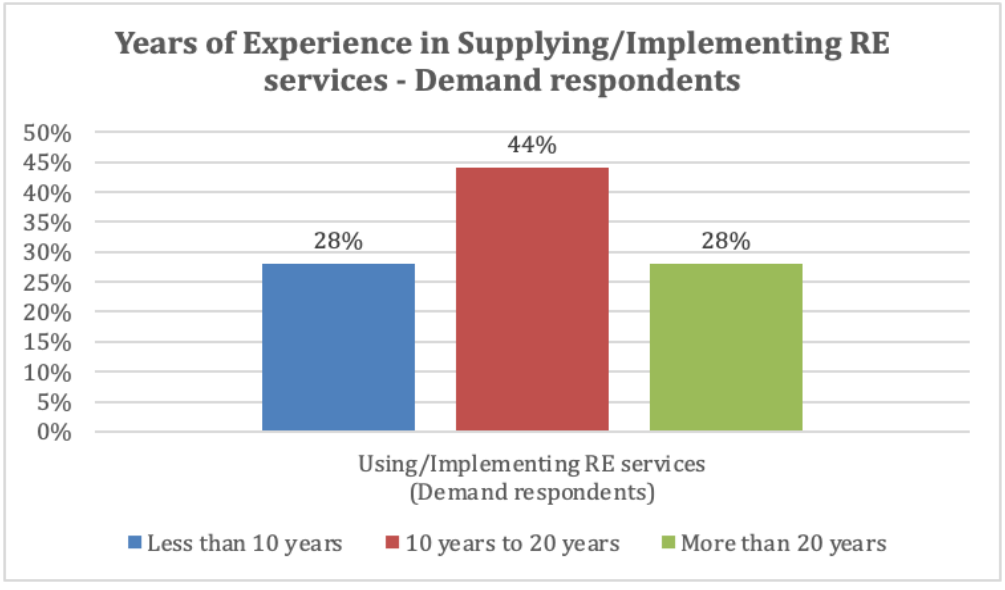

Figure 28 – Years of Experience in Supplying/Implementing RE services –Demand respondents Jordan

3.3.1 Potential of the market of the RE Services in Jordan

Jordan's power demand is growing from two perspectives, economic growth in several sectors and the increasing number of refugees from neighboring countries fleeing regional instability. In 2015, the national energy cost accounted for 20% of the country's budget but was reduced to 10% in 2018 due to the adoption of energy efficiency measures and increasing the contribution of renewable energy to the national power mix. Jordan adopted its National Energy Efficiency Action Plans (NEEAPs) in 2012 and plans to reach a 20% cut of main energy consumption by 2020, this was reduced later on to 10%. Jordan's electricity demands are rising fast and paving the road to attract overseas investments, providing the capital and additional capacity to meet the growing demand.

In 2018, electricity generation was 5,236.4 MW and is anticipated to reach 5,770 MW by 2020, thus the introduction of reliable and clean energy alternatives is essential for the country's socio-economic development. Jordan is blessed with 5 to 7 kWh/m^2 direct solar radiation intensity and averages 310 sunny days annually. The annual daily average of global solar irradiance on a horizontal surface is around 5.6 kWh/m^2 day and the total annual irradiance is between 1800-2700 kWh/m^2. The government plans to obtain 800MW from solar energy by 2020. After the issuing of the Renewable Energy Law in 2012, an estimated of 236.4MW PV has been generated in the country. Currently, there are more than 300 registered installation companies in the country, with approximately 20 companies active in the market.

Twelve direct PPAs proposals were signed in 2015 to construct and produce 200 MW, all located within Ma'an Development Area. Another 75–100 MW PV plant under assessment in the Quweirah region (Aqaba) is funded by the Gulf Corporation Council Fund (GCCF). Electricity generation capacity from stand-alone PV systems has a peak capacity of 1000 kW in remote villages and rural and desert areas, where PV is used to pump water, light homes, and support other community activities.

Around 20% of all households have their solar water heating systems on their roofs. According to the Energy Master Plan, it is expected that 30% of all households will install a solar water heating system by 2020. The first concentrated solar power (CSP) plant and first solar desalination plant will be installed in Aqaba soon with a capacity of 300–600 MW consisting of hybrid systems of CSP and PV in 2020 according to the national strategy plan.

The company, First Solar, signed a PPA with Jordan's electrical company for 20 years to manage 52.5 MW Shams Ma'an PV solar plants starting from 2016. Additional 400 MW plants (2 x 200 MW tender rounds) are under assessment. In October 2016, Masdar, a UAE based company, signed a PPA to build Jordan's largest solar power plant (200 MW) to date. It is estimated that the plant, called Baynouna, will supply 110,000 households in the south of the country with their annual electricity needs by the end of 2018. Approximately 1.40 km^2 of solar water heaters panels were installed on building roofs. Most of these panels are fabricated locally by 25 small solar water heaters enterprises, which assemble around 4500 solar water heaters every year. Approximately 30% of residential buildings are equipped with solar water heating systems. (memr.gov.jo). Figures 29 and 30 show the approximate amount of capital invested by both the suppliers and users of RE services surveyed.

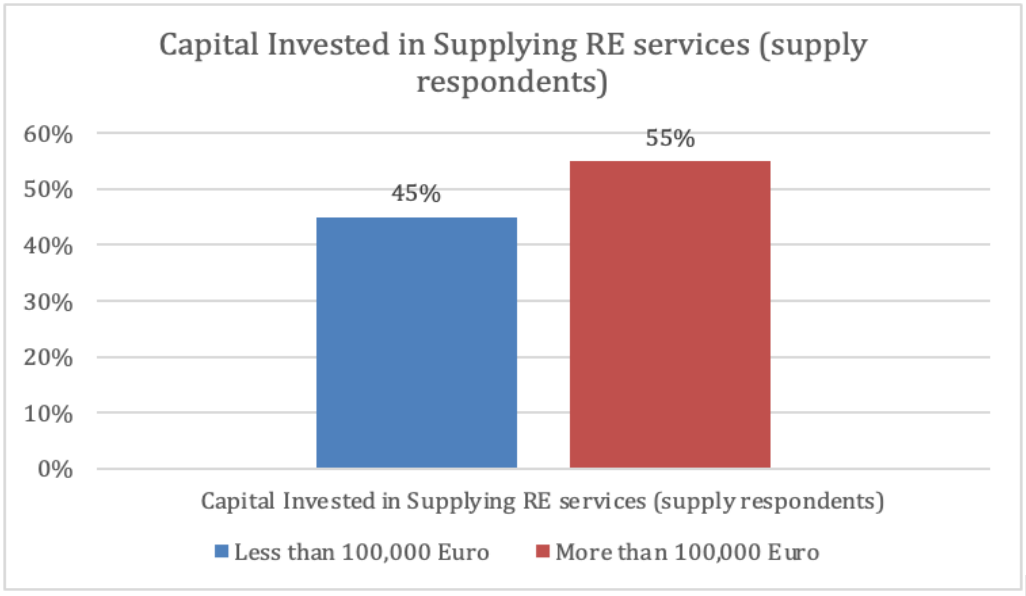

Figure 29 – Capital Invested in Supplying RE services in Jordan (supply respondents)

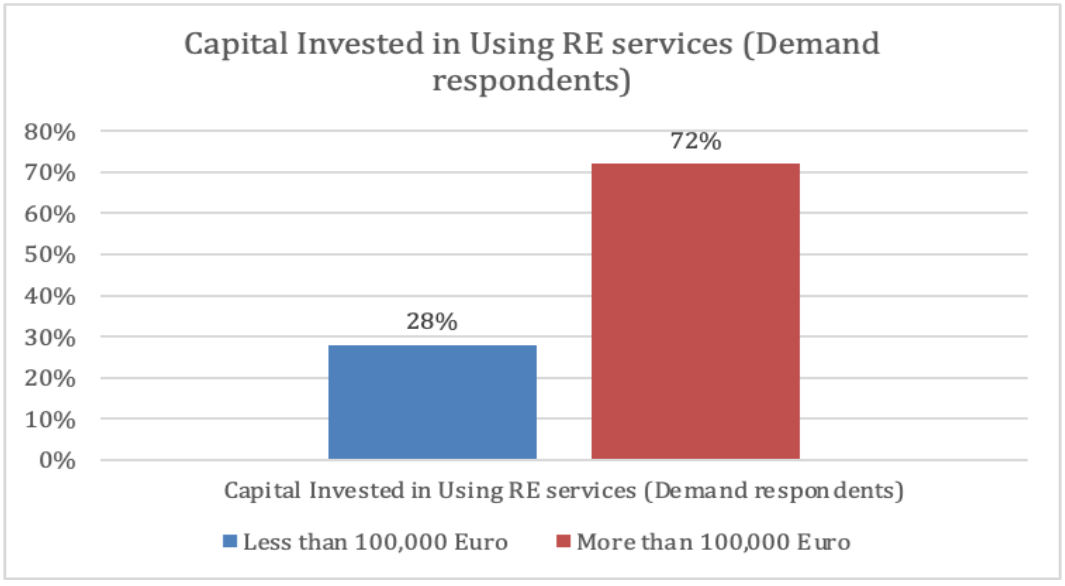

Figure 30 – Capital Invested in Supplying RE services in Jordan (demand respondents)

Future plans consist of hybrid CSPs with a total capacity of 100–250 MW and three windmills with a capacity of 125–150 MW. Sixty percent of the wind turbine parts are expected to be fabricated by local wind turbine manufacturers. At the same time, many investors are looking to manufacture photovoltaic and CSP parts in Jordan, thanks to generous taxes and customs exemptions, and solid industrial infrastructure, such domestic production is possible. All combined, this makes Jordan a regional hub for renewable energy resources training, capacity building, and technology transfer.

A summary of the Jordanian Renewable Energy (RE) market was initiated by Jordan's renewable energy country commission in 2012. It provided investors with RE market capacity, long term targets, flexible regulations, and future investments needed in the country. It also gives a short analysis of Jordanian Energy Efficiency goals, measures, andregulations.

This includes plans for 2,000MW investments in wind and solar energy plants by 2020. The approval of the REEL Law No. 13 boosted investments in renewable energy sources by simplifying the investment procedures. The REEL initiatives allow Independent Power Producers (IPPs) to sell electricity generated from renewable energy resources directly to state-owned National Electric Power Company (NEPCO). Table 12 shows the current and Planned RE projects according to NEPCO 2019 report.

Table 12 - The current and Planned RE projects in Jordan

Current RE Projects		Planned RE Projects	
Renewable EnergyType	Capacity in MW	Renewable Energy Type	Capacity in MW
Wind	376	Wind	468
PV	1098	PV	1270

Source: NEPCO Report 2019

Jordan's forecasted electricity demand, up to 2040, is detailed in the Table 13 below. Thedemand for electricity increased steadily by 3% over the years due to urban and industrialdevelopment, domestic population growth, and the influx of refugees from neighboringcountries. The maximum demand growth is expected to be around 3% with projected electrical generated growth of also approximately 3%, which is tentatively projected to meet the country's growing demands in the coming years.

Table 13 - Electricity demand and generation forecasts in the interconnected system (MEMER)

Year	Maximum Demand (Summer Load)		Electrical Energy Needed	
	MW	Growth %	GWh	Growth %
2019	3057	1.9	20143	2.6
2020	3146	2.9	20744	3.0
2022	3341	3.1	22063	3.2
2025	3645	2.9	24250	3.2
2030	4186	2.8	28230	3.1
2040	5528	2.8	38261	3.1

Source (MEMR annual Report)

3.3.2 Product types and applications (for the selected RE services)

The two selected RE service are different in terms of local implementation, demand and existence. Having that said, considering PV systems it is the dominating service available in Jordan with wide base of legal and financial infrastructure that has paved the way for the fast spread of this solution, the level of awareness, national campaigns and the interventions of the government led to increasing the demand for these systems and more investment were made by private sector as a supplier of PV or as a user (buyer) of these systems. For solar cooling systems the main issue is the low level of adaptation for this type of RE systems, less than 10 systems are installed in Jordan mainly as demonstration/Pilot projects. Even though the country's climate can drive the spread of this kind of RE yet thespecialty needed, and the expertise to install such system might be the main obstacle forbeing behind other RE systems e.g. PV or wind. Figure 31 shows the percentages of RE services used/implemented by the respondents.

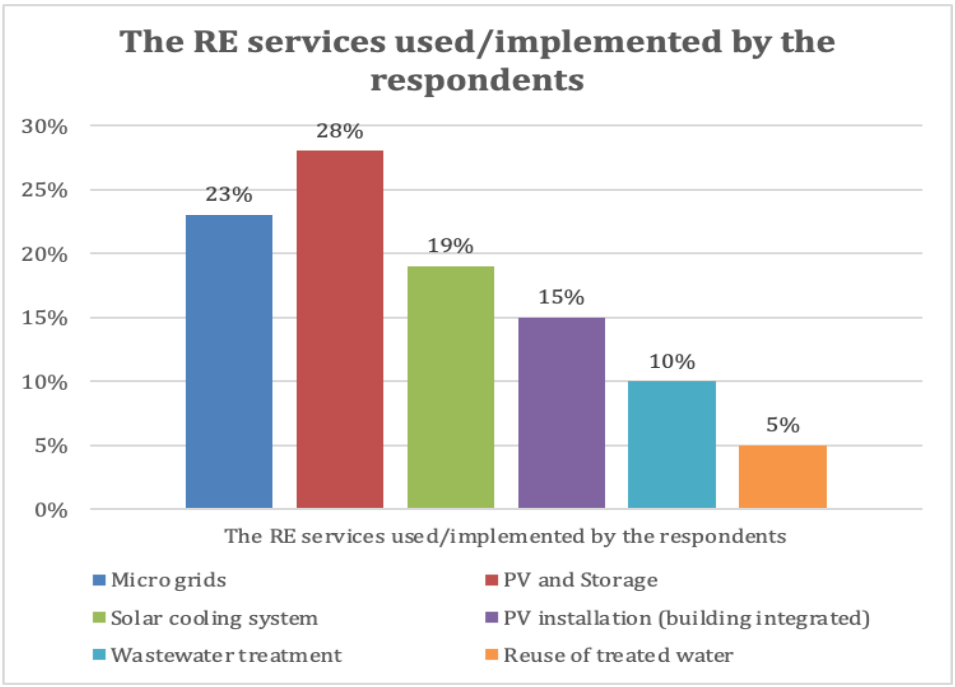

Figure 31 – The RE services used/implemented by the respondents in Jordan

As it is shown in the previous figure, the mostly used RE services is the PV and storage. It is worth noting that the majority of the respondents have only used the RE services recently over the past five years. Figure 32 presents the number of years for which RE services have been implemented in the surveyed sample.

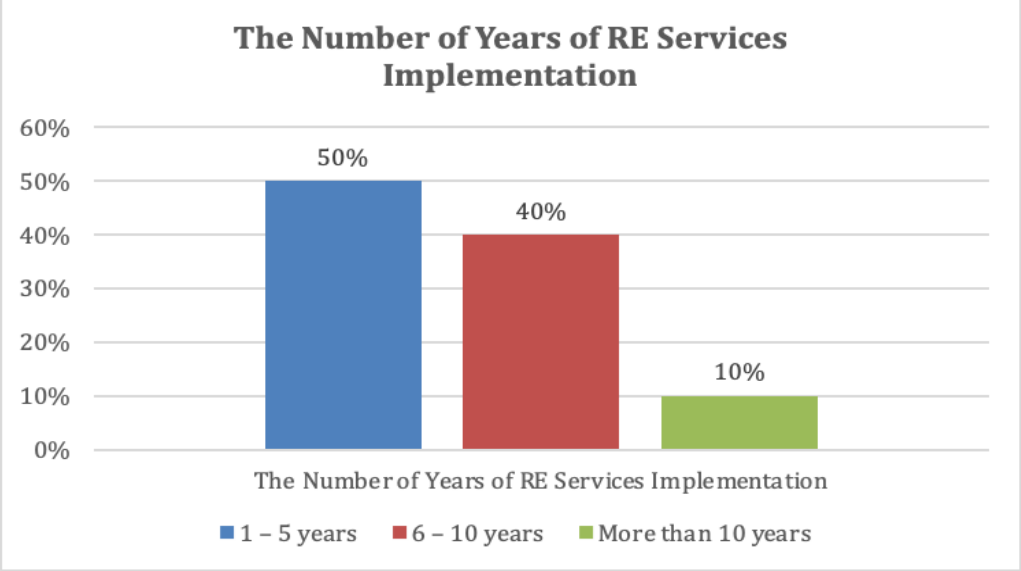

Figure 32 – The Number of Years of RE Services Implementation in Jordan

With the RE services implementation came various benefits to the organizations/companies. Table 14 shows the advantages that users acquired from implementing and using RE services.

Table 14 – Advantages of Using/Implementing RE Services

Advantages	No response	Not as beneficial asexpected	Beneficial	Very beneficial	Highly beneficial
Reduced Energy Cost	0%	10%	15%	50%	25%
Producing own energy	5%	5%	25%	55%	10%
Available good infrastructures /good sector management	0%	10%	30%	50%	10%
Ease of maintenance	5%	5%	5%	60%	25%
Reduced carbon footprint	0%	5%	0%	55%	40%
Using clean/renewable energy	5%	5%	5%	35%	50%
Increased awareness of energy usage	0%	5%	20%	40%	35%
Improved organization reputation/public image	0%	5%	25%	40%	30%

As demonstrated in the previous table, it is clear that the RE users witnessed many advantages from using RE services with the majority of them rating the stated advantagesas very beneficial and highly beneficial which is above the average rating.

To further investigate the potential demand in the RE market, the RE users were asked to indicate the RE services they are most likely to implement within the next 5 years. Microgrid presented the majority with 28%, followed by PV and storage 26%, solarcooling system 22%, PV installation building integrated 17% and reuse of treated water 7%.

3.3.3 Segmentation of the potential market between the different type of suppliers

As for the RE systems, the PV systems are dominating the local markets, the relatively short payback period, the already in place regulations and the high competition in the supply side is making PV the most prevailing RE systems in Jordan market. This in fact has to do with the already available supportive regulatory and market infrastructure, this includes the legal framework for supporting PV RE and the market tools and financial support schemes. This fact continues to help PV RE propagate in the market on the expense of other RE systems. It is especially true for small, medium and large-scale projects with a note that large scale projects are also a noticeable percentage with Wind energy.

Market segmentation can be divided as the following:

- Importer of RE systems (PV in Jordan Case)
- Distributors of PV/RE components
- Contractors of RE systems (large and medium scale projects)
- Contractors / installers of RE systems (medium and small projects)
- Installers of PV systems (micro scale projects less than 20 KWp)
- Large RE consumers (industry and service sectors)
- Small RE consumers (SMEs and households)

3.4 Overview of the production state

3.4.1 Potential market shares covered by existing players

For the PV RE systems the market is very well active in this type of RE, suppliers, trades, installers and manufacturers are in place to work on PV at domestic and commercial levels. Even the regulatory framework is in place to organize the local market on technical and financing aspects.

For the Solar cooling systems, it is not the case; this kind of systems is still in its early stages and needs more investment and awareness of its feasibility. Around 4experimental solar cooling systems are installed in Jordan; none of them can demonstratethe full potential of such systems especially in a very hot location like Aqaba.

In Jordan there are 440 registered RE companies (energy and mineral regulatory commission emrc.gov.jo) and all are categorized into 3 main groups based on the commissions' criteria for registration, in addition all these companies are described in terms of services provided including supply, installation, operating maintenance and inspection of RE systems. Table 15 shows the type of RE providers in the Jordanian marketaccording to the survey results.

Table 15 – Types of RE providers in the Jordanian Market

Type	Percentage
Large organizations	22%
Micro organizations	11%
SMEs	67%

According to the survey conducted for the RE suppliers, the majority of the market sharein the RE services market belongs to the RE distributors. The survey results showed thatthe competition in the RE market is very high and this is due to the high demand on theexamined RE services in Jordan as expressed by 72% of the respondents. It is worth noting that the survey results showed that 62% of the respondents stated that the pricesof the RE services are considered affordable and that the ROA for the provided RE services is considered rewarding. Respondents were also asked to express their opinion on the presence of a guarantee for small producers that their energy would be purchased. As shown in Figure 33, many opinions disagreed, which confirm the strong competition in the market.

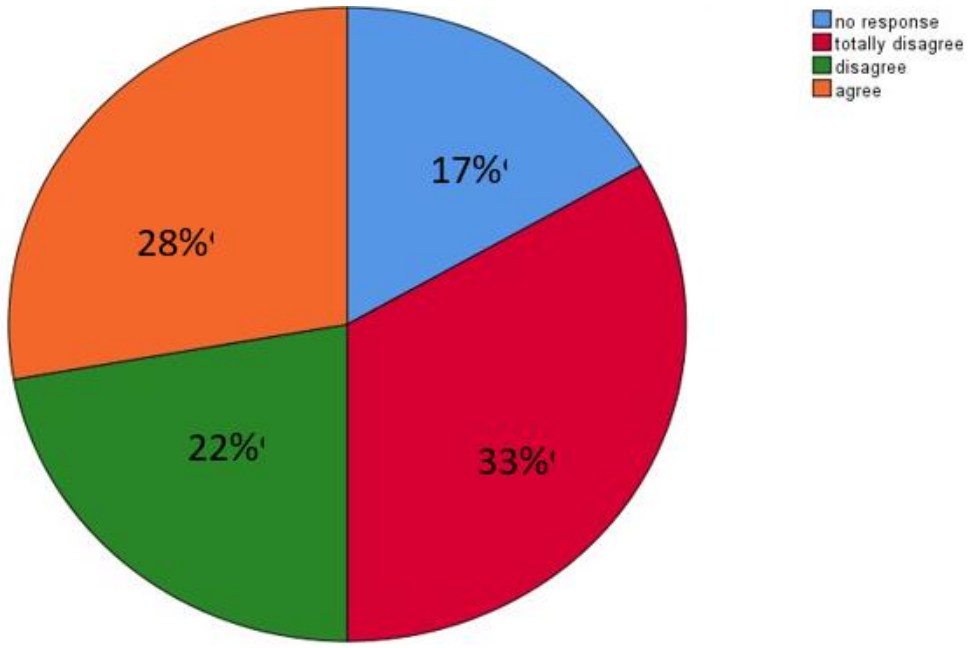

Figure 33 – Small producers energy purchase in Jordan

Moreover, the RE suppliers were asked if competitive bidding for the installation of renewable energy is usually practiced, and the majority of respondents which constitutes 61% agreed.

3.4.2 Standards and codes of practice

Annex 1 in this report provides the list of standards from Jordan Standardization and Metrology Organization (www.jsmo.gov.jo/) available in Jordan as they cover both thermal and PV energy. These standards are also extended to different testing and procedures practices. As for the practice, the Energy and Mineral Resources Commission (EMRC) is the regulating authority for licensing companies working in RE systems.

This was also shown in the results of the survey when respondents were asked about their opinion on 'describing the standards and codes of practice for RE services in Jordan'. The majority of RE suppliers (88% of respondents) agreed that grid connections are regulated, and 56% agreed that transmission access is regulated and facilitated.

In order to get more insights into the status of standards and codes of practice in Jordan, the RE suppliers were asked to express their opinions on the statements shown in Table 16.

Table 16 – The Status of Standards and Codes of Practice in Jordan

Statement	No response	Totally disagree	Disagree	Agree	Totally agree
Administrative Licensing is simple and speedy	0%	33%	28%	33%	6%
The procedure is complicated for small-scale producers	6%	6%	22%	22%	44%
Building policies in place promotes applying renewable energy, e.g. solar panels on rooftops	6%	28%	28%	33%	5%
Renewable energy equipment characteristics are sufficiently standardized	0%	17%	28%	55%	0%
In general, the administrative framework facilitates small renewable energy producers	6%	11%	50%	28%	5%
There is a renewable portfolio standard in place (i.e. a quota for renewable sources among all electricity sources)	6%	22%	28%	44%	0%

The results in table 16 show that there is a lot of room for improvement in many aspects:

a) 61% consider that administrative licensing is not simply and speedy; b) 66% agree thatthe procedure is complicated for small procedures; c) 61% of providers against the 33% consider that the administrative framework does not facilitate the small RE producers. The results also show that there are other aspects where the opinions of producers are divided. Probably this also reveals that there is room for improvement: a) 56% of providers consider that the building policies in place do not promote applying for solar energy but the other 38% replied the contrary.

The research team also asked the RE users' opinions on the status of standards of code ofpractice in Jordan to get a holistic view. The majority of RE users 80% stated that the standards and code of practice is present but need improvement, 20% stated that they are strong and solid.

3.4.3Level of Research and Technology innovation demand

The National Energy Research Centre, has been working in the field of energy research since establishment in 1983, since then the centre was focused on researching different scopes on energy efficiency and renewable energy, NERC provide reports, research and regional and international cooperation platform

The two selected RE services are available in the country yet the Solar cooling is in its earlystages in terms of market spread level, yet research on them is available on measuring their potential development specifically thermal cooling systems. Universities has been also working on RE research, at least 5 Universities have been working on RE technologiesin the past 10 years, both University of Jordan and University of Science and technology have their energy research centres working on different systems.

This fact was confirmed by the survey results as the majority of respondents (55%) stated that they can find the technology innovation needed to develop the RE services in national research centres and universities. Moreover, the majority of respondents (56%) expressed that they can find training institutions available to transfer technical skills to workers.

In addition, there is a gap between the number of specialized graduates from Jordanian universities and the market needs. The majority of RE suppliers indicated that it is challenging to find the specialized graduates who would meet the RE market size. As for the easy access to the technical expertise by small producers who wants to start generating RE services, the majority of the RE suppliers (61%) stated that it is very difficult to have such access.

Furthermore, the RE users were asked to express their opinions on the state of research and technology innovation in Jordan. The results show that 85% of the respondents stated that there is a significant development in the RE services technologies in Jordan, in addition to the easy access to information on new RE technologies, and the availability of local experts in RE technologies to provide consultations. The majority of the respondents also stated that there are regular updated reports published by local and regional research centers/universities on RE services and technologies in addition to the public and private events frequently organized in Jordan to promote RE services/technologies. Moreover, 70% of the RE users indicated that there are training programs available locally/regionally to train their technical staff on RE services implementation/maintenance.

3.5 Distribution and marketing methods

3.5.1 Channels of distribution

RE companies providing different RE systems market their products directly to consumers, in addition, the government have its campaigns through Jordan Renewable Energy and Energy Efficiency Fund (JREEF) as JREEF provide subsidies and loans guarantees for a wide community reach. Companies can reach all areas in the country and many different companies are available in different cities and can provide their services directly.

3.5.2 Marketing methods

Direct marketing for RE services is usually done by using traditional media such as television, newspapers, and social media. In order to get more insights into the status of marketing and awareness of RE services in Jordan, the RE suppliers' respondents were asked to express their opinions in the statements shown in Table 17.

Table 17 –

The Status of Marketing and Awareness of RE services in Jordan

Statement	No response	Totally disagree	Disagree	Agree	Totally Agree
There are enough marketing campaigns promoting the production of renewable energy by small producers andcitizens	0%	6%	22%	50%	22%
Newspapers and press reflect the essential role of renewable energy to public	0%	0%	45%	55%	0%
Media reflects a political willingness that supports green renewable energy usage	0%	11%	28%	61%	0%
Keeping clean environment for coming generations is a responsibility of each one of the citizens	6%	17%	39%	0%	38%

The previous table shows several interesting points. The table shows that 72% of peopleare aware about the existence of marketing campaigns on RE which reveals the efforts made for the promotion of RE in Jordan. There is no coincidence about the real impact and the message spread by traditional communication media about the RE. Here population seems divided on the issue if they reflect or not on the essential role of RE. Inthe end, this means that at least for 45% of the interviewed, newspapers and press are not playing an essential role at the time of creating awareness on the RES. The results alsoshow that there is a strong perception of the existing political willingness to support green RE in Jordan. This is clearly identified by people in the message spread by media. As for 'keeping clean environment for coming generations', the fact that 39% disagreed and 38%agreed open a very interesting discussion about the following question: cleanenvironment is an individual responsibility of every citizen? Is it a collective responsibilityas society? Where is the state responsibility? Where is the private sector responsibility? Even if we do not have more information about this 39% that disagreed, it is sure that it must gather multiple possibilities.

To get a complete view of the RE services marketing and awareness, the research team asked the RE users about how they learned about the technology sold by the RE service provider. The results showed that 35% of the RE users learned about the technology through direct sales, followed by social media 30%, catalogues 25%, and exhibition events10%. In fact, those results are very close revealing that direct sales, social media and catalogues are the preferred of the public at the time of learning on RE. Probably, this preference changes depending on the age, gender, professional or domestic approach tothis issue. What we know is that just a minority learned about this technology in exhibitionevents.

3.6 Incentive and financing methods

3.6.1 Incentives

There are different support and incentives schemes in place. This includes customs exemptions for all RE equipment's and supplies. In order to get more insights on the incentives and financing issues from the market, the RE suppliers' respondents expressed their opinions in the statement shown in Table 18.

Table 18 – The Status of RE Incentives and Financing Methods in Jordan

Statement	No Response	Totally Disagree	Disagree	Agree	Totally Agree
National subsidies and grants are available for investments in renewable energy production, particularly to small renewable energy producers and citizens	11%	22%	33%	28%	6%
Credit at low interest rates is readily available to support renewable energy production, particularly to energy producers and citizens	6%	28%	11%	50%	6%
There exists a clear information on financial support	11%	28%	28%	33%	0%
Tax reliefs are offered to small renewable energy producers	11%	17%	28%	33%	11%

As it is shown in the previous table, incentives and financing methods for RE services in Jordan are somehow developed. The results show that 40% disagree and 56% agree on the availability of low interest credit. This division of opinion among the interviewed people (with 56% agreeing) shows that even if there are credits at low cost to support the RE production, there is a lot of room for improvement and for making credits more accessible and easier for everyone. Another interesting finding is that 56% of the interviewed people against 33% affirmed that information on financial support is not clear. Either this information does not reach everyone, or it is too technical and not easyto understand, but data show that an effort is needed to make financial information on RE more accessible.

The RE users were also asked to indicate the incentives provided to encourage the implementation of RE services. Table 19 shows the rank of the incentives offered.

Table 19 – Incentives offered to RE users in Jordan

Rank	Incentive
1	Grants
2	Corporate income tax incentive + Sales or value added taxincentive
3	Subsidized traditional revolving loan + credit enhancements + Green banks
4	Mortgage related loan + performance-based incentives
5	Rebates + Property tax incentives

3.6.2Financing methods

PV and solar thermal, Jordan Renewable Energy and Renewable energy Fund (JREEEF) has different financial mechanisms, this includes Revolving Credit, Credit Guarantees and riskmitigation, equity financing, subsidy to soft investment. For the residential sector, the following programs are available:

- The mechanism of applying and benefiting from the support provided on the residential sector program (solar water heater system, solar PV system) through banks (instalment system). The bank provides a copy of the guidelines for the citizen and the implementing company to abide by when preparing the financial and technical offer for the system. The citizen chooses the company that will install the system solar cells and / or solar water heater system and take a technical and financial proposal for the system to be installed. Submitting the technical and financial offer to the Jordan Islamic & Commercial Banks, which is considered one of the approved financing bodies with the JREEEF / Ministry of Energy and Mineral Resources. After approval of the offer, 30% of the total cost of the system is provided through the JREEEF. The citizen installs the rest of the total amount, which is 70% of the cost of these systems, through the bank as follows:
  Up to 48 months for solar cell systems.

  Up to 24 months for Flat Plate solar water heater systems. Up to 12 months for Evacuated tubes

- The Mechanism of applying and benefiting from the support provided on the residential sector program (solar water heater system, solar cell system) through the Civilian Consumer Corporation (cache system):

  The institution provides a copy of the guidelines for the citizen and the implementing company to abide by when preparing the financial and technical offer for the system. The citizen chooses the company that will install the system solar cells and / or solar water heater system and take a technical and financial proposal for the system to be installed. Submitting the technical and financial proposal to the Jordan Islamic Bank, which is considered one of the approved financing bodies with the JREEEF / Ministry of Energy and Mineral Resources. After approval of the offer, 30% of the total cost of the system is provided through the JREEEF. The citizen pays the rest of the total amount, which is 70% of the cost of these systems, through the Civilian Consumer Corporation, and the Corporation charges administrative services allowance as follows:
  - 40 Jordanian dinars for each solar cell system.
  - 20 Jordanian dinars per solar system type flat mirrors or vacuum tubes.

As for the industrial sector, there is a 50% Fund of the value of the energy audit study. Companies can apply for Jordan chamber of industry and application will be studied and evaluated by the Jordan chamber of industry & JREEEF. In the case of approval, the agreement will be signed. The targeted groups in the factories sector are supported with 50% of the value of the energy audit study with the freedom of the factory to choose the energy audit company provided that:

- That the energy audit company selected by the factory is licensed to practice energy audit activity.
- The value of the energy audit study should not exceed 10,000 dinars.
- Loan interest coverage with a ceiling of 350,000 Dinars.

JREEEF will cover the interest of a loan that the factory takes to implement the outputs of the energy audit study (energy saving measures), so that the factory is allowed to take a loan of 350,000 dinars from one of the banks accredited to the fund and with a repayment period not exceeding 5 years. Guarantee of 70% of the loan amount in cooperation with the Loan Guarantee Corporation. JREEEF also provides technical assistance at all stages of the energy audit study and its outputs.

- *For Tourism Sector:*

This pilot project is aimed at three-star and below hotels, some four-star hotels were also chosen. It mainly focuses on activating the concept of energy conservation and improving the efficiency of its use. The government of Jordan is committed to finance 25% of the total cost of the project and the French Agency for International Development (AFD) is committed to finance 50% of the total cost of the project as a part of its continuous support to the government of Jordan which is highly appreciated. Hotel owners contribution is 25% of the total cost of the project conditioned to be paid at the beginning of the project for the implementing companies.

- *For Public Buildings:*

The worship buildings are considered one of the important buildings in terms of the high consumption of electric energy, as number of mosques in the Kingdom reached 6610 mosques, according to the annual book issued by the Department of Statistics for the year2017, and the number of churches reached more than 100 churches in the Kingdom; Therefore, JREEEF encourages the use of renewable energy technology applications to reduce electricity consumption in this sector, and to create an appropriate environment for worshippers. The process of installing the system would be a 50 % from the worship place local community, 25 % JREEEF and the ministry of awqaf and Islamic affairs.

- *For Schools:*

The Fund has developed a heating and cooling program for schools affiliated to the Ministry of Education in order to provide the appropriate educational environment in theclassroom.

- *For Government Buildings:*

JREEEF support a 50% of the energy audit costs for any governmental entity study, conducted so far 24 energy audits governmental entities with 50% support.

- *Agriculture Sector:*

Under this sector, one main program to support renewable energy technologies for smallfarmers, with the exception of drawing groundwater from artesian wells or natural watersources. The Agricultural Credit Corporation is the most important strategic partner, as the Foundation finances loans with a maximum limit of 15,000 Jordanian dinars for farmers wishing to benefit from the project, and the fund pays the interest of these loansaccording to the agreement concluded between the two parties.

3.7 Challenges identification for the sector

To understand the possible barriers that exist in the RE sector, the research team investigated the administrative, economic and technical challenges that the RE suppliers face in the Jordanian market. Table 20 shows the administrative challenges faced by RE suppliers' respondents in Jordan. The challenges are ranked according to their importancewhereas 1 is the highest rank.

Table 20 – Administrative Challenges in Jordan

Rank	Challenge
1	Excessive bureaucracy and slowness administrative procedures
2	Net metering issues
3	New eco-green local fees/ tariffs affecting providers and finalclients (fiscal disincentives)
4	Regulatory and market issues
5	Restrictions on foreign RE technologies purchases in dollars

As it is shown in Table 20, the most popular challenge in the RE services sector in Jordan is the excessive bureaucracy and slowness of administrative procedures. Table 21 shows the economic challenges according to the RE suppliers' respondents.

Table 21 – The Economic Challenges in Jordan

Rank	Challenge
1	The high cost of building from scratch
2	The cost of upgrading legacy equipment and infrastructure foroperation
3	Funding
4	The high cost of components
5	Difficulty in quantifying the benefits
6	Maintenance

As it is shown in Table 21, the highest economic challenge is the high cost of building fromscratch. Table 22 shows the technical challenges that RE suppliers face in the Jordanian market.

Table 22 – The Technical Challenges in Jordan

Rank	Challenge
1	Technology immaturity
2	Addressing complex energy imbalances to ensure optimal control
3	Systems adaptation to current real-time network demands and interfaces
4	Ensuring cybersecurity needs
5	Islanded micro grid protection
6	Upgrading legacy generator controls

To provide a complete view of the challenges in the RE market, the RE users who represents the demand side were asked to indicate the challenges they might face in implementing/using the RE services. Table 23 presents these challenges.

Table 23 – RE Users Challenges to Implement/Use the RE Services

Challenge	Not challenging	Somewhat challenging	Neutral	Very challenging	Highly challenging
High upfront costs	5%	10%	40%	30%	15%
Unclear payback time/ROI	0%	30%	45%	10%	15%
Roof and establishment need repairs/update	0%	15%	55%	15%	15%
Complicated program offerings	5%	25%	45%	20%	5%
Systems integration (with grids)	5%	5%	40%	35%	15%
Finding a contractor	0%	10%	20%	35%	35%
Replacing inefficient systems will be expensive	5%	10%	35%	40%	10%

3.8 Future prospects

Jordan's forecasted electricity demand, up to 2040, is detailed in the Table 24 below. The demand for electricity increased steadily by 3% over the years due to urban and industrial development, domestic population growth, and the influx of refugees from neighboring countries. The maximum demand growth is expected to be around 3% with projected electrical generated growth of also approximately 3%, which is tentatively projected to meet the country's growing demands in the coming years.

Table 24 - Electricity demand and generation forecasts in the interconnected system(MEMER)

Year	Maximum Demand (Summer Load)		Electrical Energy Needed	
	MW	Growth %	GWh	Growth %
2019	3057	1.9	20143	2.6
2020	3146	2.9	20744	3.0
2022	3341	3.1	22063	3.2
2025	3645	2.9	24250	3.2
2030	4186	2.8	28230	3.1
2040	5528	2.8	38261	3.1

Future objectives of those national industries related to the two selected RE services aremainly to improve access to wider market systems, improve efficiency and increase acceptance of RE as the best solution for energy needs.

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REGIONE AUTONOMA DELLA SARDEGNA
MAIA-TAQA

LEBANON

4. Lebanon

4.1 Introduction

Lebanon is a small country of 10,452 km² located in the Middle East. Its coastline is about225 km. As of the year 2020, the population in Lebanon is estimated to be 7,161,000 individuals (Kingston et. al, 2020). This population is mostly distributed in urban locationson the Lebanese costal and Mount Lebanon area with an urban population density of 88.6
% and a rural population density of 11.4 %. Beirut the capital of Lebanon alone is home to approximately 2,400,000 individuals that makes to around 33 % of the population.

The climate is typically mild to cool, with wet winters and hot dry summers. The terrain narrows plainly at coastal line with a Valley in Beqaa separating Lebanon and Anti- Lebanon Mountains. Elevations start with sea level up to 3,087 m. It is worth mentioning that rivers in Lebanon are numerous and one river that is particularly important is the Litani River that is 145 km longs stretching from Baalbek and emptying in the Mediterranean Sea close to the city of Tyre. The country is considered rich with water resources, the soils are fertile, and agriculture is prominent especially in the rural areas such as the Beqaa Valley. There are 360,000 hectares of arable agricultural lands in Lebanon. This comprises 35 % of the country's surface area. The greatest concentration of agricultural lands is in the Beqaa Valley (42 % of the total cultivated area), followed bynorthern Lebanon (26 %), Southern Lebanon (22 %), and Mount Lebanon (9 %). Deforestation, erosion, air, and water pollution are among the environmental challengesthat the country is facing.

Lebanon imports 95 % of its need of electricity. The sector is also suffering from a lack of generation capacity and shortages in the distribution of electricity. Approximately 61% ofthe electricity consumption is supplied by the national company EDL, and 39% through private diesel generators. Hence, actions should be undertaken to reduce the country's energy consumption and to improve the availability of electricity and reduce the need toimport it.

A pilot project to treat wastewater with low energy consumption and reuse the output for irrigation will be designed and installed at the Industrial Research Institute located inthe Lebanese University main campus in Hadat, Baabda area (7 kilometres southeast suburb of Beirut, Lebanon). The area of Hadat is around 5.52 km^2 and its population is more than 100,000.

4.2 MAIA- TAQA pilot in Lebanon: Wastewater Treatment at the Industrial Research Institute in Hadat

Lebanon, like all other developing countries, suffers greatly when it comes to pollution. Considering water pollution in specific, the lack of proper wastewater treatment is one ofthe major factors affecting the quality of the country's much-needed water. The infrastructure is very old and malfunctioning and needs a lot of rehabilitation. Also, Lebanon is expected to face major water scarcity soon if the water and wastewater sectoris not properly managed.

It was reported by the Lebanon Crisis Response Plan (LCRP) 2015-2016 that Lebanon generates an estimated 310 Mm3/year of wastewater of which 250 Mm3/year aremunicipal and 50 Mm3/year are industrial (UNICEF, 2012) with an estimated total Biological Oxygen Demand of about 119,348 tons (World Bank, 2011). 35% to 50% of untreated wastewater in Lebanon gets infiltrated to aquifers and then pumped again foragricultural and domestic use because of the lack of discharge networks and effective treatment facilities. Most houses are still using septic tanks or draining wastewater into boreholes that will ultimately cause the wastewater to reach groundwater (Ministry of Environment, 2004).

The wastewater disposal is what raises the most concern in Lebanon. Many areas lack wastewater networks and areas that have networks do not have them connected to treatment plants. For that, almost all the wastewater produced is disposed into the sea, rivers, streams, etc.

With such driving forces that are affecting water quality and its adverse effects on human health, agricultural power and economic situation in Lebanon, water and wastewater treatment is therefore essential to alleviate such dire situation. Moreover, given that agricultural practice is prominent and of economic benefit in Lebanon, irrigation reuse would also be a mitigating solution to the high demand in water used for irrigation. For example, there is proposed a master plan for the Beqaa water establishment in Lebanon that provides recommendation for a 2035 planning horizon mentioning the development of wastewater treatment for irrigation reuse purposes (DAI/KREDO, 2015).

Therefore, given the water resources situation and valuable prospects on several sectors in Lebanon, the 2 RE hereby are chosen to tackle wastewater treatment and its irrigation reuse possibilities.
A wastewater treatment facility is a combination of physical, biological, and chemical processes that serve to decrease the level of contaminants in wastewater to global standards that make it safe to be disposed into water bodies or used in agriculture or other domains. Wastewater treatment is divided into four complementary processes:

- The first process is the preliminary process. Its purpose it to prepare the wastewater for further treatment by removing grits, debris, and oil scums.
- The second process is the primary treatment. Primary treatment removes about 60% of total suspended solids (TSS) and 30 % of biological oxygen demand (BOD) in a sedimentation tank through discrete settling.
- Third process is the secondary treatment. The secondary treatment serves to remove the remaining roughly 70 % of BOD by oxidization.
- The final and fourth process is the tertiary treatment. This treatment removes specific industrial wastewater pollutants such as nitrogen and phosphorous.

Untreated wastewater has hazardous effects on public health, ground water, and water bodies that it gets disposed in, and thus affecting human and aquatic life as well. Also, it contributes to environmental pollution, and can cause the spread of diseases due to the presence of pathogens and health-threatening viruses in it. Furthermore, energy consumption is greatly related to wastewater treatment. Electricity costs are relatively high to operate the treatment plant; it costs usually between 5 to 30 percent of total operating costs for the plant. Thus, it is important to tackle the energy efficiency of the system during the treatment process. Using the 5 to 30 percent range, the global energy savings of the sector at its current level of operation could be in the range of 34 to 168 TWh per year (2008 IEA Energy Statistics). Thus, energy-efficient technologies are to be selected during the design process of a WWTP.

Another major issue in Lebanon is electricity shortages. People in Lebanon suffer daily from 13 hours of electricity blackout, thus would have to rely on alternative off-grid generators. As a result, consumers end up paying huge amounts of money to account for the utility bill and alternative generator bills. According to the World Bank, a Lebanese citizen pays the highest electricity bill in the region while experiencing the most underqualified and unreliable electricity service (Dagher and Ruble, 2011).

Therefore, energy management is very essential to any wastewater treatment plant that is about to be designed in order to avoid extra energy waste and expenses while running the facility. Electricity costs between 5 to 30% of total operating costs of wastewater utilities globally and can rise to 40% of the total cost in developing countries (Van Den Berg et al., 2011 as cited in Odigie, 2014).

4.3 Market situation

To understand the market situation in Lebanon, the research team conducted desk research, interviews, and surveys with expertise in order to provide a holistic view of themarket situation for RE services in Lebanon. The research team designed two surveys; one to assess the demand for the RE services in Lebanon (20 respondents) and the otherone for the RE supply market (22 respondents). The surveys targeted decision makers andtop management levels as demonstrated in Figures 34 and 35.

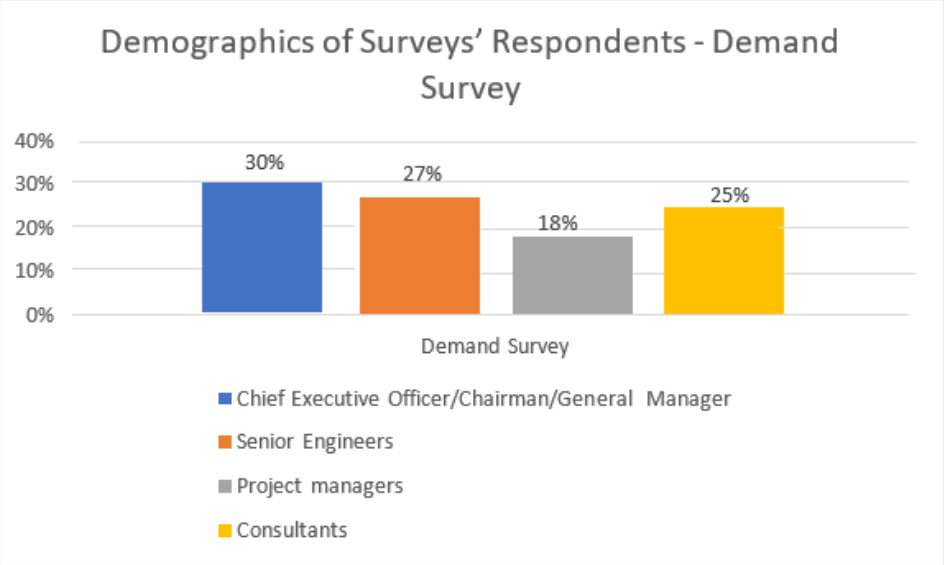

Figure 34 – Demographics of Surveys' Respondents – Demand Survey Lebanon

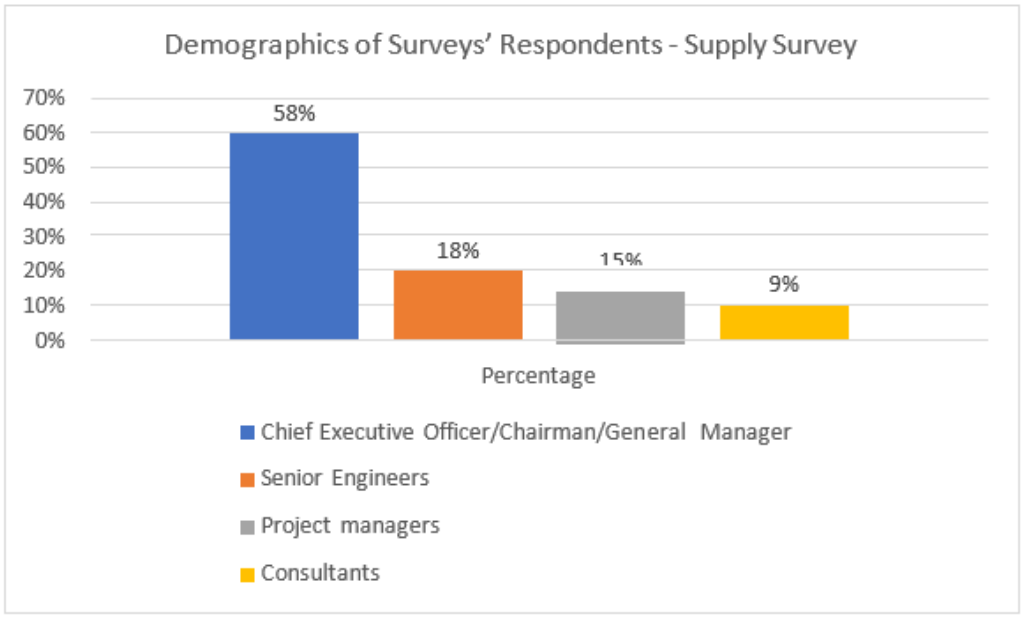

Figure 35 – Demographics of Surveys' Respondents – Supply Survey Lebanon

The majority for the respondents in both surveys belonged to the private sector except for only 5 entities in the demand survey and 1 entity in the supply survey representing the public sector in Lebanon. For the demand survey, 95% of the respondents represented local companies/organizations while the remaining 5% represented international companies. For the supply survey, 60% of the respondents were local companies and 40% presented international companies. Figures 36 and 37 show the types of organizations/companies of the respondents, and Figures 38 and 39 show the years of experience in supplying or implementing RE services.

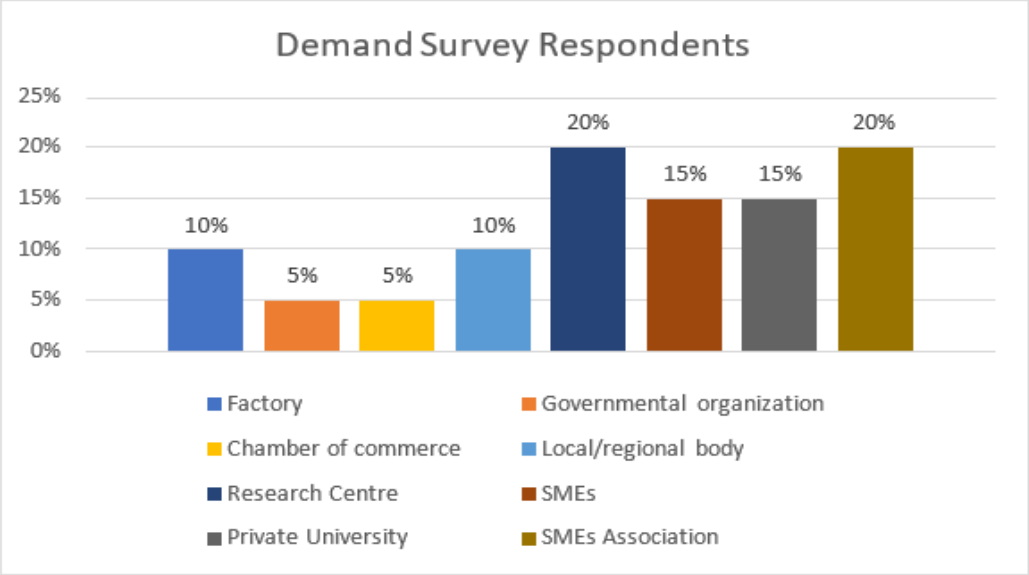

Figure 36 – Types of Organizations/Companies of the Demand Survey Respondents in Lebanon

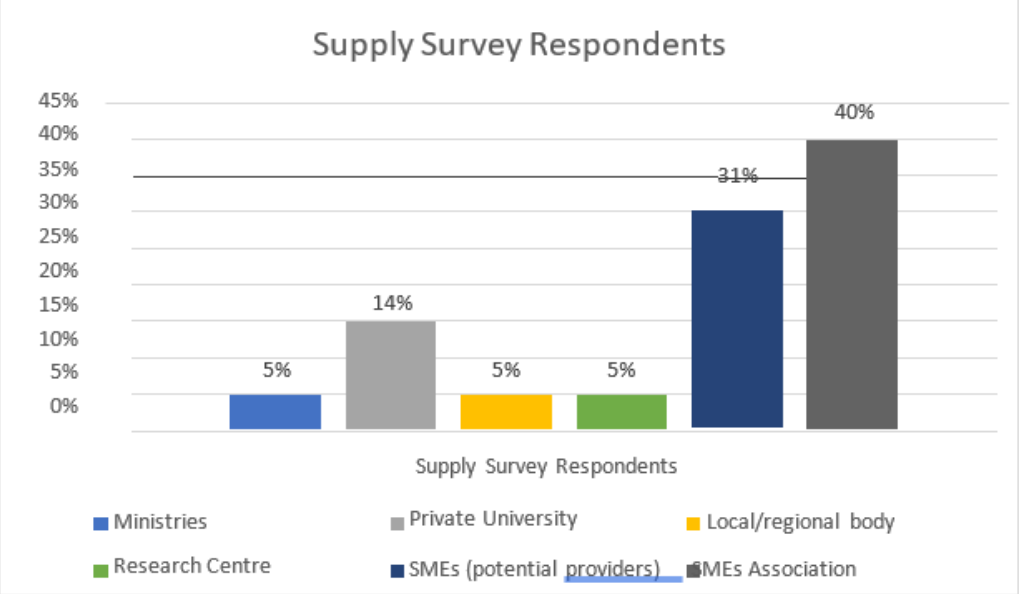

Figure 37 – Types of Organizations/Companies of the Supply Survey Respondents in Lebanon

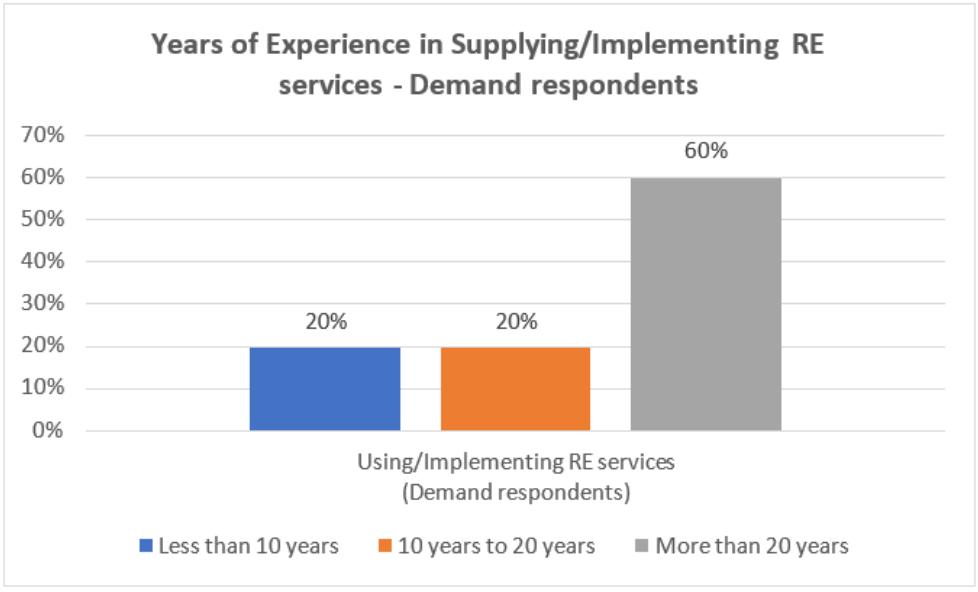

Figure 38 – Years of Experience in Supplying/Implementing RE services - Demand respondents Lebanon

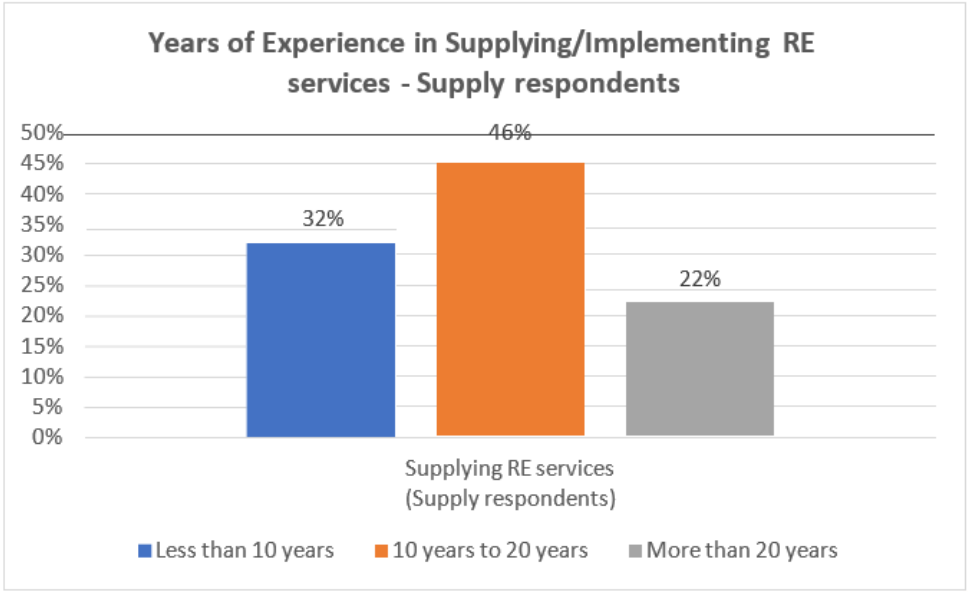

Figure 39 – Years of Experience in Supplying/Implementing RE services - Supply respondents Lebanon

4.3.1 *Potential of the market of the RE Services in Lebanon*

According to the state and trends of the Lebanese environment in 2010, it was mentionedthat Lebanon had entered a phase of water stress where, demand does not meet the annual needs. It was also projected that by the year 2020 will be further exploited to reachan annual water demand of 2000 to 2500 Mm3 shown in Figure 40. Moreover, pollutantlevels in wastewaters that are being discharged into the sea and rivers further stress on the issue that needs to be solved where, it has been estimated that wastewater treatmentis almost null with around a mere 8% of the population being served, while only 60% of the population is connected to a sewage collection network and that is in the urban cities. As per such rationalization, demand for such wastewater treatment and reuse of wastewater has a large potential in the RE market.

Figure 40- Annual drinking water demand

Sector	*2010*		*2020*		*2030*	
Domestic	467	31%	767	37%	1258	44%
Industrial	163	11%	268	13%	440	16%
Irrigation	900	58%	1020	50%	1120	40%
Total	**1,530**	**100%**	**2,055**	**100%**	**2,818**	**100%**

Assumptions: *Annual population growth* 2.5%; *Per capita water consumption* 140 L/d; *Network Losses* 35%; *Irrigated area* growing from 90,000 Ha to 140,000 Ha in 2030; *Irrigation demand* decreasing from 9,000 m^3/Ha to 8,000 m^3/Ha; Industrial demand equals 35% of domestic demand.

A World Bank group document shows that a CIP (Capital Investment Plan) is in place for the water and wastewater sectors. It contains 206 separately identified investmentprojects for a total of US$ 7,527 million. This is to be implemented over three cycles covering the period 2018-2030 (World Bank 2018).

The wastewater projects in the CIP are grouped into three groups—networks, wastewatertreatment plants and new system (WWTP+ networks). For the water sector, it was assessed that networks and dams at a cost of around US$ 1,224 million plus US$ 103 million for land expropriation, are important for the first Cycle (2018-2021). And for wastewater projects, it was assessed that a total of US$ 1,334 million plus US$ 35 millionfor land expropriation, are important for the first Cycle (2018-2021).

In general, the wastewater sector in Lebanon suffers from chronic under-investment, combined with a weak institutional and governance structure and an insufficient tariff framework.

Since 1992, the Government of Lebanon ("GoL") – through the Council for Development and Reconstruction (the "CDR") – has invested in several wastewater projects involving urgent repairs, renovations and expansion of wastewater infrastructure, completion of unfinished projects, and protection of the Lebanese coasts and water resources from pollution. By 2017 approximately USD 850 million was invested in the wastewater sector,yet the results of this investment remain insufficient. The Syrian crisis and the unexpecteduplift of population by 50% have aggravated the need for wastewater services.

As of 2018, eight medium to large wastewater treatment plants (WWTP) exist on the Lebanese coast, three in Tripoli, Chekka, and Batroun localities within North Lebanon Governorate, three in Jbeil, Ghadir and Jiyyeh localities within Mount Lebanon Governorate, and two others in Saida and Sour localities within South Lebanon Governorate. Out of these, only two are not operational yet (Jbeil and Sour).

On the Inland side, seventeen WWTP are constructed. One small scale plant in Ehden locality within North Lebanon Governorate, six small to medium size in Safa, Barouk, andupper Chouf localities within Mount Lebanon Governorate, five small to medium scale inNabatiyeh, Tibnine, Kfarsir, Zawtar and Yohmor localities within South Lebanon and Nabatiyyeh Governorates, and 5 medium to large size in Baalbeck, Zahleh, Jib Jannine, Saghbine and Yammouneh. Only five plants are not operational yet (Safa, Barouk, Kfarsir,Zawtar and Yohmor).

Foreign investments have supported municipalities in the construction of another sixty unitary WWTP but these are often not functional due to lack of maintenance exacerbatedby insufficient financing.

Any untreated wastewater is discharged either directly into the Mediterranean Sea or into rivers that lead to the sea, which can cause environmental harm and health hazards;it precludes Lebanon from complying with the Barcelona Convention for the protection of the Marine Environment and Coastal Region of the Mediterranean.

Figures 41 and 42 shows the approximate amount of capital invested by both the suppliers and users of RE services surveyed. The fact that 82% of supply and 80% of demand respondents show to have spent/ or invested more than 100.000€ in the RES surveyed reveal a potential need for those services as well as potential market.

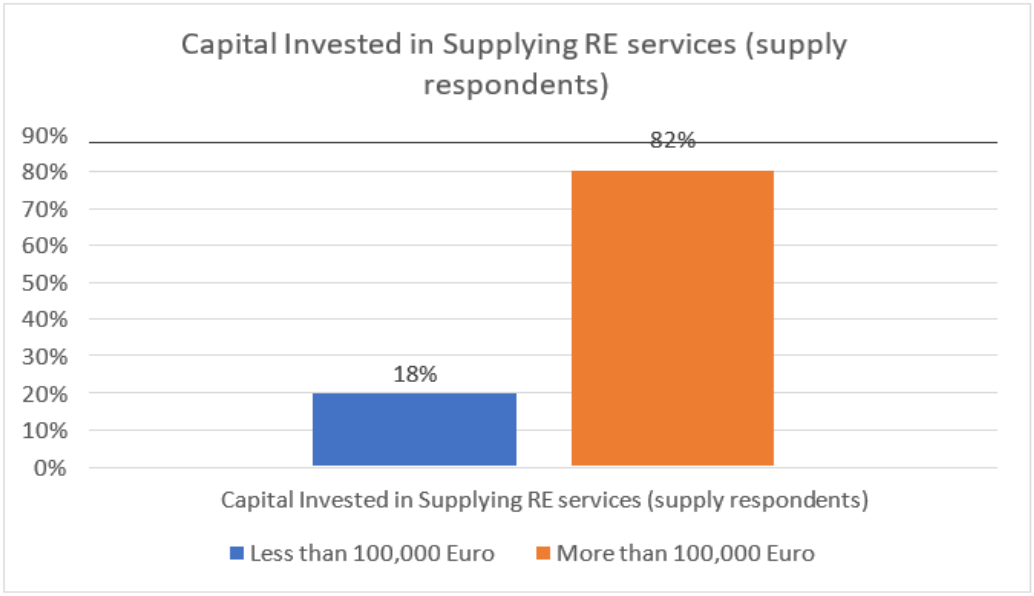

Figure 41 – Capital Invested in Supplying RE services (supply respondents) inLebanon

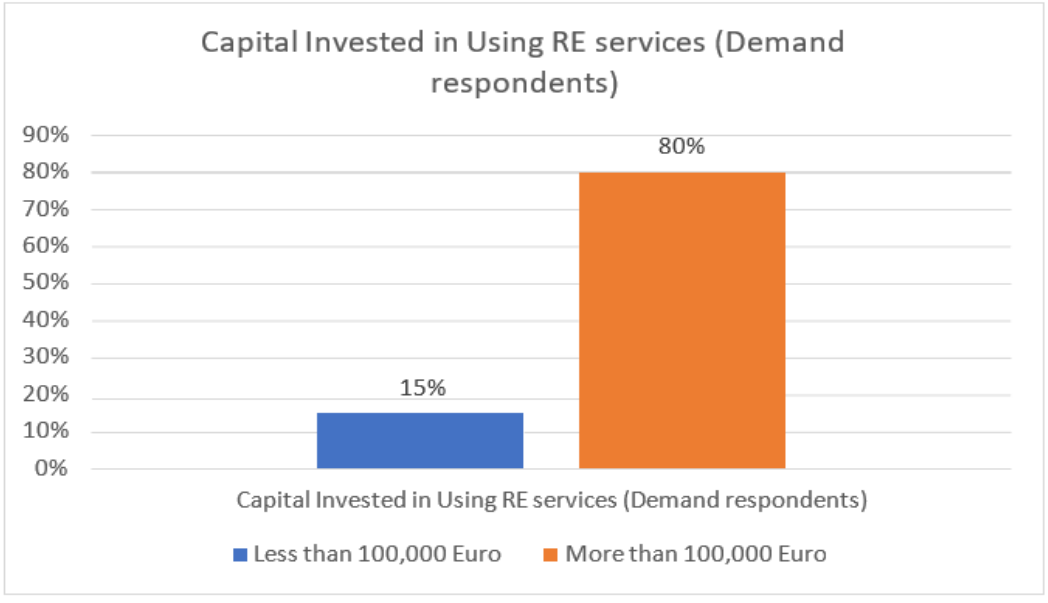

Figure 42 – Capital Invested in Using RE services (Demand respondents) inLebanon

4.3.2 Product types and applications (for the selected RE services)

Most of wastewater collected through sewer networks flow to the sea. Wastewater generated from building not connected to a sewer network flow into septic tanks or into the rivers (Mnaimneh, 2005). Many farmers use the untreated wastewater in an informal manner for irrigation. However, there are no accurate data regarding the amount of wastewater used for irrigation. According to FAO this amount could be around 2 million m^3/year. The only wastewater treatment plant generating water for irrigation, is Baalbak WWTP where 12000 m^3/day are generated. According to the National Strategy for Water Sector (NSWS, 2012) adopted by resolution No. 35, date 17/10/2012, the reuse of treated effluent should be increased to 50 % by 2020. Three main types of wastewater treatment processes exist in Lebanon: septic tanks; stabilization ponds and trickling filters (DAI/KREDO 2015).

- **Septic tanks with leach fields**

Septic tanks shown in Figure 43, are watertight containers which remove large solids and greases, provide anaerobic digestion of the solids, and storage of the sludge and scum. Septic tanks do not remove large numbers of bacteria and viruses. Septic tanks should be inspected and pumped regularly, ideally every 3 years, and percolation tests should be conducted during the wet season prior to installing a new system.

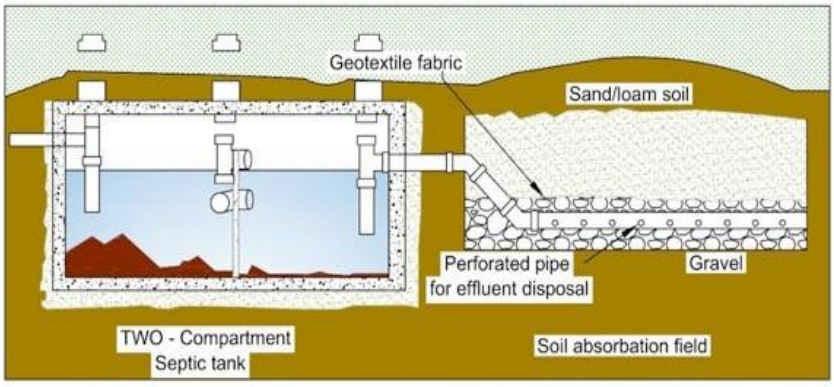

Figure 43 – Septic Tank Scheme

- **Stabilization ponds or facultative pond**

Stabilization ponds shown in Figure 44, are simple natural ponds where oxygen is transferred directly into the water across the surface area without the need for any equipment. This natural method of aeration is slow and as a result, ponds treat sewage slowly, with a long detention time hence resulting in large, required land surfaces. If the time and area are available, stabilization ponds are very economical facilities to maintain.

The ponds can be used individually or linked in a series for improved treatment. There are three types of ponds, (1) anaerobic, (2) facultative and (3) aerobic (maturation), each withdifferent treatment and design characteristics.

To maintain these ponds operational, they must be desludged once every 10 to 20 years.The sludge dredged from these ponds would be dried on the gravel drying beds providedfor this purpose. A fence should be installed to ensure that people and animals stay out of the area and excess garbage does not enter the ponds. Vegetation or macrophytes thatare present in the pond should be removed as it may provide a breeding habitat for mosquitoes and prevent light from penetrating the water column.

Stabilization ponds are among the most common and efficient methods of wastewater treatment and are especially appropriate for rural communities that have large, open unused lands. They work best in warm, sunny climates. In the case of cold climates, the retention times and loading rates can be adjusted so that efficient treatment can be achieved.

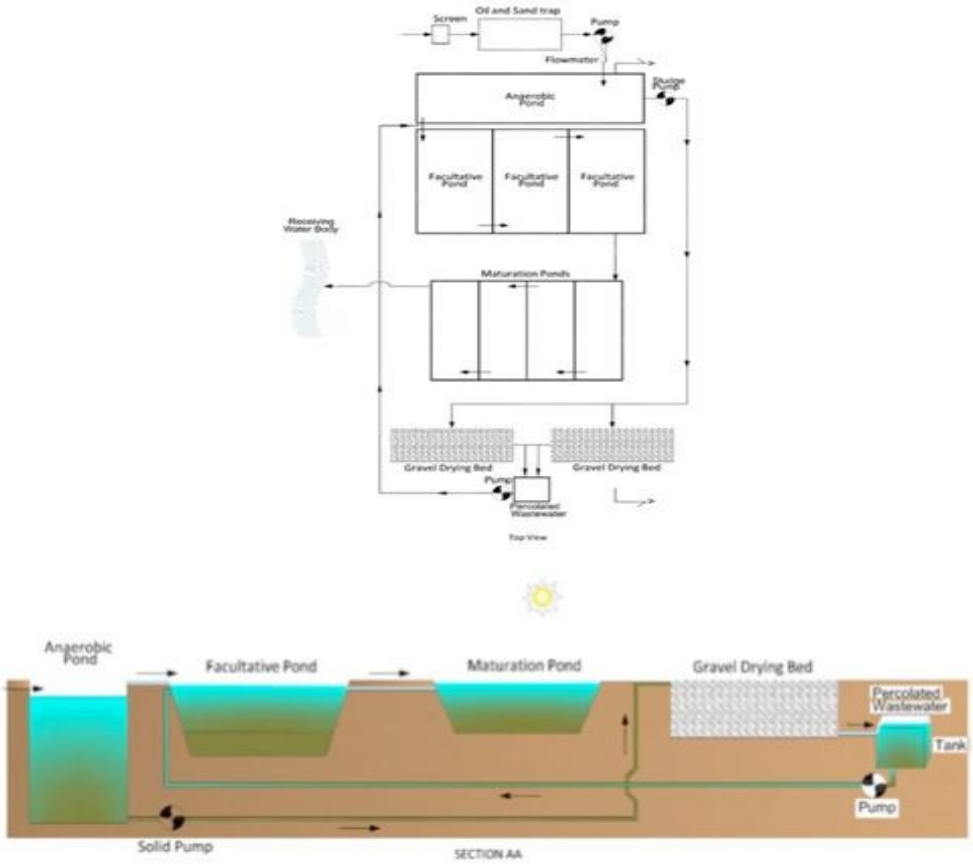

Figure 44 – Stabilization Ponds Scheme

- **Trickling filters**

The trickling filter shown in Figure 45 is a basin or tower filled with support media such as stones, plastic shapes, or wooden slats. It is designed to remove BOD. In the trickling filter wastewater is applied over the media. Microorganisms become attached to the media and form a biological layer or fixed film. Organic matter in the wastewater diffuses into the film, where it is metabolized. The organisms aerobically decompose the solids producing more organisms and

stable wastes, which either become part of the slime or are discharged back into the wastewater flowing over the media. The wastewater continues through the filter to the underdrain system where it is collected and carried outof the filter.

At the same time air flows through the filter and oxygen is transferred from the air to thewastewater and slime to maintain the aerobic conditions. The thickness of the biofilm increases as new organisms grow. Periodically, portions of the film slough off the media.A secondary clarifier to settle all the digested organic matters. Those materials will be pumped to the sludge holding tank by a solid pump. The effluent will be pumped to the water body. A sludge holding tank to thicken and store the sludge. The thickened sludge will be diverted to the drying bed and both percolated and supernatant water will be pumped back to the entrance of the WWTP.

A drying bed to dewater the sludge. It is a basin filled of porous materials to permit the water to percolate and to catch the sludge at the top. Sludge drying beds will be designedas drainage beds filled with gravels and cultivated with reeds to reduce the area requiredto the minimum and then the dried sludge and the reeds will be skimmed periodically. Allthe drained water will be drawn back to the plant entrance for recirculation.

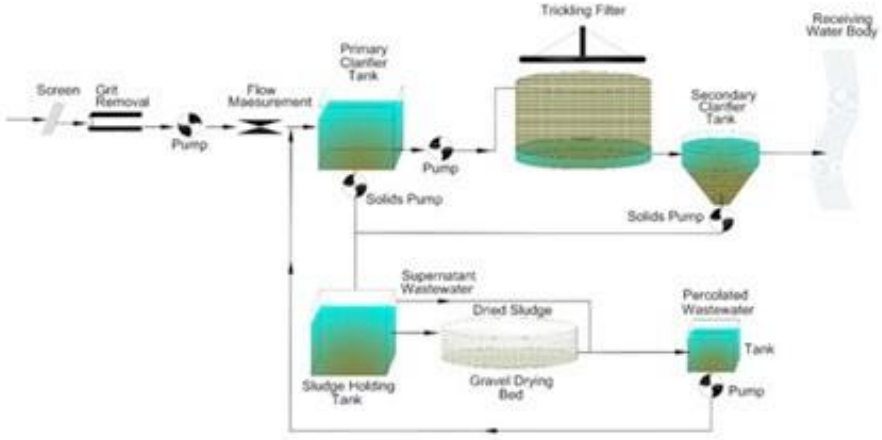

Figure 45 – Trickling Filters Scheme

The selection of the appropriate wastewater treatment process depends on the local context application. In brief, the septic tank type is used for individual cases, while the other processes are used at large scale.

Stabilization ponds are always the least costly solution in terms of total capital cost (land cost plus capital cost) or operation cost. However, the land area required is substantial and becomes impossible to find and locate for large populations as compared to trickling filters or activated sludge. Effectively, trickling filters and activated sludge are both mechanized processes that are more expensive than stabilization ponds but require less land. Moreover, trickling filters are simpler process that are less expensive than activated sludge in terms of equipment and operations.

In the surveys conducted, the respondents were asked about the usage/implementation of different RE services, including wastewater treatment and reuse of treated water. Figure 46 shows the percentages of RE services used/implemented by the respondents.

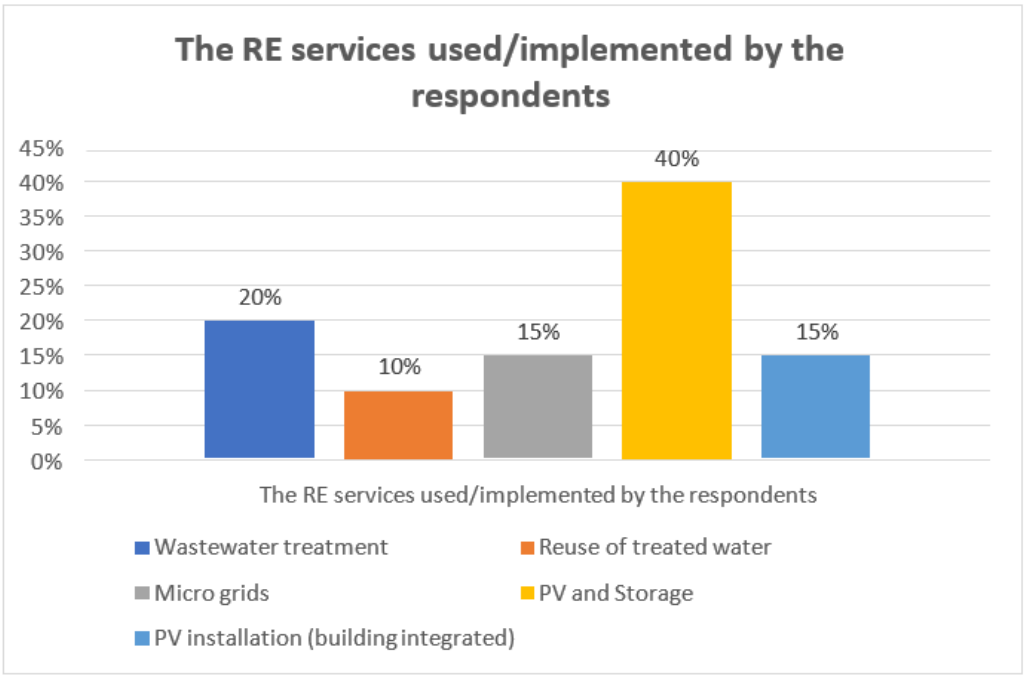

Figure 46 – The RE services used/implemented by the respondents in Lebanon

As it is shown in the previous figure, the mostly used RE services is the PV and storage. Figure 47 presents the number of years for which RE services have been implemented in the surveyed sample.

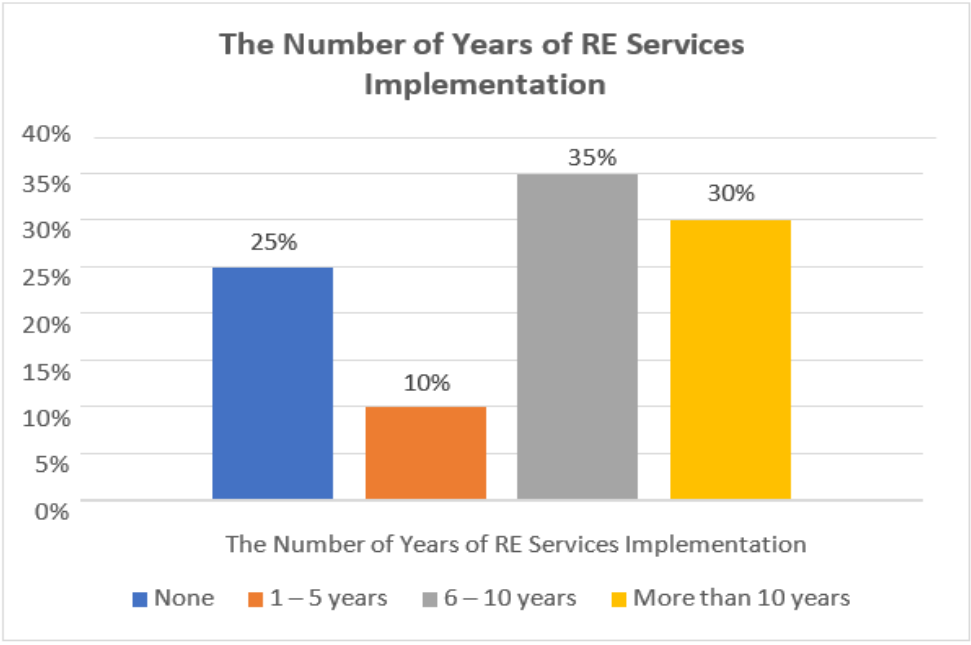

Figure 47 – The Number of Years of RE Services Implementation

With the RE services implementation came various benefits to the organizations/companies. Table 25 shows the advantages that users acquired from implementing and using RE services in Lebanon.

Table 25 – Advantages of Using/Implementing RE Services in Lebanon

Advantages	No response	Not as beneficial as expected	Beneficial	Very beneficial	Highly beneficial
Reduced Energy Cost	10%	20%	25%	20%	25%
Producing own energy	15%	25%	15%	30%	15%
Available good infrastructures /good sector management	20%	15%	15%	30%	20%
Ease of maintenance	10%	15%	35%	25%	15%
Reduced carbon footprint	15%	25%	5%	25%	30%
Using clean/renewable energy	15%	20%	5%	20%	40%
Increased awareness of energy usage	15%	20%	10%	30%	25%
Improved organization reputation/public image	10%	20%	10%	30%	30%

As demonstrated in the previous table, it is clear that the RE users witnessed many advantages from using RE services with the majority of them rating the stated advantages as very beneficial and highly beneficial which is above the average rating.

In order to further investigate the potential demand in the RE market, the RE users were asked to indicate the RE services they are most likely to implement within the next 5 years. The reuse of treated water presented the majority with 45%, followed by wastewater treatment with 35%, followed by microgrid 10%, and PV and storage 10%.

4.3.3 Segmentation of the potential market between the different type of suppliers

The segmentation for the local wastewater treatment providers is diverse, but the majority of players can be grouped into the following segments:

1. Traders and importers of small-scale WWTPs
2. Engineering firms and contractors
3. Project developers, responsible for the contracts with the government

4.4 Overview of the production state

4.4.1 Potential market shares covered by existing players

The local market share for the wastewater treatment is based on the type: Residential, Industrial, and Commercial. Among these types, the residential wastewater treatment market accounts for the largest share in the local market. There is also a big potential for reuse of treated wastewater, since today only one wastewater treatment plant in Baalbak is generating water for irrigation, where 12000 m^3/day are generated. Table 26 shows the type of RE providers in the Lebanese market according to the survey results.

Table 26 – Types of RE providers in the Lebanese Market

Type	Percentage
Micro organizations	23%
SMEs	77%
Total	100%

According to the survey conducted for the RE suppliers, the majority of the market share in the RE services market belongs to the RE installers. The survey results showed that the competition in the RE market is very high and this is due to the high demand on the examined RE services in Lebanon as expressed by 78% of the respondents. Added to the high competition is the high prices of the RE services, 64% of the respondents clearly stated that the RE prices are not affordable. In return, the ROA for the provided RE services showed a 60% agree among respondents.

4.4.2. Standards and codes of practice

In Lebanon, the institutional framework of the water sector is controlled by a large number of ministries including the ministry of environment. Where, according to Law 221of 2001, regional water establishments (RWEs) were created and given autonomy and control over their resources. The RWEs are as follows: Beirut and Mount Lebanon WaterEstablishment; North Lebanon Water Establishment; South Lebanon Water Establishment; and Beqaa Water Establishment (MOE/ECODIT/UNDP, 2011).

The standards and regulations that are in place in Lebanon that help ameliorate the adverse effects on water resources fall short as compared to other Mediterraneancountries.

There exist only regulations for drinking water and wastewater treatment, however, there is only a drafted wastewater reuse guideline set forth by the (FAO) food and agricultural organization by not enacted. According to Margane; & Steinel (2011):

1. The standard for drinking water exists only for biological and organic compounds butnot for heavy metals “Law 444 of 2002, shown in Table 27.
2. The standard for wastewater treatment used in Lebanon is based on the ministry ofenvironment (Decision 8/1 of 2001), not enforced, shown in Table 28.
3. For irrigation reuse, that is still prohibited in Lebanon, there has only been developeda draft guideline presented in Table 29.

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Table 27 – Drinking Water Standard

Parameter	standard value	Parameter	standard value
Total Coli. (MPN/100 mL)	0	NO_3 (mg/L)	5 (max 50)
Faecal streptococcus (MPN/100 mL)	0	Cl (mg/L)	25 (max 200)
Faecal Coli. (MPN/100 mL)	0	SO_4 (mg/L)	25 (max 250)
Sulphate reducing bacteria (MPN/200 mL)	1	Na (mg/L)	20 (max 150)
Thermo tolerant coli. (MPN/100 mL)	0	K (mg/L)	10 (max 12)
Salmonella (MPN/5 L)	0	Mg (mg/L)	30 (max 50)
Pathogenic staphylococci (MPN/100 mL)	0	Ca (mg/L)	100
Bacteriophages (MPN/50 mL)	0	Total Al (mg/L)	0.05 (max 0.2)
Enteroviruses (MPN/10 L)	0	Dry Residues (mg/L)	1500
Temperature (°C)	12 (max 25)	EC (mS/cm)	400
pH	6.5 - 8.5 (max 9)		

Margane; & Steinel (2011)

Table 28 - Environmental limit values for discharge of sewage into the sea, surfacewaters and sewers

Parameter (mg/L)	***discharge into***			***Parameter (mg/L)***	***discharge into***		
	sea	***surface waters***	***sewer***		***sea***	***surface waters***	***sewer***
pH	6-9	6-9	6-9	Ag	0.1	0.1	0.1
Temperature (°C)	35	30	35	Al	10	10	10
BOD_5	**25**	**25**	**125**	As	0.1	0.1	0.1
COD	125	125	500	Ba	2	2	2
Total P	10	10	10	Cd	0.2	0.2	0.2
Total N	**30**	**30**	**60**	Co	0.5	0.5	1
TSS	60	60	600	Total Cr	2	2	2
AOX	5	5	5	Cr(VI)	0.5	0.2	0.2
Detergents	3	3		Cu	1.5	0.5	1
***E.coli* (MPN/100 mL)**	**2000**	**2000**		Fe	5	5	5
Salmonellae (MPN/L)	nil	nil	nil	Hg	0.05	0.05	0.05
Hydrocarbons	20	20	20	Mn	1	1	1
Phenol index	0.3	0.3	5	Ni	0.5	0.5	2
Oil + grease	30	30	50	Pb	0.5	0.5	1
TOC	75	75	750	Sb	0.3	0.3	0.3
NH_4	10	10		Sn	2	2	2
Active Cl_2	1	1		Zn	5	5	10
Cyanides	0.1	0.1	1	SO_4	1000	1000	1000
F	25	25	15	Sulphide	1	1	1
NO_3	90	90		PO_4	5	5	

Margane; & Steinel (2011)

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Table 29 - Draft Lebanese guidelines for irrigation reuse

class	I	II	III
restrictions	produce eaten cooked; irrigation of greens with public access	fruit trees, irrigation of greens and with limited public access; impoundments with no public water contact	cereals, oil plants, fiber and seed crops, canned crops, industrial crops, fruit trees (no sprinkler irrigation); nurseries, greens and wooden areas without public access
proposed treatment	secondary + filtration + disinfection	secondary + storage or maturation ponds or infiltration percolation	secondary + storage /oxidation ponds
BOD_5 (mg/L)	25	100	100
COD (mg/L)	125	250	250
TSS (mg/L)	60 (200 WSP)	200	200
pH	6 – 9	6 – 9	6 – 9
residual Cl_2 (mg/L)	0.5-2	0.5	0.5
NO_3-N (mg/L)	30	30	30
FC (/100ml)	<200	<1000	none required
Helminth eggs (/1 L)	<1	<1	<1

Note: Irrigation of vegetables eaten raw is not allowed

Existing laws and regulations for environmental protection in Lebanon date as back as 1925. Protection against pollution was first addressed by decree No. 8735 of October 1974 that prohibited digging of wells for the disposal of raw sewage, banned infiltration from septic tanks, and the use of sewage for the irrigation of vegetables and some fruit trees.

However, in most Lebanese regions this law is not respected. The Minister of Agricultureissued a decree, prohibiting the use of wastewater in irrigation. In March 2001 Decision No. 8/1 reviewed the previously issued wastewater standards to cover the discharge of wastewater to the sea, to surface water and to sewerage system. However, standards for the reuse of treated effluents have not been addressed.

The first guidelines for the use of treated wastewater for irrigation were implemented byFAO in 2010 shown in Table 30.

Table 30 – Guidelines for the Local Reuse of Treated Wastewater in Irrigation

	Category of treated wastewater		
Parameter	**I Irrigation of vegetable eaten rawis not allowed**	**II**	**III**
BOD5	25	100	100
COD	125	250	250
TSS	60	200	200
pH	6 – 9	6 – 9	6 – 9
Cl2 residual	0.5 – 2	0.5	0.5
N-NO3	30	30	30
Faecal Coliforms (in100ml)	<200	<1000	None required
Helminth ova (in 1litre)	<1	<1	<1

Category I: (Irrigation of vegetable eaten raw is not allowed)

1. Fruit trees and crops that are eaten cooked

2. Parks, public gardens, lawns, golf courses and other areas with direct public exposure

3. In case of stabilisation pounds, the TSS limit value is 200 mg/l.

Water treatment expected to meet the criteria: Secondary treatment, filtration, and disinfection

Category II

1. Fruit trees

2. Lawns, wooded areas, and other areas with limited public access, road sides outsideurban areas

3. Landscape impoundments: ponds, water bodies and ornamental streams, where publiccontact with water is not allowed.
Water treatment expected to meet the criteria: Secondary treatment + filtration + disinfection or Secondary treatment + either storage or well-designed series of maturation ponds or infiltration percolation

Category III

1. Irrigation of cereals and oleaginous seeds, fiber, & seed crops
2. Crops for canning industry, industrial crops
3. Fruit trees (except sprinkler-irrigated)
4. Plant nurseries, ornamental nurseries, wooden areas, green areas with no access to the public Water treatment expected to meet the criteria: Secondary treatment a few days' storage or Oxidation pond systems.

In order to get more insights into the status of standards and codes of practice in Lebanon,the RE suppliers were asked to express their opinions on the statements shown in Table 31.

Table 31 – The Status of Standards and Codes of Practice in Lebanon

Statement	No response	Totally disagree	Disagree	Agree	Totally agree
Administrative Licensing is simple and speedy	18%	36%	32%	9%	5%
Existing licensing scheme guarantees the technical and financial capacity of the provider	23%	27%	27%	20%	3%
The procedure is complicated for small-scale producers	9%	9%	18%	32%	32%
Building policies in place promotes applying renewable energy	18%	9%	32%	36%	5%
RE equipment characteristics are sufficiently standardized	5%	23%	27%	36%	9%
In general, the administrative framework facilitates small RE producers	14%	18%	46%	18%	4%
There is a renewable portfolio standard in place	14%	32%	28%	14%	12%

The research team also asked the RE users' opinions on the status of standards of code ofpractice in Lebanon to get a holistic view. The majority of RE users (60%) stated that the standards and code of practice are present but need improvement, while 35% stated that they are not present and the remaining 5% lacked the knowledge. An improvement can be initiated in one or more of the four following issues highlighted by RE suppliers who participated in the survey: 72% of them consider that licensing is slow and complicated.

In addition, more than 50% consider that the existing licensing does not guarantee the technical and financial capacity of the provider. Add to it, 64% mentioned that proceduresare complicated for small producers. Finally, 64% of RE suppliers affirmed that the administrative framework complicates their activities. This strengthens the urgency for a new, faster, simpler, and business oriented administrative framework that understands SMEs/ enterprises necessities.

4.4.3 Level of Research and Technology innovation demand

Many past and ongoing research were conducted at research centres and universities onthe wastewater treatment and reuse for agriculture, but without a significant impact on the local market.

Many stakeholders are involved in this sector and can play a major role in the advancement of this resource efficiency service. The main organizations are listed below:

- Ministry of Energy and Water (MoEW)
- Ministry of Environment (MoE)
- Ministry of Agriculture (MoA)
- Ministry of Interior and Municipalities (MoIM)
- Ministry of Public Works (MoPW)
- Council of Ministers (CoM)
- Council for Development and Reconstruction (CDR)
- Autonomus Water (5 regional Offices)
- Litani River Authority (LRA)
- Mouhafazat (Districts)
- Municipalities

Some international funding organizations are also playing a role in the local context, we can mainly list the following:

- United States Agency for International development (USAID), Japan Bank for International Cooperation (JBIC), European Investment Bank (EIB), International Development Bank (IDB), and the World Bank

Several augmentations and alternatives for wastewater management in Lebanon are being research for potential applications in Lebanon.

A certain number of studies have investigated the availability of treated effluent and sludge its reuse options. From the CDR's master plan in 2003, it is projected that the quantity of treated sludge will increase from 334 t/d in 2010 to 426 t/d in 2020 (WB, 2010). It is suggested that there for such treatment, there should be limited reuse of the treated sludge in agriculture and is therefore, recommended to be incinerated. However, with regards to treated effluent sludge, the outlook is more positive.

Rainwater harvesting is also a possible innovative solution that relies on seasonal rainwater capture using dams.

The survey results showed that most respondents (69%) stated that they do not find the technology innovation needed to develop the RE services in national research centres and universities. Moreover, most respondents (64%) expressed that it is highly challenging to find training institutions available to transfer technical skills to workers.

In addition, there is a gap between the number of specialized graduates from Lebanese universities and the market needs. The majority of RE suppliers indicated that it is somewhat challenging to find the specialized graduates who would meet the RE market size. As for the easy access to the technical expertise by small producers who wants to start generating RE services, the majority of the RE suppliers (73%) expressed that it is very challenging. Thus, it is recommended to support the small producers to grant them an easier access to the needed technical expertise.

Furthermore, the RE users were asked to express their opinions on the state of researchand technology innovation in Lebanon. The results were equally divided among those who do not agree and those who agree on the development in the RE services technologies in Lebanon, in addition to the easy access to information on new RE technologies, and the availability of local experts in RE technologies to provide consultations. The RE users also pointed that public and private events are frequently organized in Lebanon to promote RE services/technologies which proved to be beneficial. Moreover, 45% of the RE users indicated that there are training programs available locally/regionally to train their technical staff on RE services implementation/maintenance.

4.5 Distribution and marketing methods

4.5.1 Channels of distribution

The wastewater treatment plants are generally directly distributed by EPC local contractors, which offer design, engineering, procurement, installation and maintenance. For the water reuse for irrigation solutions, there are importers and local manufacturersthat sell to distributers or resellers the components needed for the solutions. The marketin Lebanon is relatively a small market, therefore a direct distribution from main companyis normally adopted. Most companies are located in the capital Beirut and can cover the whole country.

4.5.2. Marketing methods

The main marketing methods used by providers in Lebanon are: Annual construction andtrade exhibitions (e.g Project Lebanon) dealing with construction innovation technologies. The main companies selling tech goods related to the wastewater treatment plants and water reuse take advantage of these exhibitions to present and selltheir products.

Companies/providers of medium and big scale wastewater treatment project have the governmental institutions and union of municipalities as their direct clients. While smallpackaged wastewater solutions companies target households through social media and exhibition forums where they can present brochures and technical catalogues, etc. for the potential clients.

In order to get more insights into the status of marketing and awareness of RE services inLebanon the RE suppliers' respondents were asked to express their opinions in the statements shown in Table 32.

Table 32 – The Status of Marketing and Awareness of RE services in Lebanon

Statement	No response	Totally disagree	Disagree	Agree	Totally Agree
There are enough marketing campaigns promoting the production of renewable energy by small producers and citizens	5%	36%	41%	14%	4%
Newspapers and press reflect the essential role of renewable energy to public	9%	36%	41%	9%	5%
Media reflects a political willingness that supports green renewable energy usage	5%	50%	29%	13%	3%
Keeping clean environment for coming generations is a responsibility of each one of the citizens	5%	9%	9%	70%	7%

As it is clear from Table 32, the status of RE services marketing and awareness in Lebanon is not strong. More than 70% of the interviewed people assume that there are not enough marketing campaigns promoting RE and for nearly 80% the media is not reflecting the political support of government on RE. This means that stronger marketing campaigns through the press and social media could be very helpful. Those are key actors to reinforce the green RE usage. The media, in addition to the main stakeholders have a vital role to play in the promotion of green energy.

To get a complete view of the RE services marketing and awareness, the research team asked the RE users about how they learned about the technology sold by the RE service provider.

The majority of RE users 40% learned about the technology through direct sales, followed by exhibition events 35% and social media 25%. This means that there is still room to improve in terms of marketing at the time to attract potential exhibitors (Ex. Specially, the medium and big scale providers/ companies selling to the Public sector) in sectoral exhibitions and social media. The companies, which offer packaged wastewater solutions for households, are found to be the ones using more this marketing channels.

4.6 Incentive and financing methods

In general, there were some minor incentives and financing initiatives in Lebanon, but they were all stopped due to many factors, especially the economic and banking crisis that the country is suffering from.

4.6.1. *Incentives*

Currently, there are no national, regional nor local tax benefits or incentives for the usage of the wastewater treatment plants and the reuse of the treated water produced. In orderto get more insights on the incentives and financing issues from the market, the RE suppliers' respondents expressed their opinions in the statement shown in Table 33.

Table 33 – The Status of RE Incentives and Financing Methods in Lebanon

Statement	No Response	Totally Disagree	Disagree	Agree	Totally Agree
National subsidies and grants are available for investmentsin renewable energy production, particularly to small renewable energy producers and citizens	18%	18%	23%	14%	27%
Credit at low interest rates is readily available to support wastewater treatment, particularly to small wastewater treatment facilities	41%	27%	13%	1%	18%
There exists a clear information on financial support	18%	50%	18%	5%	9%
Tax reliefs are offered to small renewable energy producers	36%	32%	23%	0%	9%

As it is shown in the previous table, incentives and financing methods for RE services in Lebanon are not as developed as it should be. The majority of respondents expressed thelack of national subsidies and grants for RE services, lack of low interest credits, lack of tax reliefs to small RE producers in addition to the unclear information on financial support.

4.6.2. Financing methods

The Lebanese environmental loan LEA is a financing mechanism that is supposed to provide the private sector in Lebanon with long-term loans at low interest rate in order to implement environmental projects. This initiative launched in 2015, was dedicated to support the financing of new and existing environmental projects. It offers soft loans to eligible and feasible projects.

LEA allows private sector entities (individuals, SME's, or corporate bodies) and non-profit organizations to apply for subsidized loans for environmental projects with the covered measures. In particular, wastewater treatment plant and water reused system can benefit from this loan. However, due to the financial crisis in 2019 this financing method was suspended.

4.7 Challenges identification for the sector

There is no legal or administrative barriers or any other kind of national/regional regulation for the buying of tech goods in the renewable energy and wastewater treatment sectors. A value-added tax (VAT) of 11 % is imposed on all goods. This tax is not a barrier for the implementation of the two selected RE services of wastewater treatment and water reuse in your Lebanon. However, as mentioned, the Lebanese financial crisis is the main barrier affecting all sectors. In particular, wastewater treatment plants are not considered as priority compared to renewable energy systems for electricity generation especially with the Lebanese currency depreciation and the removal of electricity subsidies.

To understand the possible barriers that exist in the RE sector, the research team investigated the administrative, economic and technical challenges that the RE suppliers face in the Lebanese market. Table 34 shows the administrative challenges faced by RE suppliers' respondents in Lebanon. The challenges are ranked according to their importance whereas 1 is the highest rank.

Table 34 – Administrative Challenges in Lebanon

Rank	Challenge
1	Excessive bureaucracy and slowness administrative procedures
2	Restrictions on foreign RE technologies purchases in dollars
3	Regulatory and market issues
4	Lack of legislations
5	Net metering issues

As it is shown in Table 34, the most popular challenge in the RE services sector in Lebanon is the excessive bureaucracy and slowness of administrative procedures. Table 35 shows the economic challenges according to the RE suppliers' respondents.

Table 35 – The Economic Challenges in Lebanon

Rank	Challenge
1	The high cost of building from scratch
2	Funding
3	The cost of upgrading legacy equipment and infrastructure foroperation
4	The high cost of components
5	Difficulty in quantifying the benefits
6	Maintenance

As it is shown in Table 35, the highest economic challenge is the high cost of building from scratch. RE projects have a high cost of capital, and with the lack of financing schemes that would encourage investors, funding will still remain a big challenge. In fact,the majority of the economic challenges are actually cost/capital related which proves the need for competitive financing schemes. Table 36 shows the technical challenges that RE suppliers face in the Lebanese market.

Table 36 – The Technical Challenges in Lebanon

Rank	Challenge
1	Lack of infrastructure
2	Systems adaptation to current real-time network demands and interfaces
3	Technology immaturity
4	Healthcare constraints

As shown in Table 36, the highest technical challenge is the lack of infrastructure affecting the RES (ex. The absence of a network of wastewater connecting to the wastewater treatment small plant).

To provide a complete view of the challenges in the RE market, the RE users who represents the demand side were asked to indicate the challenges they might face in implementing/using the RE services. Table 37 presents these challenges.

Table 37 – RE Users Challenges to Implement/Use the RE Services in Lebanon

Challenge	Not challenging	Somewhat challenging	Neutral	Very challenging	Highly challenging
High upfrontcosts	10%	10%	25%	30%	25%
Unclear payback time/ROI	10%	45%	30%	10%	5%
Complicated program offerings	15%	15%	40%	15%	15%
Systems integration(with grids)	5%	20%	35%	35%	5%
Finding a contractor	10%	40%	40%	5%	5%

For most of the interviewed users the two most challenging issues are the high upfrontcosts (55% of them) and the need to integrate systems with grids (40% of them).

4.8 Future prospects

It is important in this study to investigate the future prospects for the RE services marketin Lebanon. From the RE suppliers' perspectives, they indicated the sectors which are more likely to implement the RE services provided. Table 38 shows the sectors.

Table 38 - Sectors more Likely to Implement RE Services in Lebanon

Rank	Sectors
1	Factories
2	Schools and Universities
3	Municipalities
4	Hospitals
5	Ministries

The projection of future demand for the RE services is shown in Figure 48.
The majority of RE suppliers stated that there is a high projection for future demand for RE services inthe future.

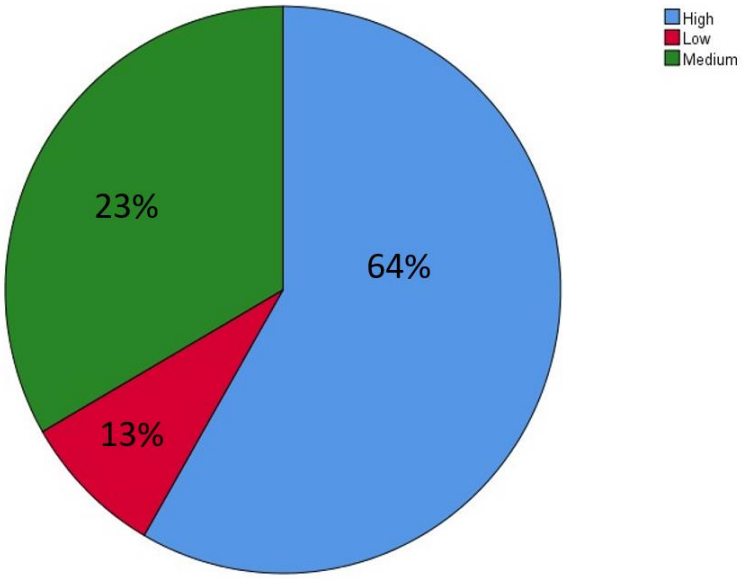

Figure 48 – The Projection for Future RE Demand in Lebanon

Lastly, the RE suppliers were asked to indicate the areas which are highly in need for the RE services installations in Figure 49. The results of the survey show their coincidence with the National Strategy for the water sector with nearly 37% of the RE suppliers, focusing on Agriculture (in the different purposes of Agriculture 23% and the need to focus in rural areas with a weak grid 14%), and pointing out the issue of water pollution (18%) due to the absence of wastewater treatment facilities. The survey also revealed another interesting potential sector for the installation of RE services, such as the public buildings (27%).

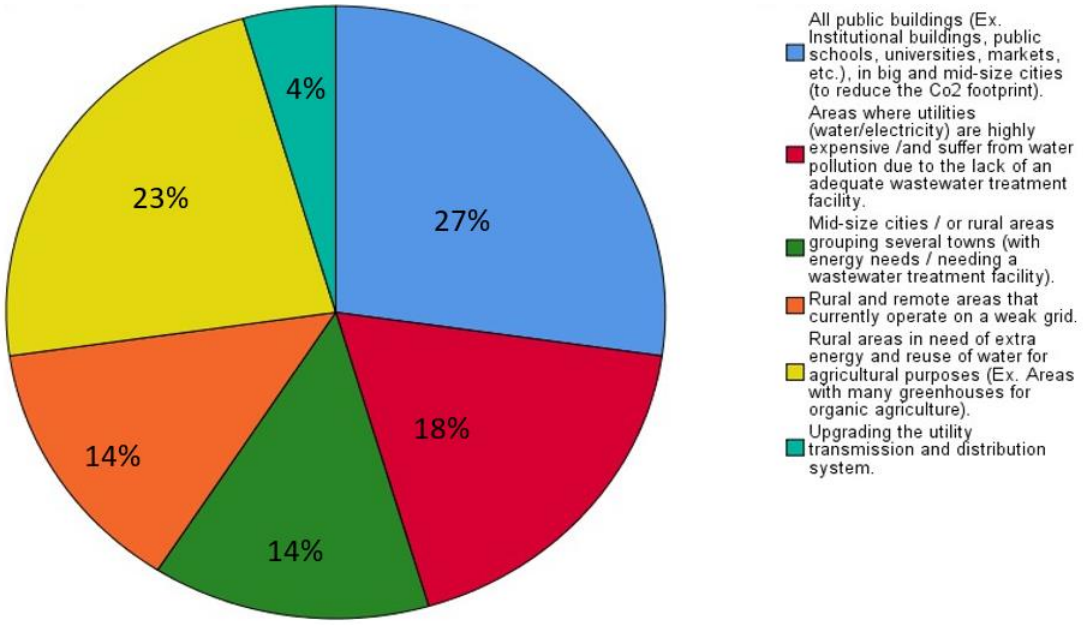

Figure 49 – Areas Highly in Need for RE Installations in Lebanon

According to the National Strategy for Water Sector issued by the Ministry of Energy and Water, the Lebanese wastewater network coverage is of 60 % which is higher than regional average, associated with significantly low treatment levels (< 8 %). Regarding the irrigation, it is the largest water consumer with low efficiencies, as open channels still constitute the majority of the networks. Therefore, the strategy recommends the increase coverage of wastewater collection networks and treatment capacities, and the optimizing of the current wastewater treatment processes and sludge disposal, and also ensuring adequate reuse of treated effluents where applicable especially for irrigation.

Future actions are planned such as:

1) Tariff structures significant modifications:

– For wastewater: a new tariff will be introduced in proportion with the used volumesof water supply;
– For water supply: the current flat tariff structure will be replaced by a volumetrictariff structure after replacement of gauges by meters;
– For irrigation: the different forms of tariffs currently applied will be replaced by volumetric tariffs.
In brief, tariff changes will have an impact on the different types of consumptions.

2) Legal framework reinforcement in order to improve the performance of the delivery of water and wastewater services and support the implementation of strategic initiatives.

3) Wastewater treatment and effluent quality improvements by:

– Reviewing and updating wastewater treatment and effluent standards

– Reviewing and adopting draft standards for wastewater reuse in agriculture andsludge reuse
– Implementing wastewater effluent monitoring systems.

4) Capacity building and pilots for wastewater sub-sector.

5. Conclusion

Over the past decades, demand on water and energy in the Southern Mediterranean countries has increased dramatically because of increasing population and urbanization growth, improvements in the standard of living and industrial development. Energy efficiency is the most cost-effective means of reducing the energy intensity of the economy and promoting a low-carbon future for the South Mediterranean countries. Energy efficiency further helps South Mediterranean countries meet their SDGs on combating climate change and its impacts (SDG13), as it cuts down on GHG emissions resulting from excessive and inefficient consumption of energy. Energy efficiency improvements can save governments, companies, and citizens billions of dollars in the Southern Mediterranean region from reduced energy bills, while at the same time quickly reducing carbon footprints – a win-win solution. Many countries in the region are now moving ahead with new laws, policies, and regulations to improve energy consumption but much more needs to be done to accelerate results and this was shown clearly in the results of this report.

This market assessment study for the three pilot countries Egypt, Jordan and Lebanon in the MAIA-TAQA project showed that there are significant opportunities for the development of RE services in the South Mediterranean countries. It is safe to conclude that the three pilot countries are in their initial stages of RE services provision and use and in this return opens different opportunities for all the stakeholders: SMEs involved in the RE sector (companies and professionals, technology distributors and sellers), business associations and chambers of commerce, national and sectorial institutions in addition to research centers and universities.

There is a wide array of measures on both supply side and demand side, to boost the pilotcountries' energy efficiency levels by promoting stringent environmental, energy saving policies to combat climate change. Formal energy efficiency programs and voluntary measures combined will help the Southern Mediterranean region to maintain its economic strength. Energy conservation programs in residential, commercial and industrial sectors can significantly reduce carbon emissions and augment energy supply in the Southern Mediterranean region. A robust regulatory and institutionalized framework can help to achieve a reduction in GHG emissions through a bundle of non- market based and market-based instruments.

By developing and enforcing more effective energy efficiency policies, providing stable sources of finance for initiatives that improve energy efficiency, and taking decisive measures to remove energy subsidies, South Mediterranean countries can significantly improve their energy efficiency, and reduce their energy intensities. Such measures will save South Mediterranean countries large portions of their GDP and will cut down their energy bills, as well as help the region fight climate change and maintain its commitmentto the UN's Sustainable Development Goals and their Nationally Determined Contributions.

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Annex 1

JS 1224-1:1999 Solar heating - Domestic water heating systems Part 1- Performance rating procedure using indoor test methods This part of the standard establish a uniform indoor test method for rating solar domestic water heating systems for thermal performance, under benchmark conditions. The test procedures are applicable only to solar water heating systems designed to heat potable water to be supplied for domestic water usage of 0.6m3 of solar storage capacity or less. (Published Document (JS))
JS 1224-2:1999 Solar heating - Domestic water heating systems Part 2- Outdoor test methods for system performance characterization and yearly performance prediction of solar - only systems This part of the standard establishes test procedure for characterizing the performance of solar domestic water heating systems operated without auxiliary boosting, and for predicting annual performance in any given climatic and operating conditions, but only for evening draw-off. The test procedures are applicable only to solar water heating systems designed to heat potable water to be supplied (Published Document (JS))
JS 1224-3:1999 Solar heating - Domestic water heating systems Part 3- Performance test for solar plus supplementary systems This part of the standard establishes test procedures for characterizing the performance of solar domestic water heating systems with in-tank auxiliary boosting, and for predicting annual performance in any given climatic conditions. The test procedures are applicable only to solar water heating systems designed to heat potable water to be supplied for domestic water usage. (Published Document (JS))
JS 1224-4:2015 Solar heating - Domestic water heating systems Part 4- System performance characterization by means of component tests and computer simulation This Standard defines characterization of domestic water heating systems performance by means of component tests and computer simulation (Published Document (JS))
JS 1224-5:2015 Solar heating - Domestic water heating systems Part 5- System performance characterization by means of whole-system tests and computer simulation This Standard defines characterization of domestic water heating systems performance by means of whole-system tests and computer simulation (Published Document (JS))
JS 1991-1:2011 Thermal solar systems and components- – Solar collectors Part 1: General Requirements 0 (Committee Draft (CD))
JS 1992-1:2015 Thermal solar systems and components – Factory made systems Part 1- General requirements This Jordanian Standard specifies requirements on durability, reliability and safety for Factory Made thermal solar heating systems. The standard also includes provisions for evaluation of conformity to these requirements. The requirements in this standard apply to Factory Made solar

systems as products. The installation of these systems itself is not considered, (Published Document (JS))
JS 1992-2:2015 Thermal solar systems and components - Factory made systems Part 2- Test methods This Jordanian Standard specifies test methods for validating the requirements for Factory made thermal solar heating systems as specified in JS 1992-1 The standard also includes two test methods for thermal performance characterization by means of whole system testing. (Published Document (JS))
JS 2086:2014 Solar energy - Solar thermal collectors - Test methods This Standard specifies test methods for assessing the durability, reliability and safety for fluid heating collectors. This Standard also includes test methods for the thermal performance characterization of fluid heating collectors, namely steady-state and quasi-dynamic thermal performance of glazed and unglazed liquid heating solar collectors and steady-state thermal performance (Published Document (JS))
JS 2113:2016 Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval This Jordanian Standard lays down IEC requirements for the design qualification and type approval of terrestrial photovoltaic modules suitable for long-term operation in general open air climates. It applies only to crystalline silicon modules types. This Jordanian standard does not apply to modules used with concentrated sunlight. (Withdrawn Document)
JS 2116:2016 Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval This standard defines requirements for the design qualification and type approval of terrestrial, thin-film photovoltaic modules suitable for long-term operation in general open-air climates as defined in IEC 60721-2-1. This standard is intended to apply to all terrestrial flat plate module materials not covered by IEC 61215. (Withdrawn Document)
JS 2117:2015 Photovoltaic devices – Procedures for temperature and irradiance corrections to measured I-Characteristics This standard defines procedures to be followed for temperature and irradiance corrections to the measured I-V (current-voltage) characteristics of photovoltaic devices. (Published Document (JS))
JS 2118-1:2015 Photovoltaic devices Part 1- Measurement of photovoltaic current-voltage characteristics This part of JS 2118 describes procedures for the measurement of current-voltage characteristics of photovoltaic devices in natural or simulated sunlight. These procedures are applicable to a single photovoltaic solar cell, a sub-assembly of photovoltaic solar cells, or a PV module. (Published Document (JS))
JS 2118-2:2016 Photovoltaic devices Part 2- Requirements for photovoltaic reference devices

	This part of JS 2118 gives requirements for the classification, selection, packaging, marking, calibration and care of photovoltaic reference devices. This standard covers photovoltaic reference devices used to determine the electrical performance of photovoltaic cells, modules and arrays under natural and simulated sunlight. It does not cover photovoltaic reference devices for use under (Published Document (JS))
	JS 2118-3:2016 Photovoltaic devices Part 3- Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data This part of the standard applies to the following photovoltaic devices for terrestrial applications: solar cells with or without a protective cover; sub- assemblies of solar cells; modules; systems. The principles contained in this standard cover testing in both natural and simulated sunlight. This standard is not applicable to solar cells designed for operation in concentrated sunlight (Published Document (JS))
	JS 2119:2015 Photovoltaic systems – Power conditioners – Procedure for measuring efficiency This standard describes guidelines for measuring the efficiency of power conditioners used in stand-alone and utility-interactive photovoltaic systems. (Published Document (JS))
	JS 2120:2015 UV test for photovoltaic (PV) modules This Standard defines a test which determines the resistance of the module when exposed to ultra-violet (UV) radiation. This test is useful for evaluating the UV resistance of materials such as polymers and protective coatings. (Published Document (JS))
	JS 2147:2016 Balance of system components for photovoltaic systems - Design qualification natural environments This standard establishes requirements for the design qualification of balance of system (BOS) components used in terrestrial photovoltaic (PV) systems. This standard is suitable for operation in indoor, conditioned or unconditioned; or outdoor in general open-air climates as defined in IEC 60721-2-1, protected or unprotected. (Published Document (JS))
	JS 2148:2016 Utility-interconnected photovoltaic inverters – Test procedure of islanding prevention measures The purpose of standard is to provide a test procedure to evaluate the performance of islanding prevention measures used with utility-interconnected PV systems (Published Document (JS))
	JS 2164-1:2018 Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance Part 1: Grid connected systems – Documentation, commissioning tests and inspection This part of Jordanian standard defines the information and documentation required to be handed over to a customer following the installation of a grid connected PV system. It also describes the commissioning tests, inspection criteria and documentation expected to verify the safe installation and correct operation of the system. It can also be used for periodic retesting. (Published Document (JS))
	JS 2165:2016 Photovoltaic (PV) systems – Characteristics of the utility interface

	This Standard applies to utility-interconnected photovoltaic (PV) power systems operating in parallel with the utility and utilizing static (solid-state) non-islanding inverters for the conversion of DC to AC (Published Document (JS))
	JS 2176:2019 Salt mist corrosion testing of photovoltaic (PV) modules Photovoltaic (PV) modules are electrical devices intended for continuous outdoor exposure during their lifetime. Highly corrosive wet atmospheres, such as marine environments, could eventually degrade some of the PV module components (corrosion of metallic parts, deterioration of the properties of some non-metallic materials - such as protective coatings and plastics - by assimilation of salts, (Published Document (JS))
	JS 2213:2019 Photovoltaic (PV) modules – Ammonia corrosion testing Photovoltaic (PV) modules are electrical devices intended for continuous outdoor exposure during their lifetime. Highly corrosive wet atmospheres, such as in the environment of stables of agricultural companies, could eventually degrade some of the PV module components (corrosion of metallic parts, deterioration of the properties of some non-metallic materials such as protective coatings (Published Document (JS))
	JS 2229-1:2019 Photovoltaic system performance Part 1: Monitoring This part of Jordanian standard outlines equipment, methods and terminology for performance monitoring and analysis of photovoltaic (PV) systems It addresses sensors, installation , and accuracy for monitoring equipment in addition to measured parameter data acquisition and quality checks calculated parameters, and performance metrics In addition, (Published Document (JS))
	JS 2229-2:2019 Photovoltaic system performance - Part 2: Capacity evaluation method This part defines a procedure for measuring and analyzing the power production of a specific photovoltaic system with the goal of evaluating the quality of the PV system performance. The test is intended to be applied during a relatively short time period (a few relatively sunny days). (Published Document (JS))
	JS 2229-3:2019 Photovoltaic system performance - Part 3: Energy evaluation method This part of Jordanian standard, which is a Technical Specification, defines a procedure for measuring and analysing the energy production of a specific photovoltaic system relative to expected electrical energy production for the same system from actual weather conditions as defined by the stakeholders of the test (Published Document (JS))
	JS 2230:2019 Design requirements - Photovoltaic (PV) arrays This Jordanian standard sets out design requirements for photovoltaic (PV) arrays including DC array wiring, electrical protection devices, switching and earthing provisions. The scope includes all parts of the PV array up to but not including energy storage devices, power conversion equipment or loads (Published Document (JS))
	JS 2231:2019 Photovoltaic (PV) Stand-Alone Systems - Design Verification 0 (Published Document (JS))

	JS 2248-1-1:2019 Terrestrial photovoltaic (PV) modules – Design qualification and type approval Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules This part of JS 2248 lays down the requirements for the design qualification and type approval of terrestrial photovoltaic modules suitable for long-term operation in general open air climates, as defined in IEC 60721-2-1. This standard is intended to apply to all crystalline silicon terrestrial flat plate modules. (Published Document (JS))
	JS 2248-1-2:2019 Terrestrial photovoltaic (PV) modules – Design qualification and type approval Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules This part of JS 2248 lays down the requirements for the design qualification and type approval of terrestrial photovoltaic modules suitable for long-term operation in general open- air climates, as defined in IEC 60721-2-1. This document is intended to apply to all thin-film CdTe based terrestrial flat plate modules (Published Document (JS))
	JS 2248-1-3:2019 Terrestrial photovoltaic (PV) modules – Design qualification and type approval Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules This part of JS 2248 lays down the requirements for the design qualification and type approval of terrestrial photovoltaic modules suitable for long-term operation in general open- air climates, as defined in IEC 60721-2-1. This document is intended to apply to all thin-film amorphous silicon (a-Si; a-Si/µc-Si) based terrestrial flat plate modules (Published Document (JS))
	JS 2248-1-4:2019 Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1-4: Special requirements for testing of thin-film Cu(In,Ga)(S,Se)2 based photovoltaic (PV) modules This part of JS 2248 lays down the requirements for the design qualification and type approval of terrestrial photovoltaic modules suitable for long-term operation in general open- air climates, as defined in IEC 60721-2-1. This document is intended to apply to all thin-film Cu(In,Ga)(S,Se)2 based terrestrial flat plate modules (Published Document (JS))
	JS 2248-1:2019 Terrestrial photovoltaic (PV) modules – Design qualification and type approval Part 1: Test requirements This standard lays down IEC requirements for the drsign qulification and type approval of terrestrial photovoltaic (PV) modules suitable for lon-term operation in general open-air climents, as defined in IEC 60721-2-1. is intended to apply to all terrestrial flat plate module materials such as crystalline silicon module types as well as thin-film modules. (Published Document (JS))
	JS 2248-2:2019 Terrestrial photovoltaic (PV) modules – Design qualification and type approval Part 2: Test procedures his Jordanian Standard lays down IEC requirements for the design qualification and type approval of terrestrial photovoltaic modules suitable for long-term operation in general open-air climates, as defined in IEC 60721-2-1. This part of JS is intended to apply to all terrestrial flat plate module

	materials such as crystalline silicon module types as well as thin-film modules (Published Document (JS))
	JS 2305-1:2020 Safety of power converters for use in photovoltaic power systems Part1:General requirements 0 (Committee Draft (CD))
	JS 434:1999 Solar energy - Flat plate solar collector - Construction requirements Specifies the design, construction, installation, workmanship and commissioning of components and system for flat plate solar collector (Published Document (JS))
	JS 61730-1:2020 Photovoltaic (PV) module safety qualification Part 1: requirements for construction 0 (Committee Draft (CD))
	JS 61730-2:2020 Photovoltaic (PV) module safety qualification Part 2: Requirements for testing 0 (Committee Draft (CD))
	JS 62109-2:2020 Safety of power converters for use in photovoltaic power systems Part 2: Particular requirements for inverters 0 (Committee Draft (CD))
	JS EN 61730-1:2012 Photovoltaic (PV) module safety qualification Part 1: requirements for construction This part of EN 61730 describes the fundamental construction requirements for photovoltaic (PV) modules in order to provide safe electrical and mechanical operation during their expected lifetime. Specific topics are provided to assess the prevention of electrical shock. (Published Document (JS))
	JS EN 61730-2:2012 Photovoltaic (PV) module safety qualification Part 2: Requirements for testing This part of EN 61730 describes the testing requirements for photovoltaic (PV) modules in order to provide safe electrical and mechanical operation during their expected lifetime. (Published Document (JS))