USAID/Community Support Program (CSP) in Lebanon

MARKET ASSESSMENT

SOLAR ENERGY SECTOR IN LEBANON

Date: April 28, 2022

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List of Acronyms

B2B	Business to Business
B2C	Business to Customers
CAGR	Compounded Annual Growth Rate
CIOM	Construct, install, operate, and maintain
CSP	Community Support Program
IRENA	International Renewable Energy Agency
LC	Lebanese Customs
LCEC	Lebanese Center for Energy Conservation
PV	Photovoltaic
RET	Renewable Energy Technologies
TP	Educational Labs *("Travaux Pratiques")*
TVET	Technical and Vocational Education and Training

Market Assessment

Preface

PFC International is currently working with Community Support Program (CSP) to conduct an in-depth assessment of the solar energy sector in Lebanon, focusing on the demand/supply gaps in the market such as, *but not limited to*, public sector's initiatives, labor market, educational institutions, and the private sector involvement, in order to provide evidence-based recommendations for a future intervention strategy in the sector's development.

PFC will support CSP in empowering the local renewable energy sector, specifically the solar energy sub-sector, by adapting and identifying existing and emerging opportunities driving the potential growth of the sector in Lebanon, covering:

Section 1	Section 2	Section 3	Section 4
Overview of the solar energy market in Lebanon: demand, supply (private and public sectors), and growth	Labor market in the Lebanese solar energy sector (qualification, skills, and experience)	Contribution of the educational institutions in the solar energy market in Lebanon	Summary of key findings, risk assessment, and recommendations for CSP

Executive Summary

Project Concept

- The project at hand consists of assessing the solar energy sector in Lebanon, in terms of demand, supply, education, and labor market, in order to provide evidence-based recommendations for any future interventions by CSP TO4.

Methodology & Data Collection

- PFC has conducted interviews with around 45 companies in the private sector, in addition to several TVETs, and entities in the public sector. The findings were also backed up with desktop research from trusted sources such as reports by LCEC, IRENA, UNDP, etc.

Lebanese Solar Energy Sector

- The Lebanese solar energy sector is currently booming, especially due to the electricity deficit, increased fuel prices, and high private generators' subscriptions that the country is facing.

Market Demand

- The sector is estimated to grow at a compounded annual growth rate (CAGR) of 10% for the forecasted period (2022-2030). The interviewed companies witnessed a 150% growth in sales and 215% growth in the number of projects compared to last year.

Market Supply

- According to LCEC, the number of Lebanese private companies involved in solar CIOM projects is increasing and is not showing any signs of slowing down. Site supervisors, technicians and workers are required on-field for solar CIOM projects. Solar companies are having difficulties finding skilled workers and technicians, which constitute the bulk of their workforces On the other hand, several initiatives by international donors and NGOs are being implemented to support the sector's growth.

Employment Opportunity

- Employment within the sector has increased, on average, by 70% in 2022 compared to 2020 to account for the growth in demand, especilly the number of projects. It is expected that around 25,000 jobs will be needed in the sector during the forecasted period.

Educational Programs

- Industrialists believe that a reinforcement of vocational training at local technical and secondary schools would be a necessity. However, few initiatives are being currently implemented, in order to equip students with the needed skills for solar CIOM projects. The curriculum should cover specific subjects such as safety measures, installation, wiring, maintenance, possible defects, etc. Currently, LT renewable energy is the only existing curriculum directly related to the solar energy sector in the Lebanese TVETs. Other curricula include 2-3 chapters/courses focusing on solar energy such as BT or TS industrial, mechanical, electrotechnical, and electrical

Conclusion

- In order to support the private sector's companies in finding the right profiles for their CIOM projects, while saving time and money spent for internal trainings, additional training materials/courses should be implememted in the TVET sector in Lebanon. Currently, these employees are either skilled or unskilled workers, having BT or TS electrical, mechanical, and electromechanical or they are workers with no educational backgrounds.

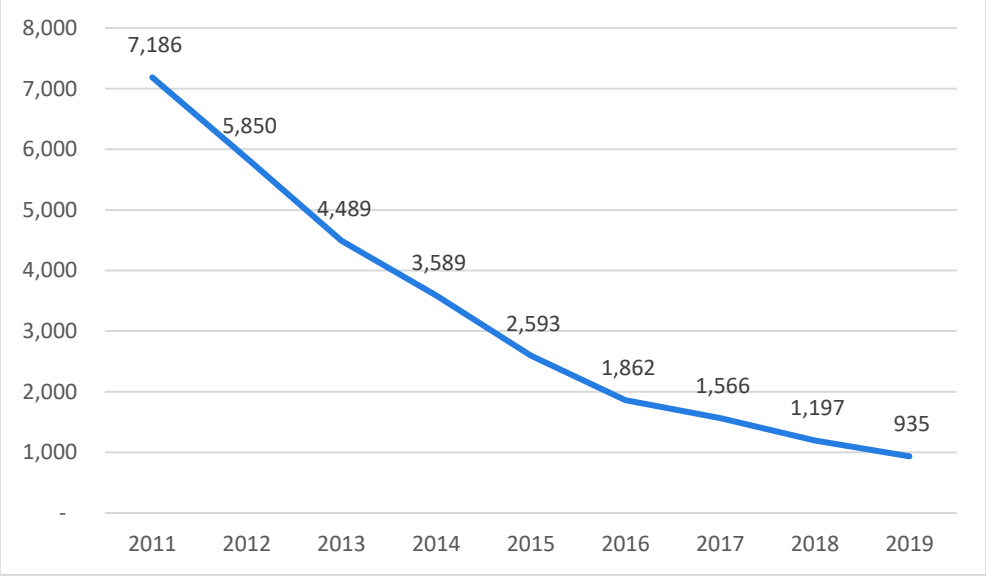
1. Solar Energy Sector in the Lebanese Market

1.1 Market Demand Overview

The Lebanese market gradually evolved from *absence of competition, know-how, and awareness* in solar PV over a decade ago to an *established market today,* according to the most recent statistics from the Lebanese Center for Energy Conservation (LCEC) and the United Nations Development Program-Decentralized Renewable Energy Generation Project (DREG). The dynamics changed over the years due to the financial incentives and instruments supported by national commitments to renewable energy as well as the market's improving technological maturity and feasibility.

Lebanon has been following the global trend in terms of declining costs of solar energy applications. The average turnkey price for solar PV has declined by 83% in eight years, as shown in the figure 1, mainly due to the drop in the cost of equipment and the financing mechanisms to incentivize technology deployment.

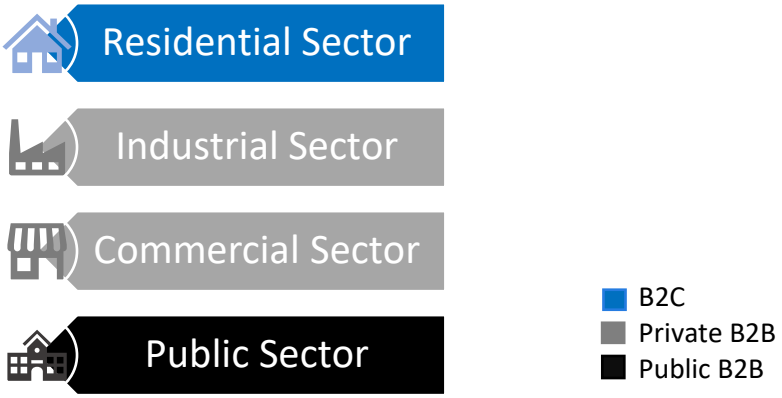
Figure 1- Yearly average solar PV turnkey price in USD/kWp



Source: LCEC

There has been recently an explosion in interest in alternative energy, and thousands of Lebanese people are now turning to solar power to seek independency from an unreliable power grid. In a country that sees about 300 days of sun per year, solar systems can be applied on small, medium, and large scale projects.

The recent projects in the solar energy sector fall under the following sections:



- The **residential sector**'s projects are considered to be small scale projects that have highly increased in the past year. They are usually self financed.
- The projects for the **industrial and commercial sectors** are large scale projects. Solar PV systems are the number one solution for alternative electricity power. They are usually funded by the entity itself, by donations or, *previously*, by loans.
- The **public sector's** projects, such as street lighting, are large scale projects usually implemented by donations from international programs/agencies.

The majority of the Lebanese solar energy contractors interviewed in this study agreed with this boom is the sector, saying they have never seen this type of interest in solar power before.

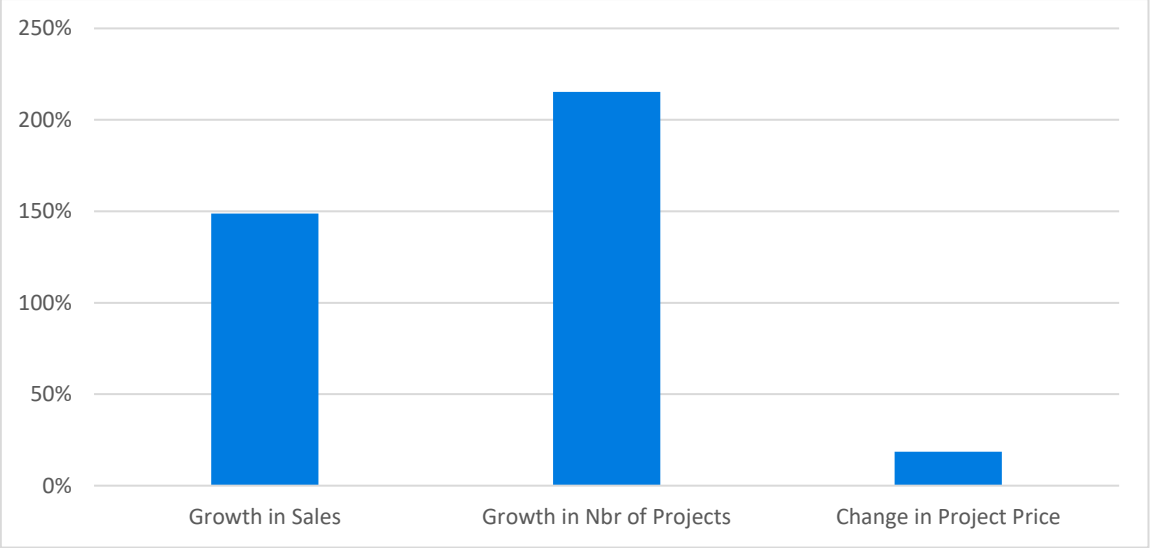
Based on the interviews conducted with private companies involved in CIOM projects in Lebanon, find in Table 1 the increased sales, number and sizes of projects of 45 companies in the past year.

Table 1-Incresed demand based on the private sector's companies

Company	Growth in Sales	Growth in Nbr of Projects	Change in Project Price
ASACO	200%	200%	-30%
Green Essence	400%	400%	55%
ME Green	300%	300%	20%
Tfaily Solar Energy	200%	250%	20%
Zmerly and Co	400%	500%	30%
Chababi Electro Store	300%	300%	-5%
Dolmen Corporation	100%	100%	-7%
Elements Sun & Wind	100%	100%	10%
AEMS	300%	300%	20%
AL DIYAR FOR ENGINEERING & CONTRACTING & TRADE	300%	300%	30%
AL SHAMS GROUP	250%	250%	-20%
Green Energy System	50%	50%	25%
Green Power Tech	100%	1000%	30%
HABASH ELECTRICAL& HYBRID TECHNOLOGY (HEHT)	700%	800%	50%
Ijazi Investment Company LTD.	100%	100%	60%
JF GROUP	100%	100%	10%
JUBAILI BROS SAL	100%	100%	5%
Kypros/MAWARED & CONSTRUCTION CO	400%	400%	60%
COGEDIS SAL	- 50 %	- 50 %	0%
Contracom International	500%	500%	1.5%
DERVICHE HADDAD	- 60%	- 40%	15%
EMARTS / GREEN ESSENCE LEBANON	30%	30%	20%
EMPS	100%	100%	40%
Energies-Sport-Sante	500%	200%	20%
Energon	50%	50%	25%
FENDI	70%	30%	25%
GEORGES AZAR	100%	1300%	15%
GIO Electrical services	100%	100%	20%
Plemicor Industries	6%	20%	20%
Power & Automation Control- PAC	60%	150%	20%
Power and Green	15%	50%	10%
Prominence Gold PRG sal	45%	175%	15%
RAYMOND EL ACHKAR & SONS	60%	250%	20%
RENEWABLE MED ENERGY	30%	25%	10%
SAAB RDS INC	30%	50%	20%
SLOGA SARL	50%	120%	30%
Smart Business SAL	200%	300%	-10%
SOLARTECH	0%	10%	5%
SUN FOR FREE	100%	200%	10%
Sustainable Energy Partners SARL	50%	100%	0%
T.G.M electronic	100%	160%	30%
TABET ENGINEERING AND LIGHTING Co.	50%	100%	25%
Aquarius	0%	50%	40%
Black Box	95%	90%	20%
BUTEC	60%	70%	20%

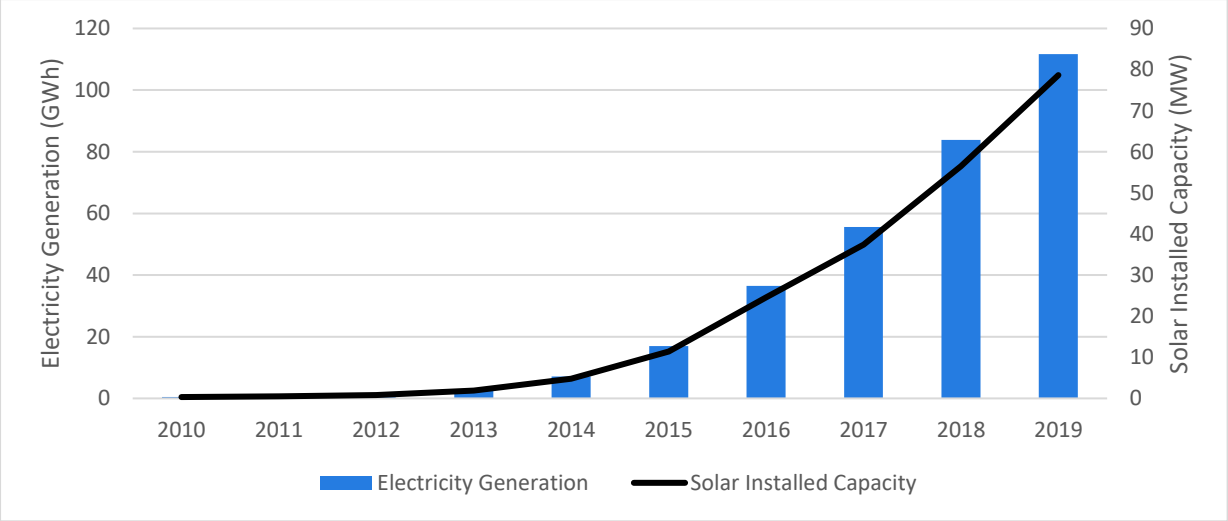
In conclusion, kindly find below the average growth rate of sales, number of projects, and price per project for the private sector's companies:

Figure 2-Growth Rate – Private Companies' Growth



Furthermore, based on a recent report by IRENA, the annual growth in the Lebanese solar energy sector compared to the general electricity generation over the years is shown in figure 3.

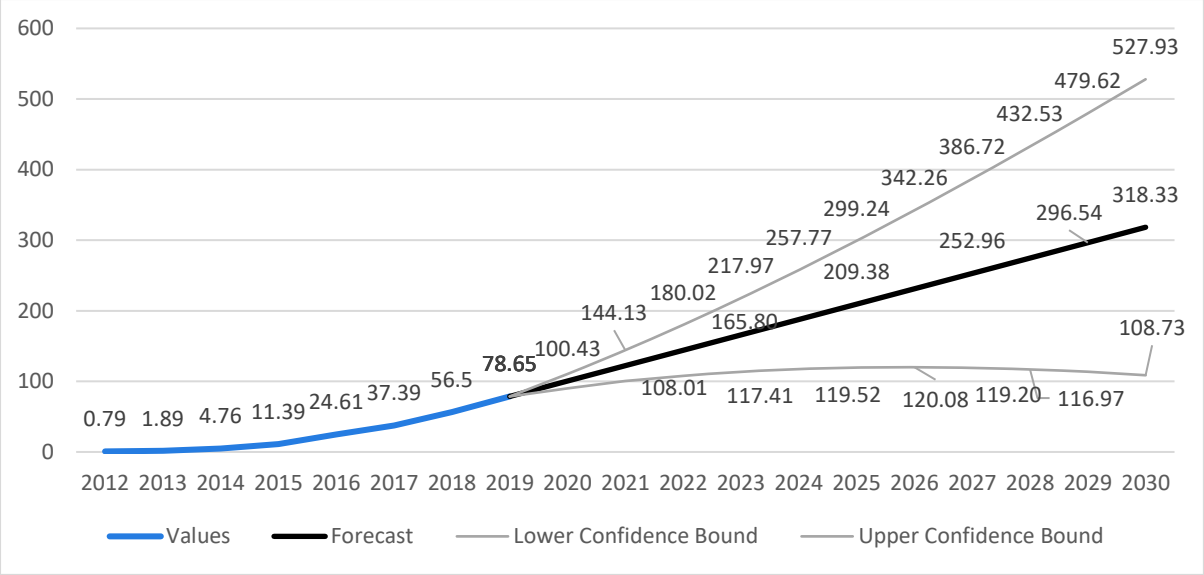
Figure 3-Solar Installed Capacity (MW) and Electricity Generation (GWh)



Source: Renewable Energy Outlook by IRENA

Using the "Forecast Sheet" option in Excel, the projected growth in solar installed capacity could be estimated as follows:

Figure 4 – Forecaste Growth Rate of the Solar Installed Capacity in Lebanon



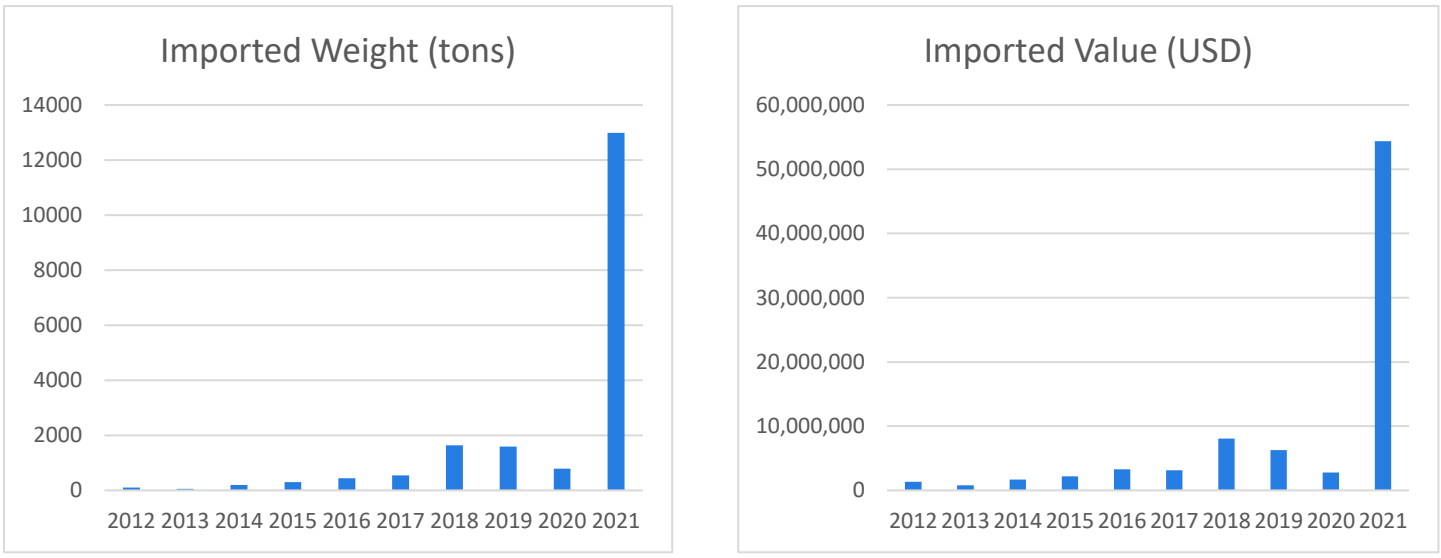
The average growth rate (following this boom in the sector) for the upcoming years is expected to stabilize to a CAGR of **12%.**

The 2019 Solar PV Status Report For Lebanon by LCEC confirms the same numbers shown in figure 3:

- From 2010 until the end of 2019, the cumulative installed solar PV capacity grew by an average rate of 89% per year.
- The number of new public and private solar PV projects per year increased from 25 in 2011 to 360 in 2019.

On the other hand, based on the Lebanese customs' (LC) website, it can be seen clearly that the import of solar energy equipment was increasing gradually since 2012 but increased in an unexpected way in 2021:

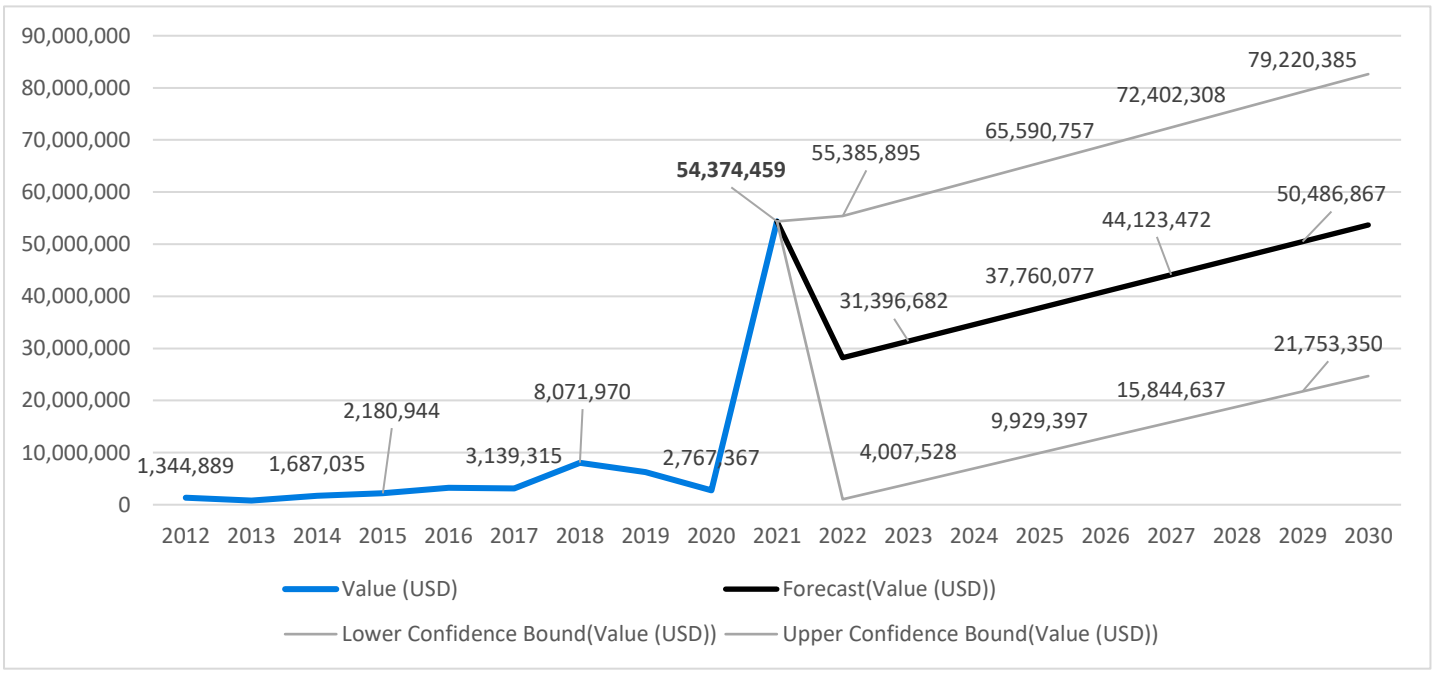
Figure 5 - Lebanese imports of PV systems (based on the Lebanese Customs)



Source: Lebanese Customs

As per our interviews with the private sector's companies, they have stated that they can not afford buying huge quantities without having pre-orders or being 100% sure that the projects will be implemented. In other terms, no stock can be afforded nowadays due to the economic crisis, reflecting directly on the high demand on solar PV systems. Using the "Forecast Sheet" option in Excel, the projected growth in imports of PV systems could be estimated as follows:

Figure 6-Projected growth in the importation of Solar PV systems (in USD)



The average growth rate (following this boom in the sector) for the upcoming years is expected to stabilize to a CAGR of **8%.**

1.2 Expected Market Growth Rate

1.2.1 Demand Drivers

The main factors driving the demand for solar energy in Lebanon are the following:

- **Electricity Deficit and Blackouts:** The electricity prodided by EDL has dwindled to 2-3 hours per day, and has been shut off completely is some areas of the country. Even at maximum capacity, EDL fails to deliver the amount of electricity that the country requires based on euronews.green's article. Faced with total blackouts in summer 2021, households and businesses - *which can afford to* - are now rapidly shifting to solar power for their basic electricity needs.
- **Private Generators Subscriptions:** The diesel required for generators were heavily subsidised by the Lebanese state. Therefore, the subsidy program, as well as the better economic conditions that existed before 2019, meant that a majority of households were able to bridge the gap in the state supply, by subscribing to private generators. These subsidies are estimated to have contributed to as much as 43% of Lebanon's rocketing public debt, while the energy sector incurs huge annual losses due to inefficient plants, low fees, and poor rates of collection.
- **Fuel Crisis:** The subsidy for fuel has been officially stopped. As a result, the cost of subscriptions to local generators has sky-rocketed. In a country where the minimum wage is currently less than $50, households are now paying up to USD 400 per month for generators and still not receiving 24-hour power.
- **Decreased costs for solar energy projects:** As a result to the crisis faced nowadays, the price of electricity generated by solar panels is cheaper than the one generated by fossil fuels. Therefore, the payback period of the solar panels has decreased to be around 2 years for the residential sector.
- **New law in the making:** The new law "puts" the existing electricity network, infrastructure, substations, networks, and equipment owned by EDL under the authority of the private sector. For example, private entities could buy or rent a land anywhere in Lebanon, build their private solar farm, and use the network provided currently by EDL to transfer electricity to their facilities. The private sector would be able to produce green energy, and use it in its daily operations, driving the demand to solar power plants.

1.2.2 Growth Rate

In order to forecast the growth rate for the solar energy sector in Lebanon we have first estimated the historical growth:

Parameter	Growth Rate (2020-2021)	Source	Allocation*
Solar Installed Capacity	89%	IRENA – Figure 3	30%
Sales Growth (private companies)	152%	Interviews	20%
Imports of Solar PV systems	232%	LC – Figure 5	50%
173% Growth Rate in 2020 - 2021			

**A lower allocation was attributed to the interviews' findings the to avoid outliers and non-accurate responses*

Using the same approach, the forecasted growth rate could be estimated as follows:

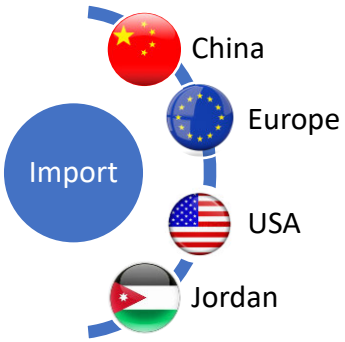
Parameter	Growth Rate (2022-2030)	Source	Allocation
Solar Installed Capacity	12%	IRENA – Figure 4	30%
Sales Growth (private companies)	13%	Interviews	20%
Imports of Solar PV systems	8%	LC – Figure 6	50%
10% Yearly Growth Rate (2022-2030)			

1.3 Market Supply Overview

1.3.1 Equipment Supply

According to a report by the UNDP-CEDRO, the country relies on imports of modules, inverters, and controllers from many countries, often from China, Germany, and the USA. This is further justified by the interviews conducted with the private companies:

- Most of the companies such as GP Stellar, ACEMCO, Arison as well as many others import the majority of their equipment from **China.**
- Companies like ME Green import from **Europe** for BIPV projects.
- Few companies like ASACO import some of their equipment for **USA**.
- Other companies are currently relying on imports from **Jordan** to avoid shipping delays.



It is important to note that sometimes the origin of the importer is imposed by the donor or is determined within the tender's specifications. Not to forget that some companies like Power Matrix Network make the **final assembly in Lebanon** in rare cases. However, the final assembly needs a lot of effort, time and expertise. As a result, local private companies usually avoid it but would be able to do it only if the government would offer certain incentives (custom duties' reduction for example) or if the NGOs would be more likely to work with them in certain tenders, as recommended by [redacted] ME Green.

On the other hand, these private companies are facing problems when importing the solar-related equipment regardless of the country of origin caused by:

- **Shipping delays:** A problem faced worldwide caused by the coronavirus pandemic.
- **Shortage of equipment:** Due to the global increased demand on solar energy panels.
- **Poor quality of equipment:** During summer 2021, solar panels imported from Europe were supposed to be brand new but they turned out to be used and having bad quality, causing trust issues within the customer.
- **Congestion at Port of Beirut:** The delivered orders are taking a lot of time to undergo quality assurance testing before entering the Lebanese territory. The quality check is mainly made by the Industrial Research Institute (IRI).

On the other hand, they are facing several challenges when installing the systems:

- **Poor Infrastructure:** Due to the absence of norms and regulations in regard of the solar energy sector, the electrical infrastructure that is already installed in the country is very poor, thus leading to deteriorating solar energy systems.
- **Lack of space:** The lack of space required to install the PV systems is a main constraint faced by the contractors, especially in the residential sector. These buildings include several appartments willing to benefit from the solar panels but are restricted to the little space available on the roofs.
- **Absence of norms and regulations:** This is the main reason behind the poor quality of systems installed in Lebanon.

Noting that the supply of solar PV systems has notably increased as shown in Figure 5 (section 1.1).

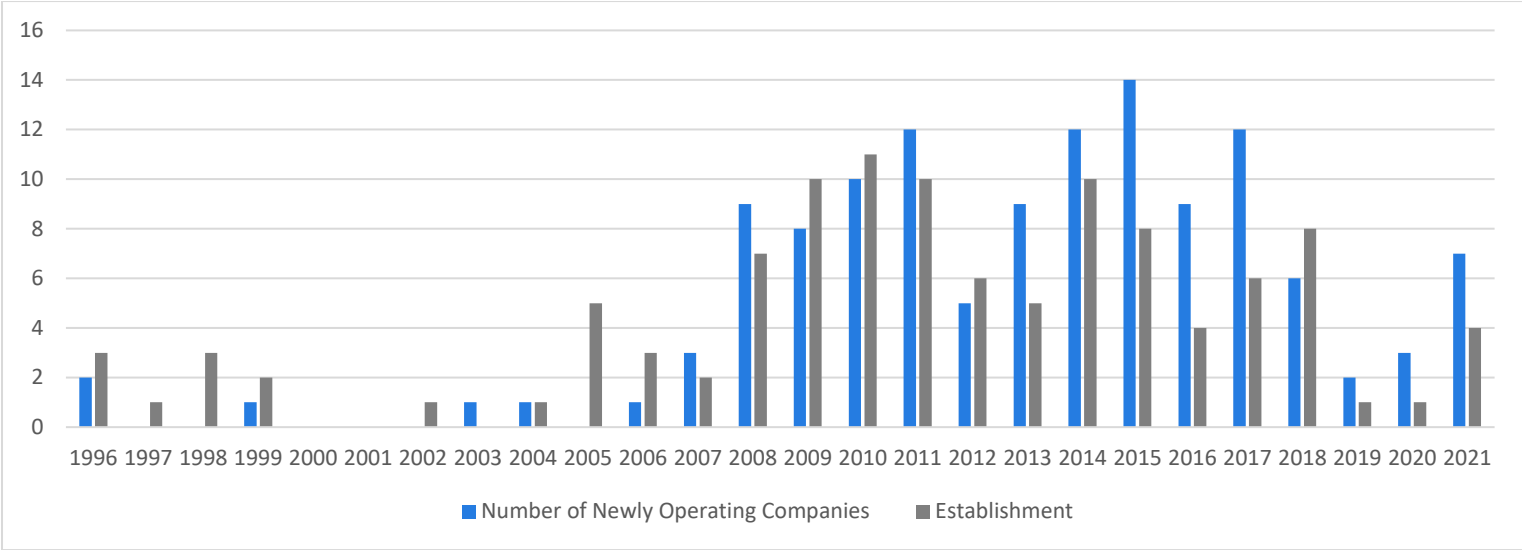
1.3.2 Private Sector

A lot of Lebanese companies are currently working in the solar energy sector. The majority of the companies usually execute turnkey projects including:

The companies majorly work in all sectors: industrial, commercial and residential in addition to applying for tenders in order to execute projects for the public sector. Some companies like ACEMCO and Matrix Power Network are also distributors of the solar panels for certain brands.

On the other hand, the increased demand for solar energy systems recently resulted in an increase in the number of companies currently operating in the sector, as shown in Figure 7. It is important to mention that some of the new companies are not professional and not competent to be working in this sector due to their lack of knowledge and experience which irritates the competent companies.

Figure 7-New Solar Energy Companies Established and Operating Each Year



Nowadays, the solar panels installation turned out to be a commodity that should be present in every Lebanese house. This is highly illustrated by the private companies like GP Stellar and Power Matrix Network that noticed a market shift during the last year from large projects usually implemented in the industrial sector to small projects in the residential sector.

1.3.3 Public Sector

The current dependency on external grants and support has limited solar projects to some municipalities, which were willing to select renewable energy alternatives. There is still no substantial large-scale government-driven implementation of solar PV in Lebanon, and this is directly related to a lack of targeted policies, which promote this aspect. In general, the projects implemented in the public sector are usually via donations from NGOs or from countries contracted by Lebanese private companies.

- Solar Street Lighting in collaboration with municipalities
- Solar panels for public schools
- Solar panels for public hospitals
- Solar panels for public librairies
- Solar panels for public institutions such as municipalities, ministries, etc.

The NGOs/donors invite specific parties to submit a proposal for a specific solar energy project, by preparing and submitting a “Terms of Reference (TOR)” or “Request for Proposal (RFP)”. These documents outline what the NGOs/donors need, their criteria, requirements, and any other instructions. Entities interested in providing the services use these documents to develop their proposal. They explain why they are the best choice for the project, convincing the procurer that they’re offering the best value for the money.

For example, ALMEE gets the funds from the European Bank to offer solar street lighting for the municipalities. Another example is GIZ that works with DRC, UNICEF, and Mercy Corps to conduct projects for the public sector like installing solar panels for schools and hospitals.

Moreover, UNDP usually works with USAID to provide the required funding for these types of projects. Find in the Table 2 below some projects implemented by these NGOs in the Lebanese solar energy sector:

Table 2 - Projects in the Solar Energy Sector Provided by NGOs

NGO	Project	Description	Timeframe	Partners	Donor
OSAS	#Sawa_Mendawi_ Beirut	Installation of Solar Energy Systems in Beirut to support the affected families near Beirut port after the explosion on the 4th of August 2020.	30/11/21 - ongoing	Live Love, Tadamon Crowdfunding Community, UNDP, IsDB, and IsFD	Donations
MONEERA	(About)	MONEERA is a non-profit social enterprise focused on alleviating the electric power shortage problem in Lebanon. Their vision is to relief the national power grid through solar hybrid distributed generation in remote areas.			MONEERA
ALMEE	(About)	ALMEE is "a non-political & non-profit association" committed to better handling of multiple issues and technologies associated with Energy and Environment, not just in Lebanon but also across the Mediterranean Basin and worldwide.			
Greenpeace MENA	Solar Power To The Women	The solarization of the women cooperative center will start with an energy audit that will identify its energy consumption. Then, a set of energy efficiency measures to reduce energy consumption such as lighting retrofit and piping insulation will be implemented. Finally, a solar energy system will be installed on the roof of the Cooperative.	25/08/16 - N/A	researchers and volunteers	Donations
René Moawad Foundation (RMF)	Promoting Sustainable Livelihoods- PSL	The PSL project aims to improve the livelihoods of residents of target municipalities through training, technical assistance, infrastructure rehabilitation, and marketing and improve and upgrade existing assets in their municipalities. The PSL goal is to sustain the livelihoods of 31,500 households across 7 clusters joining 130 municipalities in the North, Bekaa, South and Mount Lebanon areas (first phase).			USAID
	Arzoun PV system	A PV system will be installed in Arzoun village which is located in Tyr District, to promote renewable energy solutions in order to reduce dependence on fuel consumption, and upgrade the back-up electricity distribution networks, which are powered by the municipal generators.	22/03/21 - N/A	BALADI	USAID
	Design and supervision for the implementation of two solar water-pumping systems	Request for the Services of a Solar Energy Consultant for design and supervision. Two solar pumping systems to be installed consists in adding solar panels with all accessories and required electronic equipment to power the existing water pumping system. One in Burj Rahal, South Lebanon and the other in Deir Qanoun Ras el Ain, South Lebanon.	16/01/21 - 24/03/21	BALADI	USAID
UNIDO	Market-based construction skills training for all	The purpose of the project is to enhance the potential for job creation in the construction related sector and/or sub-sectors in specific to increase in the number of skilled labour accessing jobs and economic opportunities in the construction related sector and/or subsectors. The primary objective of this assignment is to engage the different partners and stakeholders in developing a sustainability strategy to ensure the continuity of the training after the end of the project.	11/08/20 - 30/12/20		UNIDO
IRENA	IRENA Outlines Key Actions Needed to Accelerate Renewables in Lebanon - 2022	Prepared by IRENA in collaboration with Lebanon's Ministry of Energy and Water, and the Lebanese Center for Energy Conservation, the report aims to support the establishment of a clear and well-designed roadmap for the country's renewable energy development by 2030. The Outlook examines the policy, regulatory, financial and capacity-related challenges to overcome in pursuing Lebanon's energy transition plans.	2020 - ongoing	Lebanon's Ministry of Energy and Water, and the Lebanese Center for Energy Conservation	NEEREA, LEEREFF and GEFF

UNDP	Country Entrepreneurship for Distributed Renewables Opportunities	The CEDRO 5 project aims at assisting the Government of Lebanon to reach its Nationally Determined Contribution targets for Renewable Energy and Energy Efficiency. On the other, it aims at assisting Lebanon in fostering growth for Small and Medium Enterprises (SMEs) and creating jobs from the momentum of existing value chains in RE/EE and creating new momentum in new RE/EE value chains	15/11/19 - ongoing Expected end date: 14/11/23		UNDP
	USEK and the EU-funded CEDRO	Université Saint-Esprit De Kaslik – (USEK) teams up with the European Union funded CEDRO project to implement a sustainable energy strategy at the university level and action plans to mitigate climate change. All this providing positive change to the university community at large.	1/1/14 - 1/8/18	USEK	EU-funded
	Solar power for women empowerment	To transform potential energy solutions into women economic empowerment, UNDP, in partnership with the Government of Canada, is enhancing the integration and advancement of women in the renewable energy sector by improving their know-how and active role in installing, repairing, and maintaining solar panels.	2021 - ongoing	Government of Canada	UNDP
	Response to the impact of COVID-19 in Lebanon, Solar for Health Project	Funded by KfW Bankengruppe and in coordination with the Lebanese Ministry of Public Health, the Response to the impact of COVID-19 in Lebanon will work on several activities, including Activity 1.3 "Implementing solar for health initiatives". Sustainable energy interventions will be designed and implemented to target 10 public sector hospitals that were selected in different regions of Lebanon under the Ministry of Public Health Phase 1 plan for COVID-19 response.	23/12/20 - 06/01/21	Lebanese Ministry of Public Health	KfW Bankengruppe, UNDP
Sustain The World Org - Sustainable Empowerment for Youth International	RISE2030	RISE2030 is a community-led initiative that focuses on empowering women and youth, aiming at capacity building and improving living conditions through access to education and employment. RISE2030 launched the first all-women solar team in Lebanon to challenge the gender stereotypes in the male-dominated construction sector.The solar training for women was also replicated in North Lebanon and Mount Lebanon under the Women Economic Empowerment Project with The Embassy of Canada, UNDP and RMF.	2015 - 2030	GIZ - UNDP - RMF - Sustain The World Org - Sustainable Empowerment for Youth International - WECF - Federal Ministry for Economic Cooperation and Development	
PCPM	MASAR	MASAR for Local Governments is a programme funded by the EU MADAD trust fund and implemented in Lebanon and Iraq. The overall aim of the programme is to strengthen the long-term resilience of targeted subnational governments and their host, refugee and IDP populations to deal with displacement. The aim of the consultancy is to support GIS units of three Unions of Municipalities (UoMs) as well as a wastewater treatment plant with designs of feasible solar energy systems allowing them to function despite the poor supply of electricity.	05/09/21 - N/A	Unions of Municipalities (UoMs)	EU MADAD
GIZ	SUFA	"Sustainable Facility Management in Public Schools in Lebanon" (SUFA) program will support the Lebanese Ministry of Education and Higher Education (MEHE) in managing their facilities in a more efficient and eco-friendly way. SUFA aims at ensuring a healthy and safe environment for the children, reducing the schools' environmental footprint and operating costs, promoting the concept of Green Schools, and strengthening the digital capacities of schools in Lebanon The objective of this consultancy is to focus on Facility Management and Green Schools.	13/04/22 - 30/11/23	Lebanese Ministry of Education and Higher Education (MEHE) - SUFA	German Federal Ministry for Economic Cooperation and Development
Mercy Corps	Solar energy system vocational training	Mercy Corps is seeking to contract service providers (private institutions, non-governmental organizations, Technical Schools/Institutions, and specialized firms), or Individual trainers to provide short vocational courses for PV Solar Energy System.	02/01/22 - ongoing		Mercy Corps

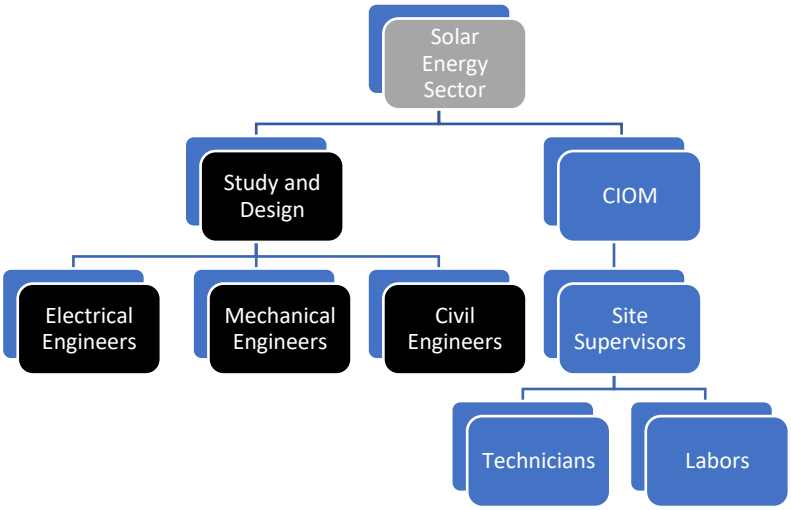
One the other hand, other donations being used in the solar energy sector such as the donation provided by Japan in collaboration with the ministry of education, that have recently funded the installation of solar panels for 122 schools in the country.

- **International Finance Corporation (IFC):** IFC assisted the Lebanon Green Building Council (LGBC) in developing a rating system for existing commercial buildings.
- **Lebanon Energy Efficiency & Renewable Energy Finance Facility:** The LEEREFF project concerned a EUR 80 million Global Loan provided by EIB (EUR 50 million) and AFD (EUR 30 million) supporting small-scale investments in energy efficiency and renewable energies by private companies in Lebanon, with a particular focus on SMEs. Energy efficiency measures will target fields of e.g. cooling, lighting, heating, ventilation, air-conditioning, motors and production processes in industry and in the tertiary sector. Investments in new buildings ("Green" buildings) in the tertiary sector achieving a substantial energy performance increase compared to the usual standard may also be eligible. Individual projects may have investment costs of up to EUR 15 million and in exceptional cases up to EUR 25 million.

2. Employment Opportunities in the Lebanese Solar Energy Sector

2.1 Employment and Skills Needed

All the companies interviewed agreed on the following organization structure for their technical team working in the solar energy sector:



Noting that our main interest is in the positions highlighted in blue.

- The engineers mainly work on the design of the solar systems, contacting the suitable supplier and keep track of the execution of the projects.
- The site supervisors take care of the project's execution based on the design assigned by the engineers and supervise the workers on site to insure a safe installation of the solar panels.

- The technicians usually execute the projects: install the panels and link them to the existing electrical infrastructure.
- The labors usually help the technicians in completing the tasks by installing and transporting the needed equipment for example.

2.2 Job Requirements

The job requirements for CIOM projects is currently met through companies' training and orientation:

- For the study and design, the electrical and mechanical engineers acquired the needed skills during their university years.
- The site supervisors can be both electrical engineers or TS electrical graduates.
- The technicians can be TVETs graduate students in the electrical, mechanical, and electro-mechical majors. They can be also unskilled labors who gained skills during the implementation of previous projects.
- The labors can be both skilled or unskilled since their main task will be carrying the equipment and helping the technicians install the systems.

Upon interviewing the private sector's companies, they stated that, because of the lack of vocational trainings, courses, or even chapters about solar energy projects in the educational sector, they are internally training the employees to equip them with the needed skills for CIOM projects. Moreover, according to the interviewed employees within the sector, they have faced several difficulties when they first joined their jobs, and recommended having vocational trainings during their school years (TVETs).

- **Engineers:**
    - The responsibilities of engineers are as follows:
        - Test or evaluate photovoltaic cells or modules.
        - Review specifications and recommend engineering or manufacturing changes to achieve solar design objectives.
        - Perform thermal, stress, or cost reduction analyses for solar systems.
        - Develop standard operation procedures and quality or safety standards for solar installation work.
        - Provide technical direction or support to installation teams during installation, start-up, testing, system commissioning, or performance monitoring.
        - Perform computer simulation of solar photovoltaic (PV) generation system performance or energy production to optimize efficiency.

- Develop design specifications and functional requirements for residential, commercial, or industrial solar energy systems or components.
- Create plans for solar energy system development, monitoring, and evaluation activities.
- Create electrical single-line diagrams, panel schedules, or connection diagrams for solar electric systems using computer-aided design (CAD) software.
- Create checklists for review or inspection of completed solar installation projects.

  - The qualifications and requirements for engineers are as follows:
    - 2+ years of commercial PV system design, permitting, construction, commissioning and O&M
    - Experience in providing technical support energy-related projects with accountability for project performance and design
    - Strong knowledge of photovoltaic system design and optimizing system components for energy production
    - Strong knowledge of electrical and structural design components and manufacturers
    - Experience in value engineering of photovoltaic or other constructions projects
    - Good working knowledge of standard utility process for interconnection approval and design requirements

- **Site Supervisors:**
  - The responsibilities of site supervisors are as follows:
    - Works with Project Manager and Design Engineer to coordinate equipment procurement and manage logistics for projects;
    - Manages staffing for individual projects, including assignment and supervision of in-house and/or subcontracted technicians;
    - Supervises solar PV installations, including mechanical, electrical, civil and/or structural aspects, while prioritizing high quality workmanship and a safe working environment;
    - Execute with little instruction on day-to-day work or with only general instructions on new assignments.
  - The Qualifications and Requirements for site supervisors are as follows:
    - 2-3 years experience working on grid-tied and/or off-grid solar PV installations;
    - Willingness and ability to guide technicians on best-practice tools, materials and techniques;

- **Technicians:**
  - The responsibilities of technicians are as follows:
    - Mechanical/structural mounting of racking, modules and electrical equipment
    - Assembly of mounting hardware
    - Verifying structural attachment
    - Working on residential and commercial roof tops as well as installing ground mounted systems
    - Pulling inventory for specific projects
    - Following layout of solar modules

  - The Qualifications and Requirements for technicians are as follows:
    - TVET graduate is preferred from electrical, mechanical, or electro-mechanical background
    - 1-2 years of solar energy background is preferred
    - Experience in mechanical installations, general construction and ladder work
    - Experience with all types of hand-held and power tools
    - Basic understanding and experience with electrical wiring of AC and DC systems is preferred.
    - Experience working with all types of building materials - various roof types: stucco, wood, concrete, Uni-strut, etc., is preferred
    - Desire to learn and master all aspects of installing solar PV systems.

2.3 Current Employment Status

2.3.1 Qualifications

The majority of the employees currently working in the solar energy sector expanded their knowledge via internal and external trainings and certificates like CEM, CMVP, EEP, PCF, CDSMA and developed the skills needed by experience.

Whereas, a small proportion of the employees in the solar energy sector is specialized.

- **The engineers:** Some companies (ASACO, ARISON, ACEMCO) have engineers who pursued their masters in renewable energy in a foreigner university or the companies even employ PhD holders like ASACO and ALMEE.
- **The site supervisors:** They can be both electrical engineers or TVETs graduates from an electrical or mechanical background having an experience in the solar energy sector.

- **The technicians:** They are TVETs graduates (BT or TS graduates) in mechanical, electrical, or electromechanical. They might be also unskilled people who developed the skills needed in the PV market by attending trainings or simply by experience.
- **The labors:** The majority of the labors are uneducated labors who recently joined the solar energy sector by helping the technicians on site. They are usually contracted workers on a project by project basis.

On a side note, skilled employees and technicians tend to gain their experience entirely through their job, but industrialists believe that a reinforcement of vocational Renewable Energy Technologies (RET) training at local technical and secondary schools would be helpful. Emigration of professional staff and skilled workers to better paying countries remains a major obstacle for RET industry owners.

According to industry experts, much of the technical skills required are the same as regular construction related technical skills, and only need adaptation to renewable energies. There are some variations that need to be taken into consideration.

2.3.2 Demand/Supply

The demand for workers in this sector has obviously increased as the number of solar projects has increased. Companies are increasing the number of their team members to complete their projects on time. This demand is for engineers as well as technicians. Several companies like ACEMCO are currently working with technicians on project basis to be able to cover this huge demand. Find in the table below, the average increasing employment rate per each contacted company:

Table 3 - Increaing Employment Rate per Company

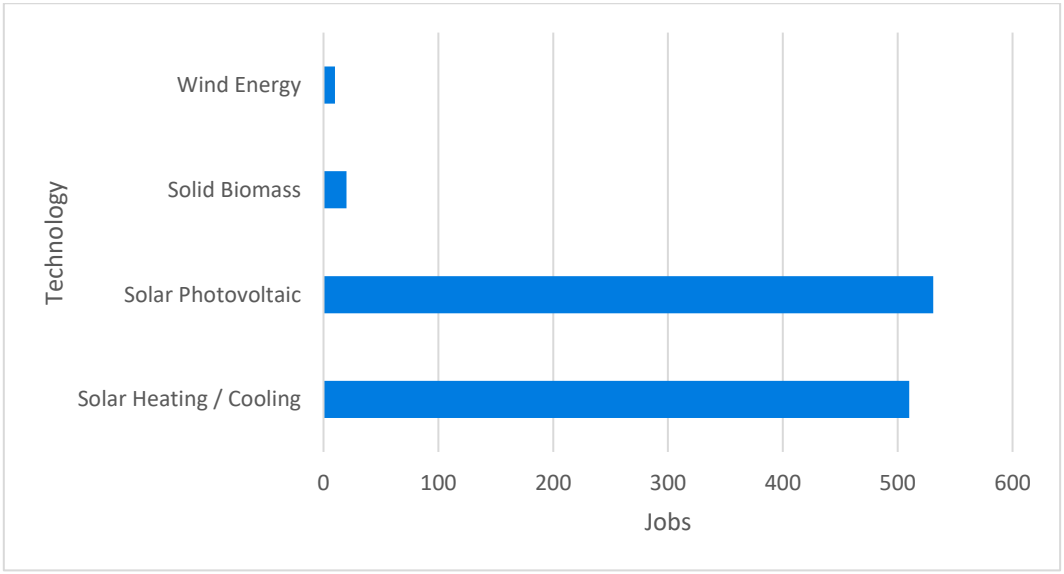
Company	Increased Nbr. Of Employees
ASACO	10%
Green Essence	60%
ME Green	700%
Tfaily Solar Energy	100%
Zmerly and Co	80%
Chababi Electro Store	0%
Dolmen Corporation	0%
Elements Sun & Wind	20%
AEMS	0%
AL DIYAR FOR ENGINEERING & CONTRACTING & TRADE	0%
AL SHAMS GROUP	600%
Green Energy System	200%
Green Power Tech	100%
HABASH ELECTRICAL& HYBRID TECHNOLOGY (HEHT)	50%
Ijazi Investment Company LTD.	2%
JF GROUP	10%
JUBAILI BROS SAL	20%
Kypros/MAWARED & CONSTRUCTION CO	500%
COGEDIS SAL	-30%
Contracom International	30%
DERVICHE HADDAD	-20%
EMARTS / GREEN ESSENCE LEBANON	20%
EMPS	50%
Energies-Sport-Sante	30%
Energon	10%
FENDI	0%
GEORGES AZAR	300%
GIO Electrical services	150%
Plemicor Industries	0%
Power & Automation Control- PAC	0%
Power and Green	0%
Prominence Gold PRG sal	5%
RAYMOND EL ACHKAR & SONS	6%
RENEWABLE MED ENERGY	5%
SAAB RDS INC	30%
SLOGA SARL	15%
Smart Business SAL	20%
SOLARTECH	0%
SUN FOR FREE	20%
Sustainable Energy Partners SARL	10%
T.G.M electronic	0%
TABET ENGINEERING AND LIGHTING Co.	20%
Aquarius	0%
Black Box	0%
BUTEC	30%
Average Employment Growth Rate	**70%**

Noting that the companies contacted agreed on:

- **Design Phase:**
    - Electrical, mechanical, and civil engineers are mainly engaged in the design phase of solar PV projects
    - The companies are struggling to find the competent engineers mainly due to the current situation in the countries (engineers are migrating from Lebanon)
    - Junior or fresh-graduated engineers are easier to find. With proper training, they are easily prepared to conduct full design of solar PV systems
- **Installation & Maintenace Phase**
    - BT/TS (electrical, mechanical, or electro-mechanical) graduate students are involved in the CIOM phase
    - People with no educational backgrounds are trained to be ready to install and maintain PV systems

Based on a study made by IRENA, it can be seen that the solar energy sector got the biggest number of employees compared to the other renewable energy technologies in Lebanon.

Figure 8 - Renewable Energy Employment by Technology in 2020



Source: Renewable Energy Outlook by IRENA

According to UNDP-CEDRO, the amount of university graduates with RET qualifications theoretically covers the local corporate requirements for professional staff. There are 1,500 RET graduates—more than the amount of graduates required to work in the current RET professional labor force.

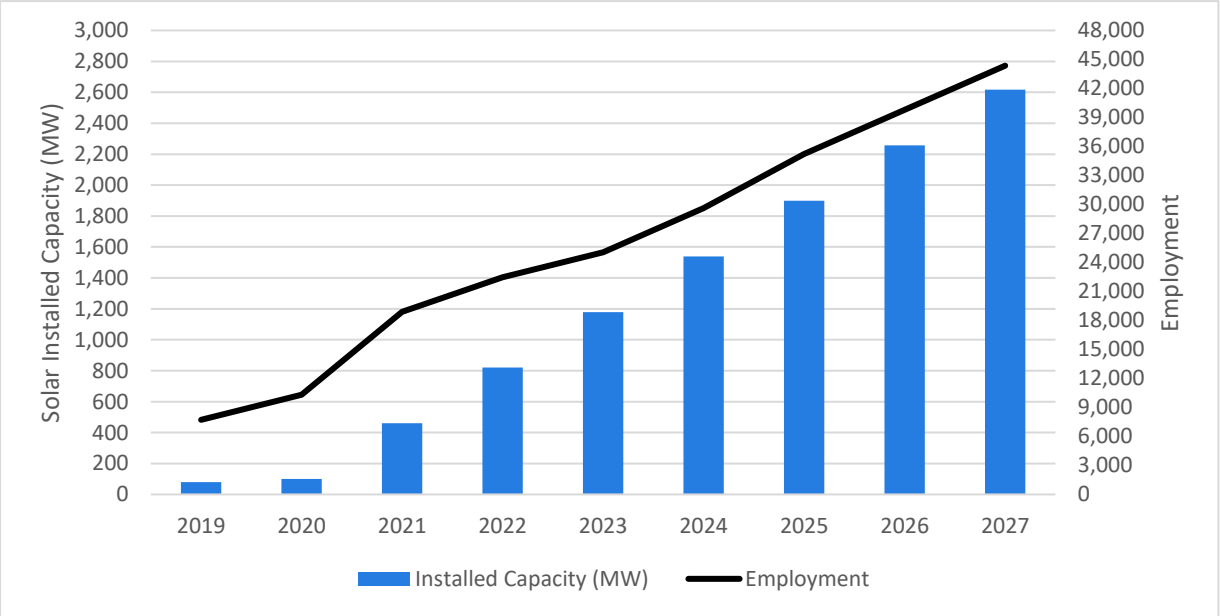
Manufacturers and importers are having greater difficulties finding workers with a lower level of expertise, namely skilled workers and technicians, which constitute the bulk of their respective workforces. There is a global shortage of such workers, and the problem is even more acute in

Lebanon, where the relatively small industrial base has not created a significant pool of trained workers who could be shifted to such tasks. RET are relatively recent in the local market so there is a general lack of experience and knowledge of RET, which forces the companies to invest significant amounts of time and money in employee training.

2.4 Future Employment Opportunities

According to the "Renewable Energy Sector in Lebanon" report by UNDP, several actions are needed to support the deployment of RE as well as the creation of jobs in Lebanon. The report states that, approximately, 25,000 jobs could result from the deployment of renewable energy systems in the upcoming years.

Figure 9 - Lebanese Solar Energy Sector - Employement Potential



The future employment is considered through the direct (in CIOM projects) and indirect (in construction, education, wholesale, import, transport, etc.) effects along the value chain.

The bulk of this number is found in the PV sector, from distributed as well as from large PV installation. Most jobs are in the installation phase, which means they are temporary; however a succession of installations can turn these temporary jobs into permanent careers. This is further justified by the increase in employment whithin the private sector's companies, as shown in Table 3. They stated that, on average, they have increased the number of employees working in CIOM projects by 70% this year, and this growth is not showing any signs of slowing down.

3. Educational and Vocational Programs Focusing on the Solar Energy Sector

3.1 Current Available Curriculum

LT renewable energy is the only existing curriculum directly related to the solar energy sector in the Lebanese TVETs. Other curricula include 2-3 chapters/courses focusing on solar energy such as BT or TS industrial, mechanical, electrotechnical, and electrical.

Find below the curriculum offered to LT -Renewable Energy students:

TL-Renewable Energy	
Material	**Hours Per year**
Industrial legislation	60
Communication skills	30
Hydraulics and hydroelectric power plant	60
Thermal power plants[1]	90
Active and passive solar thermal energy[2]	120
Wind turbines	60
Environment and Geothermal energy, biomass, and bio fuel	60
Photovoltaic Solar Energy	60
Transmission, distribution and quality of electrical energy	90
Control and regulation of energy systems	60
Cogeneration and sorting energy generation	30
Energy audit of buildings	60
Energy storage	60
Total Theories	**840**
RETSCREEN Software (TP)	30
Solar thermal T.P[3]	60
Photovoltaic solar T.P.[4]	60
Total P.T.	**150**
Annual total	**990**
Green Building Project (group of 2 or 3 students per project)	30h/projet

Chapters content:

[1] Solar thermal power plants

1. Cylindrical Parabolic solar thermal plants
2. Solar power towers
3. Parabolic Stirling thermal plants
4. Solar chimney thermal plants

[2] Active and passive solar thermal energy (120Hrs)

1. Solar Energy

1.1 Context

1.2 Resource Overview

1.3 Movements of the Earth

1.4 Apparent Motion of the Sun

1.5 Hours and times

1.6 Duration and rate of sunshine

1.7 Earth's atmosphere

1.8 Solar radiation on the ground

1.9 Solar radiation on any plane

1.10 Typical radiation variations

2. Solar Collectors

2.1 Principle

2.2 Overall heat balance

2.3 Thermal balances of the different constituents

2.4 Relations yielded flow to the fluid / temperatures

2.5 Other characteristic quantities

2.6 Calculation method for a solar collector

2.6.1 Simulation of a solar collector

2.6.2 Simulation of a solar collector coupled to storage

2.6.3 Sizing

2.6.4 Approximate calculation

3. Uses Of Solar Energy

3.1 Hot water production

3.1.1 Collector-storage solar water heater

3.1.2 Packaged solar water heater

3.1.3 Split-element solar water heater

3.1. 4The individual solar water heater

3.1.5 Collective solar hot water

3.1.6 The combined solar system

3.1.7 Solar swimming pools

3.1.8 Combined collective facilities

3.1.9 Needs assessment for collective hot water

3.1.10 Component sizing

3.1.11 Connection of solar water heaters with another heat source

3.1.12 Sizing elements and calculation of DHW needs, private and collective with sizing of the distribution piping.

3.2 Refrigeration and air conditioning

3.3 Distillation

3.4 Cooking

4. Solar Drying

4.1 General information on drying and definitions

4.2 Principle and description of drying

4.2.1 Principle

4.2.2 Drying temperature

4.2.3 Drying rate

4.2.4 Yields relative to drying

4.2.5 Evaporation capacity of a dryer

4.3 The different types of solar dryers

4.3.1 Natural convection solar dryers

4.3.2 Forced convection solar dryers

4.4 Simplified sizing methods

4.4.1 Natural convection solar dryers

4.4.2 Forced convection

5. Passive Solar

Architectural elements and guidance

[3] Solar thermal T.P

TP1 Sensor installation procedure

TP2 System installation procedure

TP3 Care and maintenance

TP4 Fault finding and repair

TP 5 Study of a hotel (sizing)

TP 6 Heating study for a 100 sqm room (sizing)

[4] Photovoltaic solar T.P

- Realization of a PV panel and measurements of the electrical characteristics
- Analysis of a photovoltaic solar panel, and determination of the interest of use in a well-defined situation
- Calculation of the sizing of a photovoltaic installation, taking into account all the parameters that influence this calculation.
- Explanation of the optimal characteristics of a photovoltaic panel, and determination of the maximum power MPPT, then demonstration of the need to use a regulator in a PV system finally the realization of an intelligent regulator and a PWM regulator
- Realization of an inverter and connection to the PV system already carried out in the previous labs

- Theoretical study (dimensioning) of the installation of an autonomous PV system (Off-grid), in a Hybrid system (Source EDL, with PV system) taking into consideration all the protection conditions, comparative economic studies with a hybrid installation (“diesel” generator source, and EDL source).

Students enrolled in BT electronics, electrical, and mechanical might have to take 2 renewable energy chapters/courses in addition to a T.P. for photovoltaic systems including:

1	The Status of pv modules - World statistics	11	Study a photovoltaic installation connected to the grid
2	Solar deposit, Solar radiation, spectral content	12	Prevention of occupational risks, Texts and regulations
3	Illumination, solar constant surface orientation (panel)	13	Electrical clearance, Commissioning
4	The basic principles of PV Characteristics of photovoltaic cells, Features of the PV system	14	Maintenance
5	Basic principles of the design and construction of photovoltaic power plants	15	Test on Solar Panel (PV module) / Isc, Uoc and diode by pass
6	Selection criteria for PV modules, Chains and PV group, Support structures	16	Battery testing and maintenance
7	Fire Prevention, The Energy Conditioning Unit	17	Autonomous system with regulator
8	The autonomous system, The hybrid system	18	Autonomous system with regulator and inverter
9	Connection to the grid	19	Grid-connected system
10	Study a photovoltaic installation in an isolated site (autonomous)	20	Grid-connected system

3.2 Initiatives

Currently, no initiatives are being taken into consideration internally by the TVETs regarding solar energy majors/courses. The private TVETs believe that a specialization in solar energy doesn’t need 3 years of learning, but additional chapters could be incorporated in the curriculum to cover this rise in demand. Public TVETs are subject to the policies set by the government, where, also, no initiatives are being implemented to offer additional learning materials regarding the solar energy sector. The interviewed TVETs supported the idea of having a 3-month vocational training that would include more practical work when it comes to CIOM projects. This training can mainly include the following:

Electrical, Mechanical, & Civil Engineers

- Project Criteria
- PV Module Data Sheet
- Cable Sizing & Selection
- Battery, Inverter, & Controller Sizing
- Project Site Assessment
- Mechanical Design
- Electrical Design
- System Monitoring
- Project Documentation
- Permits & Approvals
- Design of Strings/Arrays
- Lighting Protection Calculations
- BOQ of Solar PV Plants
- Losses Calculations
- System Design
- Safety Precautions
- Maintenance and Trouble Shooting

BT/TS, Electrical, Mechanical, & Electromechanical

- Examine the differences between DC current and AC current
- Planning and installation based on wiring charts and material lists
- Preparing the site, tools and equipment
- On-site safety
- Hands-on PV installation on different roof types
- Wiring of PV System
- Typologies and modality of installation
- Integration of the photovoltaic modules in the building structure
- Practical training (installation of PV panels, installation and commissioning of grid-connected inverters, etc.)
- Simulation-based practice of locating and mounting equipment, routing and installing conduit, monitoring installation, and labelling
- Solar system components
- How to install systems correctly according to international standards
- How to plan and manage a project and size the system including the battery pack according to the client's requirements.
- Determining the optimum place to put solar panels

TL Renewable Energy

- Perform professional energy audits
- Describe the differences among various PV cell technologies
- Define factors that impact the amount of peak sun hours reaching the array
- Identify tilt angle and orientation that provides maximum energy production
- Identify data required to size and design solar PV systems
- Identify the different types of inverter technologies
- Determine the correct wiring configuration of PV modules for a given application
- Identify potential jobsite hazards and opportunities for additional safety training
- Install solar panels on rooftop using a roof model
- Perform solar inverter integration with existing house wiring using an electric circuit simulation board
- Know different types of battery technology available in the market
- Know how to read battery cycle life
- Understand how to choose the right battery type for specific site
- Understand the steps required for solar system installation
- Identify tools required for solar system installation
- Interpret manufacturers data sheet for solar PV system components

3.2.1 Past Initiatives

The most recent curriculum update was done through an IECD initiative, to include some chapters related to solar energy in the electro-mechanical curriculum.

Few TVETs and schools currently offer courses related to renewable energy:

- **Don Bosco** (3-9 months courses) - Solar PhotoVoltaic Systems, Solar Thermal Systems.

In addition, several initiatives are held in order to enhance the employment of Lebanese citizens, Syrian and Palestinian refugees:

- **GIZ:** A training curricula was organized by GIZ, targeting medium to large projects and including 4 modules: installing PV panels, maintenance and cleaning, testing and commissioning. The main target of this training was students of public TVETs and additional beneficiaries schools. The trainings were given in form of extra sessions during afternoon.
- **IECD:** IECD organizes trainings for TVETs students in order to help them develop the skills needed to the Lebanese solar energy market. For example, IECD organized a training 4 years ago in collaboration with Cortbawi Institute related to the installation of solar panels.

On the other hand, in the frame of the many skills development initiatives related to the Syrian refugee crisis, several donors offer short term courses related to renewable energy:

- **Mercy Corps:**
    - **Under INTAJ,** the LSES has conducted energy audits for Lebanese MSMEs to introduce renewable energy technologies that lower costs, boost competitiveness and facilitate increased hiring.
    - **Under FORSA,** LSES provided trainings for prospective technicians in the renewable energy sector. The trainings were delivered in two parts. Part One discusses the theoretical aspects and introduces the participants to major topics in the field, while Part Two offers practical application. FORSA will further explore the feasibility and development of a LSES-operated renewable energy training centre located in the Bekaa Valley through the development of a comprehensive organisation development plan.
- **UNRWA**: In their VTE training center in Sibline, UNRWA offers short term courses in solar energy (20h).
- **UNDP**
    - The United Nations Development Programme (UNDP), in partnership with the Ministry of Energy and Water, has initiated **the fourth phase of the CEDRO** (Community Energy Efficiency and Renewable Energy Demonstration Project for

Lebanon) Programme funded by the European Union. The CEDRO 4 project includes several sustainable energy projects that are designed to promote related renewable and energy efficiency systems.

- Furthermore, UNDP implemented the **DREG project**, funded by the Global Environment Facility (GEF) in partnership with the Ministry of Energy and Water (MoEW) and the Lebanese Center for Energy Conservation (LCEC). Among others, DREG, supported the amendment of the Electro-Technical Baccalauréat Téchnique (BT) curriculum to include the newly developed Photovoltaic (PV) course. Consequently, Lebanese vocational school teachers in the frame of a ToT were familiarized with Solar PV technologies so that they become certified to teach the course in their respective schools.

Involved were the following TVETs schools:

Area	School Name	Location	Type
Beirut & Mount Lebanon	Ecoles des Arts et des Metiers	Dekwaneh	Public
	EcoleTechnique Superieur Amlieh	Haret Hreik	Private
	Institut Cortbawi de Formation Technique	Adma	Private
	Ecole Technique de Hammana	Hammana	Public
	Ecole Technique de Choueifat	Choueifat	Public
North	Institut Technique et Publique de Zgharta	Zgharta	Public
	Institut Professionel Industriel	Tripoli	Public
	Institut Technique Orthodox	Akkar	Private
South	Institut Foyer de la Providence	Salhier - Saida	Private
	Ecole Professionelle de Jabal Amel	Tyr	Private
	Ecole Technique Martyre Rani Bazzi	Bint Jbeil	Public
Bekaa	Institut Technique Secondaire et Supérieur de Taanayel	Taanayel	Private

3.2.2 Future Initiatives

- **GIZ:** Followed by the current Lebanese economic crisis, the solar market shifted from large scale projects to small scale projects. Therefore, GIZ is currently updating their training curriculum to fit the new market requirements. They aim at launching the trainings in the upcoming months.
- **UNDP:** They are currently preparing a training for Lebanese youth especially students aiming at developing their technical and soft skills needed to work in this field. The training will be launched in the upcoming months. The trainers will be both Lebanese and foreigners.

Further initiatives are also shown in table 2, section 1.3.3.

3.3 Impact on the Labor Market

Students graduating from TVETs (electrical, industrial, mechanical, electro-mechanical) are finding jobs easily as they have developed practical and experimental skills. During their school years, they are required to perform around 2 internships to complement their skills. These internships also have helped them shape their skills as they are required to be involved in solar CIOM projects. However, upon interviewing the technicians and workers (in CIOM projects) in the private sectors, we have witnessed the following:

85%

of the workers stated that they faced several difficulties in installing, operating, and maintaining solar PV systems, right after the trainings that they have taken inside the company they are working at

70%

of the workers confirmed that the trainings they took inside their companies weren't enough to acquire the skiils needed in CIOM projects

75%

of the workers agreed that having vocational trainings in the Lebanese TVETs would benefit the sector, especially if the training focus on how to construct, install, operate, and maintain PV panels

Having said that, the internal trainings given by the private sector companies aren't sufficient to acquire the needed skills to install and maintain solar PV systems. A 2-3 months vocational training in the TVETs for students enrolled in BT electrical, mechanical, and electromechanical, in addition to students enrolled in LT renewable energy is very essential and needed. Following the different interviews in addition to a heavy desktop research, this vocational course should focus on the topics stated under section 3.2. The students undertaking this training would be ready to install and maintain solar PV systems in Lebanon, and would save time and money for the companies involved.

4. Conclusion

4.1 SWOT Analysis

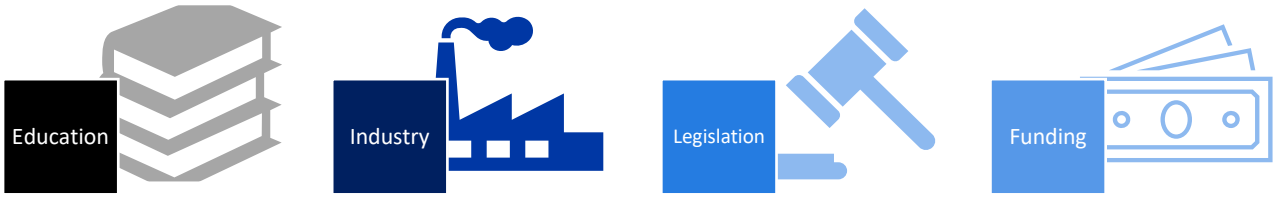
STRENGTHS	WEAKNESSES
• High number of qualified private companies with several years of experience in the field • The private sector's companies are meeting the demand for the increasing solar energy projects • Increasing solar installed capacity compared to the overall electricity generation in Lebanon • Skilled engineers, with the needed requirements, are involved in the design phase of solar PV systems • Experience in governmental, industrial, commercial, and residential projects	• Absence of vocational trainings to acquire the needed skills for solar CIOM projects • Failure to find qualified technicians and workers • No manufacturing facility in Lebanon, and very limited number of companies are involved in assembly • LT renewable energy is the only existing curriculum directly related to the solar energy sector in the Lebanese TVETs. Other curricula include 2-3 chapters/courses focusing on solar energy such as BT or TS industrial, mechanical, electrotechnical, and electrical.
OPPORTUNITIES	**THREATS**
• The presence of international programs supporting the sector's growth • High electricity costs driven by the EDL's deficit, fuel prices, and private gnerators' subscriptions • Booming solar energy sector in Lebanon • The private companies' sales have increased by 150% compared to the past couple of years • More than 25,000 jobs would be needed to account for the solar energy projects' increading demand • The drop in the solar PV projects' price is driving the demand • Public awareness on the environmental impact of the solar energy sector is on the rise • 300 days of sunlight a year support the solar energy sector in Lebanon	• Brain drain caused by the current Lebanese situation • Very limited curriculum focusing on renewable energy, specifically solar energy • Supply is met through international donors and NGOs, and no clear strategy is implemented by the Lebanese government • Regulations and norms concerning solar energy projects are wighing heavily on the sector

4.2 Risk Assessment Matrix

Market Risk			
Risk		**Rating (1-6)**	**Mitigation**
Demand	**Description:** The demand on solar energy systems was booming during 2021-2022 **Impact:** New incompetent companies are emerging in the market	**Probability: 5** **Impact: 4**	**Risk Mitigation:** Set norms and regulations for the companies operating in the sector.
Supply	**Description:** The orders of panels are taking too long due to shipping delays and customs congestion. **Impact:** Delaying the project's execution	**Probability: 6** **Impact: 3**	**Risk Mitigation:** - Simplify the customs' process. - Have a local assembly and manufacturing of panels which is not highly recommended.
Labor Risk			
Risk	**Description**	**Rating (1-6)**	**Mitigation**
Labor Opportunities and Qualifications	**Description:** The demand for skilled and qualified labor has increased **Impact:** A lack for skilled labors was found	**Probability: 6** **Impact: 3**	**Risk Mitigation:** Companies are organizing internal trainings to develop the skills needed
Educational Risk			
Risk	**Description**	**Rating (1-6)**	**Mitigation**
Curriculum	**Description:** The existing curriculum do not match the market needs in the solar energy **Impact:** Unqualified students are graduating	**Probability: 6** **Impact: 4**	**Risk Mitigation:** - Curriculum adaptation by adding courses or chapters related to solar energy - Organizing extra curricular trainings

4.3 Recommendations

The recommendations mainly fall under the following categories:



4.3.1 On the Educational Level

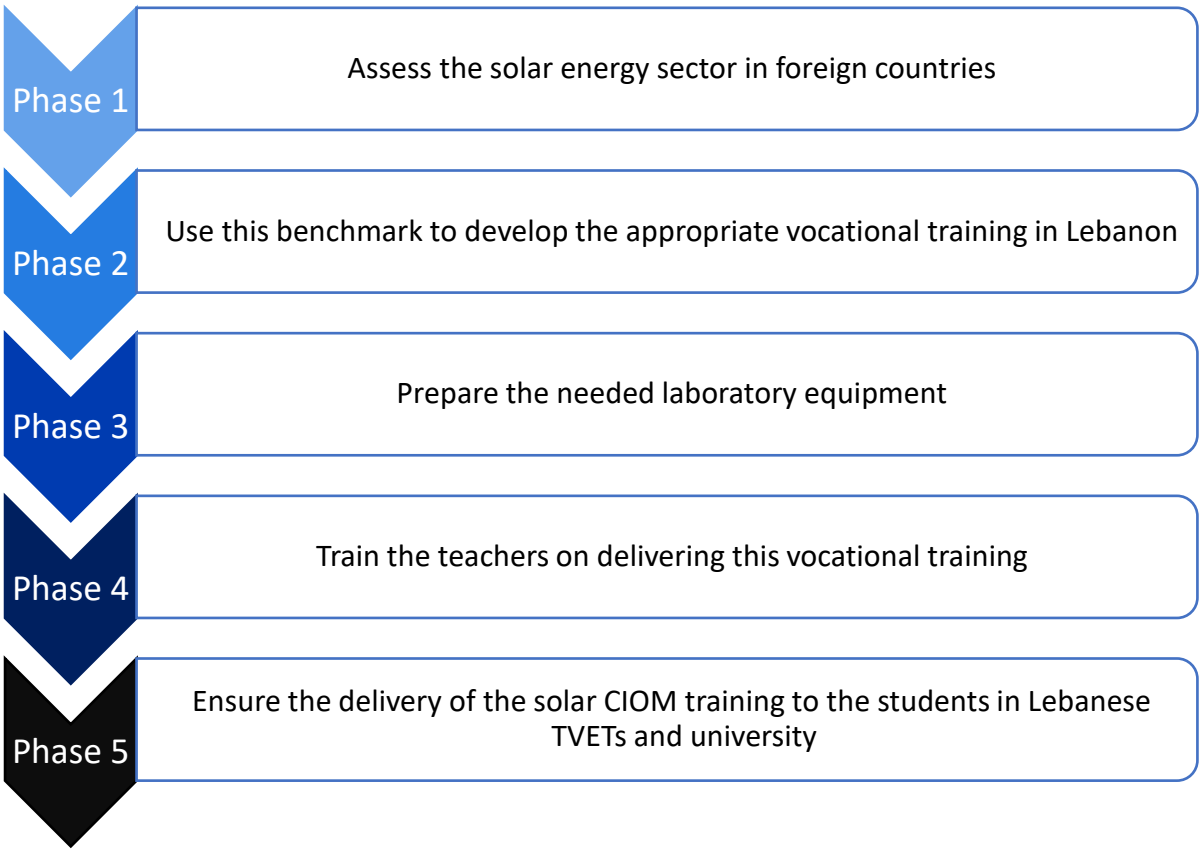
Based on field investigations, it was found that there is a need to update the technical curriculum in the Lebanese TVETs and universities that offer solar energy-related courses. Updating the existing curriculum by adding a vocational training is needed to enable students to develop their skills for CIOM projects, and meet the solar labor market's requirements.

Since making changes in the formal technical curriculum is a beauracratic process that requires years to be achieved (obtention of the approval of several governmental entities), vocational trainings can be organized in collaboration with the Lebanese TVETs and universities. In this case, funds could be used to:

1. **Train the teachers so they can, in their turn, teach the students on CIOM projects:** as stated earlier, this training would be a vocational course/training that would equip the students with the skills needed for CIOM projects
2. **Buy the needed laboratory equipment:** ensuring the availability of well equipped labs (PV modules, wiring, etc.) for the development of a practical vocational training
3. **Study foreign countries (including Arab and non-Arab countries)**: an in-depth assessment of the solar energy sector in countries with similar conditions but advanced solar energy sector is highly needed. This assessment would focus on interviewing:
    a. **Foreign private sectors' companies** to study the ease of finding qualified workers, the training they provide (if any), their recruitement process etc.
    P.S.: the assessment should focus on whether they give CIOM-related trainings or not. If so, what is this training (obtain their curriculum), if not, are they finding easily the needed qualified workers based on trainings conducted in the educational sectors?
    b. **Foreign TVETs and universities** to assess the solar-related vocational trainings they provide.

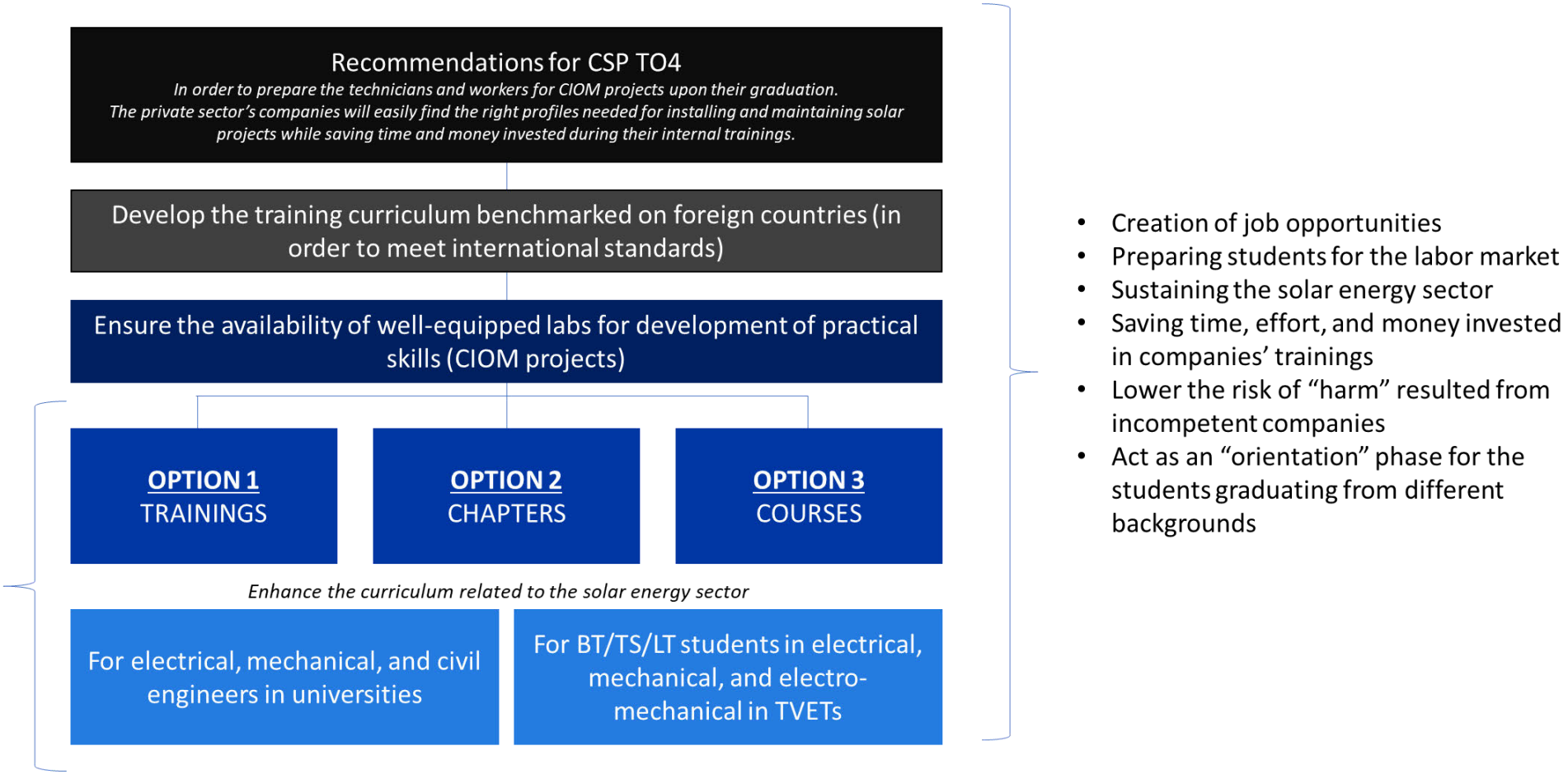
    This assessment is a crucial phase that will enable CSP TO4 to develop the appropriate vocational training in Lebanon that would meet international standards.

The recommended action plan for the implementation of the above should be as follows:



Moreover, and as stated earlier, the new incompetent companies that are emerging in the market due to this boom in the solar sector, lack of the technical skills needed for CIOM projects, especially in the residential sector. The latter is facing problems in their solar systems mainly due to to technical projects arising from this incompentency, especially during installation and maintenance. The proposed vocational training would be a solution for this lack of proper implementation since the workers would be equipped with the needed and essential skills to avoid (or minimize) any default that might occur. Having said that, the more the workers are trained, the less the probability of "harm" caused by CIOM projects.

On the other hand, TVETs that do not provide solar energy-related courses/chapters would incorporate the suggested vocational training in BT/TS electrical, mechanical, or electromechanical to expose the students on the solar energy sector. By doing so, the student would have the chance to explore solar-energy related projects and would be aware of the job requirements needed for solar CIOM projects (the training could act as an "orientation phase" for the students: the latter could choose to whether continue or not in this field).


Recommendations for CSP TO4
In order to prepare the technicians and workers for CIOM projects upon their graduation.
The private sector's companies will easily find the right profiles needed for installing and maintaining solar projects while saving time and money invested during their internal trainings.
Develop the training curriculum benchmarked on foreign countries (in order to meet international standards)
Ensure the availability of well-equipped labs for development of practical skills (CIOM projects)
OPTION 1
TRAININGS
OPTION 2
CHAPTERS
OPTION 3
COURSES
Enhance the curriculum related to the solar energy sector
For electrical, mechanical, and civil engineers in universities
For BT/TS/LT students in electrical, mechanical, and electro-mechanical in TVETs
Refer to section 3.2 for the subjects that need to be incorporated during school/university years
Creation of job opportunities
Preparing students for the labor market
Sustaining the solar energy sector
Saving time, effort, and money invested in companies' trainings
Lower the risk of "harm" resulted from incompetent companies
Act as an "orientation" phase for the students graduating from different backgrounds

4.3.2 On the Manufacturing Level

With the current booming of the solar energy sector, having a local manufacturing facility in Lebanon is not recommended. Solar energy compartments in general and solar panels in particular requires an economy of scale in order to be economically feasible and this is what lacks in Lebanon.

Incentives by the Government or donors are required to encourage the companies to **assemble** the compartments locally. These incentives could include *(but are not limited to)*:

- Providing microfinancing for Lebanese citizens will facilitate the installation of solar panels
- Reducing customs' fees related to the importation of solar PV systems
- Updating the current curriculum in the TVETs to include more focused solar-related courses
- Funding vocational trainings in the Lebanese TVETs to equip students with the skills needed for solar CIOM projects. By doing so, students will be given higher employment opportunities within the sector, and the private companies would easily obtain the right human resources for such projects.
- Implementing several solar energy projects that can be part of the national strategy for energy efficiency
- Providing campaigns that focus on the impact of the solar energy sector on the environment in addition to highlighting the cost-reduction that can occur from the deployment of solar-related projects
- Subsidizing solar-related projects that might benefit a certain Lebanese area

4.3.3 On the Legislation Level

Updating the current norms and rules governing the installation of solar energy systems is urgently needed. Moreover, it is highly recommended to include the solar energy licensing within the building license to ensure the quality and durability of the system.

To avoid the import delays, we suggest simplifying the quality checks at the customs. For example, if the imported equipment is from the same supplier, the quality tests should be reduced in order to fasten the procedure.

On the funding level:

NGOs should hire an energy consultant who will be responsible of:

- Keeping the tenders' technical specifications up to date and adapting new innovative designs used in this sector.
- Fixing the funds' amount to be realistic and to suit the result expected at the end of the project.

- Keeping track of the project's execution.

Concerning the sectors benefitting from the funds:

- Public schools and hospitals are in desperate need of solar panels due to the high cost of fossil fuels.
- Funds are needed in the industrial sector because the investment needed for these projects is very high and the capacity of the industries to be self funded is very low. In case funding cannot cover this sector, having the green loans back is highly recommended.
- For the residential and commercial sectors, funding is needed to help the Lebanese citizens survive this crisis.

5. References

- Solar PV Status Report for Lebanon published by LCEC
- Renewable Energy Outlook by IRENA
- Lebanese Customs' website
- Lebanon Daily Star
- Technical Assistance for a more practice oriented VTE in Lebanon
- International Renewable Energy Agency (IRENA)'s website
- UNDP's studies about solar energy systems (2020-2021)
- Darpee's website
- Science Direct's article about Lebanon's electricity from fuel to solar energy production

List of interviewed companies in the private sector:

Interviewed Companies	
ASACO	Energon
Green Essence	FENDI
ME Green	GEORGES AZAR
Tfaily Solar Energy	GIO Electrical services
Zmerly and Co	Plemicor Industries
Chababi Electro Store	Power & Automation Control- PAC
Dolmen Corporation	Power and Green
Elements Sun & Wind	Prominence Gold PRG sal
AEMS	RAYMOND EL ACHKAR & SONS
AL DIYAR FOR ENGINEERING & CONTRACTING & TRADE	RENEWABLE MED ENERGY
AL SHAMS GROUP	SAAB RDS INC
Green Energy System	SLOGA SARL
Green Power Tech	Smart Business SAL
HABASH ELECTRICAL& HYBRID TECHNOLOGY (HEHT)	SOLARTECH
Ijazi Investment Company LTD.	SUN FOR FREE
JF GROUP	Sustainable Energy Partners SARL
JUBAILI BROS SAL	T.G.M electronic
Kypros/MAWARED & CONSTRUCTION CO	TABET ENGINEERING AND LIGHTING Co.
COGEDIS SAL	Aquarius
Contracom International	Black Box
DERVICHE HADDAD	BUTEC
EMARTS / GREEN ESSENCE LEBANON	Energies-Sport-Sante
EMPS	

Market Assessment – Solar Energy Sector in Lebanon

USAID/Community Support Program (CSP) in Lebanon