THE POTENTIAL FOR EGYPTIAN START-UPS TO UNLOCK SOLAR TECHNOLOGY MARKETS IN AGRICULTURE

BASELINE DIAGNOSTIC

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Abstract

The following baseline diagnostic, takes an in-depth analysis of a sub-sector, off-grid solar, which has been identify as one with significant potential in Egypt by a recent World Bank Group policy paper[1]. The aim of the baseline study is to understand the constraints and needs which would enable clean tech SMEs to innovate, grow, and scale in off-grid solar, namely in agricultural areas in Egypt. The analysis included interviews of over 100 entities in the sector, including ecosystem players, banks, and startups, covering 9 governorates. The diagnostic found that the challenges faced by entrepreneurs in this sub-sector included customer finance and payments, access and distribution to rural regions in Egypt, working with partners who are not linked to the Cairo-centric ecosystem, and developing innovative solutions which would require multi-disciplinary approach. In order to support these entrepreneurs, Government, intermediaries, the private sector, and donors should consider the market and value chain systems which these entrepreneurs are operating in, barriers faced, and the role which various players, including entrepreneurs, can play to unlock value through system change. This diagnostic is meant to serve as a knowledge tool for World Bank Group task team leaders, donors, governments, NGOs, and intermediaries to guide their strategic interventions to support clean tech startups to unlock solar technology markets in agriculture in Egypt.

[1] Sakr, Dalia Abdelhamid Mahmoud; Huenteler, Joern Torsten; Matsuo, Tyeler Marissa; Khanna, Ashish. 2017. Scaling up distributed solar in emerging markets : the case of the Arab Republic of Egypt (English). Policy Research working paper; no. WPS 8103. Washington, D.C. : World Bank Group.

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Acronyms and Abbreviations

AAIB	Arab African International Bank
ACDB	Agriculture Commercial Development Bank
AUC	American University in Cairo
CAPEX	Capital Expenditures
CAPMAS	Central Agency for Public Mobilization and Statistics
EEAA	Egyptian Environmental Affairs Agency
ENCPC	Egyptian National Cleaner Production Center
EPC	Engineering, Procurement and Construction
EGP	Egyptian Pound
FEI	Federation of Egyptian Industries
FiT	Feed-in-Tariff
GW	Gigawatt
JCREEE	Joint Committee for Renewable Energy, Energy Efficiency and Environmental Protection
kW	Kilowatt
MALR	Ministry of Agriculture and Land Reclamation
MED-ENEC	Energy Efficiency in the Construction Sector in the Mediterranean
MIIC	Ministry of Investment and International Cooperation
MoRE	Ministry of Electricity and Renewable Energy
MoTI	Ministry of Trade & Industry
MSMEDA	Micro Small, Medium Agency (formerly SFD Social Fund for Development)
MW	Megawatt
NREA	New and Renewable Energy Authority
PPA	Power Purchase Agreement
PV	Photovoltaic
RCREEE	Regional Center for Renewable Energy and Energy Efficiency
VC	Venture Capital

Executive Summary

The rise in energy prices with the gradual phase out of subsidies and challenges in securing energy in remote areas has allowed new clean technologies to emerge as a sustainable solution to meet the increasing market demand in Egypt. The opportunities in Egypt are significant, replacing diesel with solar power is potentially transformative. Despite the significant opportunities, growth in the clean technology market is below its potential. Clean technology markets are relatively new in Egypt and globally, hence clean technology business models, norms, and practices are still being defined.

A recent World Bank Group policy paper "Scaling up distributed solar in emerging markets: the case of the Arab Republic of Egypt", identified off-grid application of Solar in agriculture as a significant opportunity, amounting to nearly 2000 MW in photovoltaic (PV), approximately $4 billion in investment[2]. The paper indicated that despite the large potential market and improved economics there remain several barriers to the growth of the market. These barriers included; uncertainty of government policy, policy advocacy, access to debt financing, access to data, and tailored business models. The paper continues by emphasizing the opportunity in replacing diesel power pump sets with solar pumps, and the need to understand additional potential barriers facing market growth.

The following study aims to build on this policy paper, by observing the emerging trends of PV use in the agriculture sector, the role of PV startups in the market, business model applications, and customer acquisition challenges. This study is meant to serve as a knowledge tool for (i) PV startups on market needs and trends, (ii) for ecosystem players to better serve the sector, (iii) for policy makers to guide the strategic interventions to grow the PV market in Egypt as well as, (iv) for donors to better plan their interventions to target the gaps in the PV entrepreneurship ecosystem.

Energy consumption in farming is highly reliant on diesel, both for direct use for equipment (i.e. pumps), or the generation of electricity. Agricultural processes and applications require energy, in the form of electrical and mechanical power for many uses including land preparation, seeding, irrigation, delivery of pesticides, and harvesting among others. The following table builds on a study carried out by the Regional Center for Renewable Energy and Energy Efficiency (RCREEE)on the opportunity for Solar to replace diesel applications in Egypt[3]. The study breaks down the use of diesel pumps by type (fixed or portable), size (horsepower), number, and tons of diesel consumed annually. Based on these estimates, and the current subsidized prices of diesel EGP 3.65 / litter, it is estimated that EGP 2.9 billion (approximately $175 million) is spent annually on diesel for off-grid pump use in Egypt.

Type	**# of pumps**	**Total Diesel tonnes**	**Total Liters**	**EGP Annual Expenditure** (subsidized diesel)
Portable Pumps	187,195	544,500	460,647,000	1,681,361,550

[2] Sakr, Dalia Abdelhamid Mahmoud; Huenteler, Joern Torsten; Matsuo, Tyeler Marissa; Khanna, Ashish. 2017. Scaling up distributed solar in emerging markets: the case of the Arab Republic of Egypt (English). Policy Research working paper; no. WPS 8103. Washington, D.C.: World Bank Group.

[3] Regional Center for Renewable Energy and Energy Efficiency (RCREEE) 2016. "Diesel to Solar Transformation Accelerating Achievement of SDG 7 on Sustainable Energy: Assessing Untapped Solar Potential in Existing Off-Grid Systems in the Arab Region." RCREEE. Used Size, # of Pumps, & Diesel tonnes data from RCREEE, however applied more conservative assumption of diesel pump use to 1200 hours per year rather than 6000 hours per year.

Fixed Pumps	71,044	399,250	337,765,500	1,232,844,075
Total	**258,239**	**943,750**	**798,412,500**	**2,914,205,625**

Egypt's decentralized PV market is dominated by startups; young companies which were established starting 2012 with limited capital or angel investment. This report analyzed the performance of 20 PV startups which have collectively installed 112 MW of Egypt PV systems, estimated to be 124MW based on PV imports recorded by CAPMAS[4]. These startups, with an average age of 3 years, and approximately EGP16.8 million in seed investment, achieved collectively revenues of EGP 79.5 million[5] in the first 9 months of 2017. These startups have made significant headway in growing the PV market in Egypt, with most of the focus being on early adopters, and demand driven clients. They have faced a relatively uncontested new market place, successfully replicating known business models. Growth has largely been attributed to the large farmer market segment, however medium and small holder farms, representing a significant market opportunity, are untapped.

Solar PV startups are creating jobs across Egypt, not limited to Cairo, employing both skilled and unskilled workers. The 20 interviewed startups have created 552 jobs, 372 of which are full-time jobs. These jobs are spread over the skills and education spectrum, where 47% of those employed were identified as university graduates, 26% were identified as having a technical education, and 27 % were identified as unskilled or semi-skilled workers. The size of the company and the role played by founders influence the number of employees hired. University graduates tend to dominate office or operation positions mainly in Cairo, and semi-skilled workers tend to work on-site PV installation and maintenance frequently in governorates outside of Cairo, in agricultural areas.

Startups are well positioned to unlock new market opportunities and support technology transfer in Egypt. The competitive edge of startups is in their agility and adaptability which allows them to develop new business models, introduce new technologies, identify niche market segments, and serve diverse client needs. For instance, an off-grid agriculture farm that wishes to utilize a solar water pumping solution, startups have used a variety of business model innovations in order to adapt to user requirements, these have included; power purchase agreements to provide solar energy for pump operation, financial models to sell water instead of power produced, or a simple technology innovation of a water storage tank to eliminate the use of batteries and save costs. Each of these solutions needed to be tailored to meet the end-user's needs, and startups continue to help define the *modus operandi* of this growing market. These small growing businesses, have been better positioned to innovate, take risk, and unlock PV than larger firms in Egypt.

Customer financing remains a significant barrier to market growth. A customer's decision to purchase PV systems is often affected by the availability of financing. Renewable energy systems typically require the customer to commit higher CAPEX up front with the promise of payback in the form of energy savings. While the returns may be attractive, securing the cash upfront to purchase the PV systems remains a barrier for customers across all small, medium, and large farm segments. The majority of transactions occurring in the sector are based on immediate cash payments. For instance, suppliers require cash on delivery from

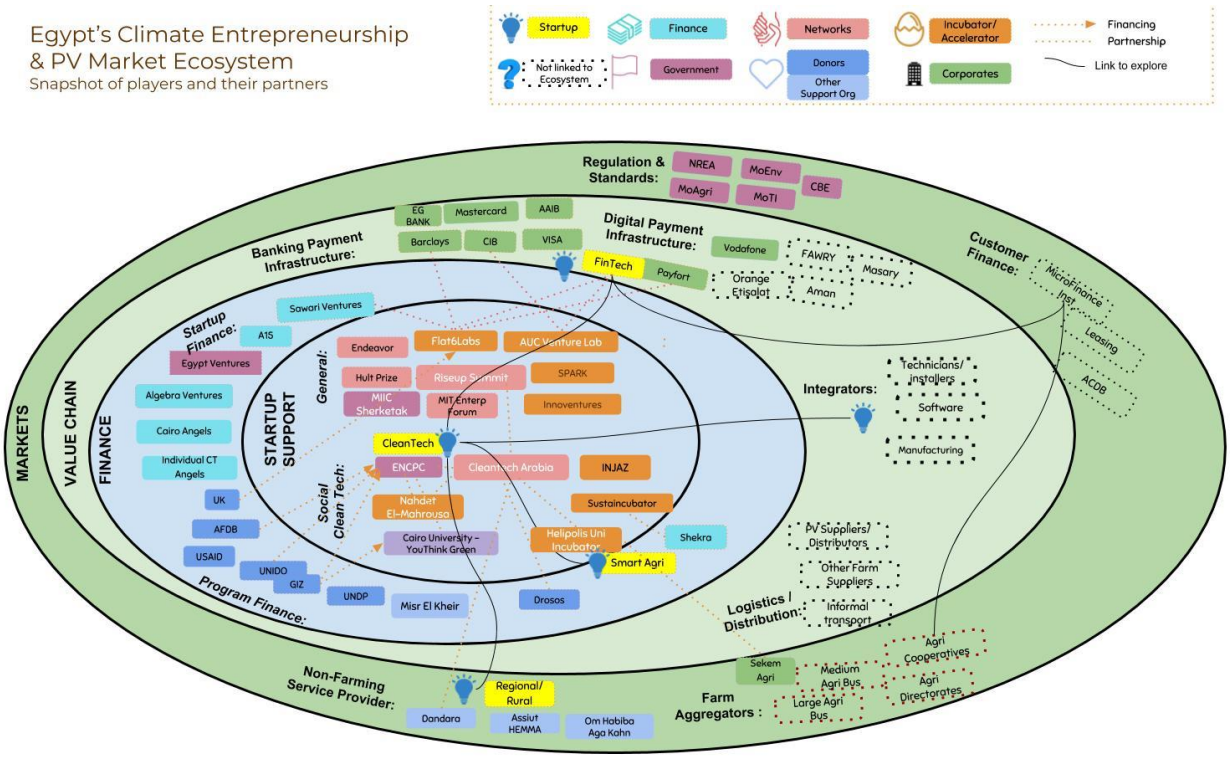
[4] CAPMAS data captures PV dollar value imported by suppliers and traders, however values of imports that goes as capital assets or into large EPC projects (for instance the upcoming Solar Park in Benban) might not show in the CAPMAS data. Thus, the 124 MW are considered as the lower limit of the data, yet they also strongly represent decentralized PV where most startups are active.
[5] Revenue figures based on startup interviews. Revenue figure does not include revenues of from firms supplying to installers/EPC which would take the figure to 126.5 Million revenue in the first 9 months of 2017

the startup who then have limited ability to provide other payment terms to their customers. Of the 20 PV startups interviewed, only 20% of transactions included short-term finance to allow payment in installments (of less than 6 month), and more than 70% of transactions were based on cash and direct payment. Only very limited cases offered the customer payment in installments or leasing options. Customers purchasing systems through loans is not common. However, some startups that were able to secure financing for their inputs, were then able to provide financing solutions to their customer. For instance, in the case of Karm Solar, they secured funding from Social Fund for Development[6] and then developed a power purchase agreement with its customer who purchased electricity rather than acquiring directly the system. Having a market based on direct cash transactions means that only a limited segment of the market is accessible, those with the capacity to spare such cash and pay for the system fully.

Business as usual will not transform this market, new innovative business models targeting the needs and challenges of the small and medium size farmers are key to unlocking solar PV's potential in Egypt: PV applications in agriculture is a rapid evolving market with significant opportunities for growth and impact. In order to open up high growth opportunities, PV startups need to pivot, both in their market segment focus and their business models. For instance, small holder farmers have limited financial means to purchase clean tech products and, they lack access to financial products due to their legal status (i.e. informal land tenure). Startups also face challenges when engaging with small holder farmers, due to engrained practices on the farm, geographical diffusion, logistical challenges related to product distribution/installation, and managing multiple, small, and dispersed transactions. Accordingly, in order to catalyze the changes needed to grow this market segment, it is important to work beyond the startup level, and examine the market, value chain, and ecosystem connectivity to support market creation.

Clean tech entrepreneurship programs tend to focus on startup support and financial support programs; however, they often miss the importance of engaging with value chain entities and market enablers. In order to support entrepreneurs and the sectors they are operating in, Government, intermediaries, the private sector, and donors should consider the market and value chain systems which entrepreneurs are operating in, barriers faced, and the opportunity to unlock value through system change.

[6] The Social Fund for Development (SFD) is being supported by an existing WBG operation through which this financing was made available. SFD has recently been merged into the new MSME Agency within the Ministry of Trade & Industry (MSMEDA).



Supporting programs and entities need to focus on tailoring their technical support to encourage not only startup growth, but ways of engaging to help grow the market. This could include new PV applications and business models, leveraging other platforms such as fintech, shared economy, data, and expanding their geographical focus. Startups working in manufacturing system components could also be supported as feeding entities to existing PV firms, which can help tailor products to customer segment needs. Linking fintech with cleantech can help foster innovative business models which can address both customer financing needs and risk aversion.

Designing programs which leverage a cross sectoral, institution, and startup approach are needed to unlock market potential. It is important to take into consideration the value that can be created by exposing startups to other startups in related fields (i.e. fintech, big-data, smart-agri), exposing them to global business models which they can adapt through business to business matchmaking programs, as well as exposing and linking startups to institutions (i.e. microfinance institutions, banks, cooperatives etc.). Cross-disciplinary approaches create opportunities for new business models and solutions to be developed leveraging strengths and skills to solve complex challenges. In addition, it is important to note that startups can also contribute to existing institutions such as microfinance providers and banks, by acting as sources of internal innovation. The value of convening and supporting these various groups, building a common vision, and level of trust amongst each other is an important design element of a future support program.

Engaging with players who are not traditionally involved in the entrepreneurship or the clean tech sector in Egypt, such as microfinance institutions, leasing companies, or agriculture cooperatives, is likely to be an important element in catalyzing market growth. Defining and developing successful engagement models are important to evaluate not only their potential role, but also the level of interest or willingness to engage in clean tech related initiatives. The objective is not to increase the number of

interaction points, but rather to strategically understand and define the optimal way to engage in order to achieve a market objective, enable access to startups, or address binding constraints.

Experience has shown that building climate technology markets requires a wider approach than is currently used. This shift in approach has an impact on the role of intermediaries and how they engage within the ecosystem and markets they operate in. Accordingly, this study is meant to serve as a knowledge tool for governments, donors, and intermediaries to guide their strategic interventions to support clean tech startups to unlock solar technology markets in agriculture in Egypt.

The following is a summary of the key recommendations of the report:

1. **Supporting business model innovation and adoption**

1.1. **Innovative and localized business models are needed to meet diverse client needs.** Startups need to develop business models that can meet the unique needs of their clients, this need is emphasized for small and medium off-grid farmers. For example, farmer needs can range from ease of utilization, avoiding distribution network cost, energy security, ease of payment, risk reduction, to financial saving. Accordingly, successful business models could involve innovative financial solutions but also rely on system sharing business models to address low utilization rates of small farmers. For these types of solutions to be developed is likely to require multi sectoral/disciplinary approaches (i.e. cleantech with fintech) and could require working with multiple startups towards a single objective.

Who? General startup support entities (incubators/accelerators) focused on fostering business model innovation.

How? Encouraging the ecosystem to link clean tech incubation and acceleration programs to existing fintech, smart-agri, or other programs. This can be achieved by supporting jointly designed programs, joint cohorts, rotational programs where respective startups can have access to respective training opportunities and resources provided in the ecosystem. Another approach could encourage incubators / accelerators to adjust support models from directly supporting one startup, to instead support multiple startups together to achieve a market objective.

1.2. **Connecting startups to relevant PV applications, business models, and technologies through matchmaking programs.** PV applications can provide more than a source of energy, for instance many customer segments rely on PV for ease of utilization, not simply as an energy source. There are limited PV applications in the Egyptian market, mainly lighting, pumping, and general electricity use. Other applications in desalination, powering handheld devices, pesticide sprayers, pest control devices could have strong potential in Egypt. However, many startups are not aware of the other technologies or applications which exist, or they do not have easy access to them in Egypt. Exposing startups to global business models and technologies can increase the business opportunities for startups and increase PV adoption rates in agriculture communities.

Who? Local clean tech incubators/accelerators with global incubators/accelerators, networks, or platforms (north-south and south-south) to expose Egyptian startups to the available technologies and business model applications.

How? Filling the knowledge gaps in the ecosystem by linking to global networks. This can be done by leveraging the World Bank Group's Climate Technology Program, UNIDO's Clean Tech Innovation Program, Shell Foundation, and other global knowledge hubs and networks. By using matchmaking programs and widening the reach of the local ecosystem players, Egyptian startups will have better exposure and access to the latest technologies and business models to adapt and develop locally. In addition, by improving the linkages between ecosystem players and R&D in

universities it could also serve as a channel to open opportunities for startups and help commercialize relevant research.

2. Supporting innovative financial and payment solutions

To expand market penetration to the small and medium size farmer market segments, improved access to finance and payment solutions are needed. Innovative financing models are needed to address the upfront capital expenditure for PV applications, while digital payment solutions are needed to address the multiple transactions and distributed nature of farms throughout Egypt. It is important to note, that there are many challenges faced in this segment are due to legacy issues such as lack of land tenure. It is not anticipated that titling issues would be addressed, rather they should be taken into consideration as a barrier, and furthermore this exemplifies the need for developing innovative financial solutions.

2.1. **Fin-tech and mobile payments.** The inclusion of fintech startups or infrastructure as an intermediary either between the PV startup and farmers or between intermediaries and farmer would decrease transaction cost, allow for managing larger portfolio of clients, facilitate collection fees, enable sharing models, and provide alternative methods to measure credit risk based on digital data.

Who? Fintech startups and PV startups. Incubators/accelerators should support the development of the business models through co-supported programs. Fintech infrastructure providers such as Fawry, Masary, Aman, and the telecom companies would have a key role in sharing data, providing access to their technologies / platforms, and providing support to startup programs.

How? Design acceleration programs in coordination with financial infrastructure providers aimed at a specific market challenge or opportunity. The financial infrastructure providers would be encouraged to actively provide startups with support on how to use their platforms, share data (i.e. mobile penetration / usage in the market segment targeted), and provide seed financing for promising business models.

2.2. **Inclusion of intermediaries and leveraging existing finance systems.** The agriculture sector has various intermediaries that finance small farmers through banks. These include NGOs and Cooperatives. There is potential demand to include PV systems among standard products financed for farmers. Relevant ministries should raise awareness regarding PV applications with these intermediaries and identify barriers for extending financing.

Who? Ministry of agriculture, ACDB, ministry of irrigation and water resources, ENCPC, NREA.

How? Knowledge dissemination and engaging, with agencies and NGOs articulating the opportunity for PV systems in agriculture and how existing financing systems can be adapted to include PV systems.

2.3. **Policy interventions and credit guarantee schemes.** There are merits to review the lending limits placed on microfinance institutions with the objective of enhancing their ability to engage with farmers. In addition, government and donors should consider the possibility of developing innovative finance vehicles based on guarantees to address information asymmetries and perceptions of risk.

Who? MIIC, other ministries, central bank, international donors, and financial organizations.

How? Diagnostic assessment and stakeholder engagement to determine if, or how, lending limits or other factors, are impacting microfinance institutions ability to engage with farmers, and if policy or other interventions are required. Review of international experience in de-risking the financing of similar technologies and customers through credit guarantee schemes which provide lenders with third-party credit risk mitigation.

3. Data to achieve market impact

3.1. **Developing market data.** Availability of data such as market size, energy use, mobile penetration, at the geographic and customer segment levels would help startups identify opportunities and design better business models. As well, it would help angel investors, banks, and other financiers better understand, evaluate, and have confidence in the market opportunity.
Who? NREA, ENCPC, accelerators/incubators, ministries, governorates, think tanks, donors.
How? Intermediaries should engage with the startups they support to gather and aggregate startup market data requirements and other needs. Ministries and agencies should be encouraged to engage with intermediaries, to understand startup needs, and provide access to market data and other resources to support them. Data can be disseminated in the form of detailed market intelligence reports, white papers, quarterly or annual data dashboards on agency websites etc.

3.2. **Accessing market data.** Information asymmetries prevent the sector from reaching its potential. For example, a key limitation to access to finance in the sector is perceived risk, sharing data and knowledge is key to managing this perception. This can be done by sharing widely government data on the sector, including diesel consumption data at a village, district or municipality level, sharing mobile usage and penetration data, developing project briefs with benchmark financials targeting banks, encouraging PV startups to share data regarding their projects, services, and findings.
Who? NREA, ENCPC, accelerators/incubators, ministries, governorates, international organizations and donor agencies.
How? Intermediaries should engage with the startups they support to gather and aggregate startup market data requirements and other needs. Ministries and agencies should be encouraged to engage with intermediaries, to understand startup needs, and provide access to market data and other resources to support them. Startups should be encouraged to share data through existing peer-to-peer networks and online platforms, such as the Solar Data Platform *https://solardataegypt.info/* developed by the American University in Cairo. Online platforms can be effective tools to allow entrepreneurs in Egypt's lagging regions to access data and engage with their peers and value chain players.

4. Addressing quality and customer perception risks

4.1. **PV startups need to address perceived and real quality risk by their customers.** Startups should be encouraged to build their business models around eliminating the perception/risk of low quality by their customers.
Who? Clean tech startup support entities (incubators/accelerators).
How? Startup support entities to include in their programs how to develop integrated models which include PV installation and maintenance support, emphasizing the risk which low quality products have had on market development through similar cases in Egypt. Intermediaries can also share with startups how business models in other countries have been developed to de-risk customer use of new technology (i.e. pay-as-you-go models).

4.2. **Addressing market risk of low quality PV installations.** The risk poor practices in design and installation and low-quality products have on the market as a whole is significant. When PV startups install low quality PV systems which fail to work, this has an impact on the perception of PV quality as word of mouth spreads quickly in communities. PV startups or a group of startups can self-

regulate and establish agreed upon quality control and monitoring systems. This is important to ensure growth can a positive demonstration effect increasing customers confidence in the PV technologies rather than negatively affect it.

Who? NREA, Egyptian Organization for Standards & Quality(EOS), and other related agencies.

How? NREA, EOS, in close cooperation with PV startups and companies, should assess the merits of developing PV and inverter quality and installation guidelines, firm certification schemes similar to what has been done for the feed-in-tariff, and the phasing in of standards on PV systems as needed. Note, firm certification schemes should not act as a barrier to firm entry, but rather help inform potential customers.

4.3. **Off-grid PV firm certification and certification of engineers and technicians.** Startups are operating in many remote areas to reach their customers and are highly dependent on outsourcing engineers and technicians to carry out installation and maintenance work. Developing training and certification program could reduce risk and resources needed to identify and employ capable technicians or engineers while improving quality of service provision in the market.

Who? Universities, vocational programs, private entities, NREA, and PV associations or training centers.

How? Initiate a review of the expected skills requirements of PV firms, as well as the anticipated geographical location of those needs, as it is anticipated the growth of this sector will largely be in rural regions, in particular in Upper Egypt. Existing programs need to be refined or redesigned to meet identified market needs. Leverage existing platforms to help connect job seekers with emerging job opportunities in the sector.

5. Value Chain Development

5.1. **Supporting startup integration in the value chain with incumbent companies and other rural based startups.** Startups can benefit significantly by linking to established companies in the value chain, such as logistics providers, leasing companies, and farming equipment providers. Creating these linkages is important to provide startups with market access. In addition, there is value to be unlocked by linking Cairo-based startups to their counterparts based in the rural areas and bring complementary skills and networks to each other. Cairo based startups tend to have the best access to the Cairo centric support ecosystem and technical knowledge, while rural based startups have strong access to the customer and local value chain networks.

Who? Startup support entities (incubators/accelerators) and NGOs operating in Cairo and rural areas, by working together linking respective startups and designing joint programs.

How? Joint programs or competitions between incumbent companies and incubators and accelerators targeting a specific value chain objective (i.e. linking startups to equipment logistics companies). The ecosystem has carried out previous joint programs with large corporates, however the emphasis in this case would be to achieve a value chain objective and bringing in a relevant incumbent company (not necessarily a large corporate). In addition, encouraging Cairo based support programs to engage with rural based NGOs with similar objectives or target markets could provide significant value to both Cairo based and rural based startups.

5.2. **Localization of solar systems, components, and product design.** There is an opportunity for Egyptian startups to develop local components which require less-sophisticated technical know-how. These components and accessories could include: the aluminum framing of the panels, the

mounting system on which the modules are installed and connected, the cabling – both A.C. and D.C.; and possibly inverters. Encouraging local manufacturing of some components is important as it create the know-how needed to enable future equipment modifications needed to meet business model design/objectives (i.e. shared/mobile PV pumps).

Who? Clean Tech startup support entities (incubators / accelerators).

How? Linking startups to relevant workshops and maker-spaces. Upgrading of maker-space and workshop equipment (i.e. laser cutters, 3D scanning and printers) and improving accessibility to startups outside of Cairo.

6. Creating markets by strengthening the ecosystem

6.1. **Strengthening linkages in the Ecosystem using market objectives and a shared vision.** Government entities and intermediaries can play an important role showcasing the market opportunities and challenges faces in order to convene like-minded and capable ecosystem players to design comprehensive programs to unlock markets. Market information and data should be shared to give the various entities with a joint understanding and joint vision on the needed path forward to unlock markets and support startup growth. Resources are needed to support stronger collaboration and coordination to improve overall effectiveness as well as to extend support outside Cairo.

Who? Government, Donors, incubators, accelerators, industry association, universities, corporates.

How? Market data and intelligence reports need to be developed in order the support program design and bring together relevant players of the ecosystem to provide support. By having a clear market objective and road map, ecosystem players are more effectively able to commit and provide relevant support. As well, market intelligence reports will reduce information asymmetries and improve investors ability to make funding decisions. Through this process, gaps in the ecosystem can also be identified, which need to be addressed, or can be filled by linking to global networks.

6.2. **Strengthening sector specific startup support programs (i.e. cleantech, fintech, smart-agri, digital).** For incubators and accelerators to better serve startups, strengthening sector specific support programs are recommended. By being sector specific it allows incubators and accelerators to focus and provide more relevant services to their startups, tie into applicable networks, and be more accountable for their service offering. For instance, mentorship selection becomes more rigorous and avoids the use of general mentors, as well programs can provide better support to startups by developing connections with technical support entities, industry associations, and investors interested in the sector.

Who? Government, Donors, incubators, accelerators.

How? Creating an enabling environment conducive for global sector specific incubators and accelerators, impact investors, and venture capital to setup operations in Egypt. Linking local support entities to global networks to help improve the capacity, knowledge, and network gaps of existing sector specific incubators and accelerators.

6.3. **Strengthening quality, range of support, inclusion, and geographical reach of existing and future incubators and accelerators.** For startups to grow, their success is impacted by the quality and range of services provided by the ecosystem. Resources should be allocated with the objective of improving the robustness of service provision by the ecosystem, the number of startups the ecosystem can support, and the geographical reach of the ecosystem (in particular outside main cities). In addition, programs should be designed to take into account challenges faced by female entrepreneurs accessing support services.

Who? Government, donors, incubators, accelerators
How? Providing additional resources to incubators and accelerators, in particular those which aim to support female participation and geographical diversity. Creating an enabling environment conducive for top tier global incubators and accelerators, impact investors, and venture capital to setup operations in Egypt. Linking local support entities to global networks and partners to help fill ecosystem gaps in the short term, and improve the capacity of the local ecosystem in the medium term.

1. The Emerging Agri-Solar Market in Egypt

1.1. Background

The rise in energy prices with the gradual phase out of subsidies and challenges in securing energy in remote areas has allowed new clean technologies to emerge as a sustainable solution to meet the increasing market demand in Egypt. The opportunities in Egypt are significant, replacing diesel with solar power is potentially transformative.

Despite the significant opportunities, growth in the clean technology market is below its potential. Clean technology markets are relatively new in Egypt and globally, hence clean technology business models, norms, and practices are still being defined.

A recent World Bank Group policy paper "Scaling up distributed solar in emerging markets: the case of the Arab Republic of Egypt", identified off-grid application of Solar in agriculture as a significant opportunity, amounting to nearly 2000 MW in photovoltaic (PV), approximately $4 billion in investment.[7] The paper indicated that despite the large potential market and improved economics there remain several barriers to the growth of the market. These barriers included; uncertainty of government policy, policy advocacy, access to debt financing, access to data, and tailored business models. The paper continues by emphasizing the opportunity in replacing diesel power pump sets with solar pumps, and the need to understand additional potential barriers facing market growth.

The following study aims to build on this policy paper, by observing the emerging trends of PV use in the agriculture sector, the role of PV startups in the market, business model applications, and customer acquisition challenges. The study concludes by carrying out a value chain analysis of the sector, and developing recommendation to building an ecosystem positioned to unlock further market growth.

This study is meant to serve as a knowledge tool for (i) PV startups on market needs and trends, (ii) for ecosystem players to better serve the sector, (iii) for policy makers to guide the strategic interventions to grow the PV market in Egypt as well as, (iv) for donors to better plan their interventions to target the gaps in the PV entrepreneurship ecosystem.

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1.2. Startups and the growth of PV in Egypt

The international PV energy market has experienced significant growth since 2000. This growth has been systematically underestimated by most forecasts as shown in Figure 1. Egypt has one of the highest solar energy yields in the world and is a prime location of photovoltaic energy applications. However, photovoltaic (PV) penetration in Egypt did not follow this trend largely due to a highly subsidized energy market with very little room for private sector involvement. Egypt's energy market has seen rapid changes since 2012. This included removal of subsidies and the convergence of the gap between supply and demand which peaked in 2013. The Government of Egypt launched a Feed-in-Tariff (FiT) program to boost the PV market in Egypt in 2014 and revised it in 2016 aiming at attracting 2.3 GW of PV.[8] However, despite these positive developments, the off-grid PV market is still nascent in Egypt, and there are segments, such as the small farm segment, which remain untapped.

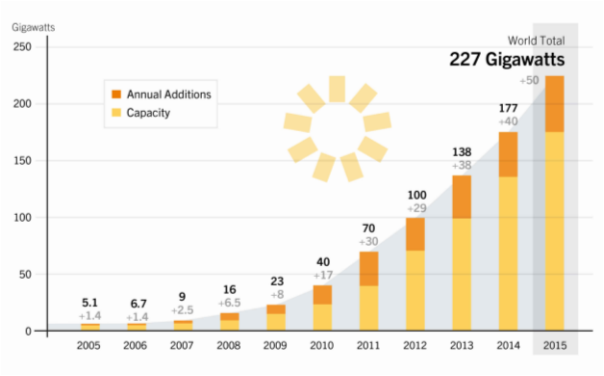


Figure 1: Solar PV Capacity and Annual Addition – Source REN21

The following analysis demonstrates that PV use has been growing in Egypt, particularly for off-grid applications. According to CAPMAS data, the cumulative estimated capacity of PV modules entering the Egyptian market has grown significantly from 2008 -2016, with installed capacity increasing significantly from 2014-2016 (Figure 2)[9]. The rapid changes to the energy market has created business opportunities for the private sector and job opportunities in Egypt's lagging regions. The study estimates that Egypt currently has at least 124 MW of PV system 75 MW of which are installed in the agriculture sector. The agriculture sector represents a key market for PV in Egypt where in cases it can serve the purpose of replacing diesel and ensuring energy security for its customers. These diverse needs in the agriculture sector created large opportunities for PV.

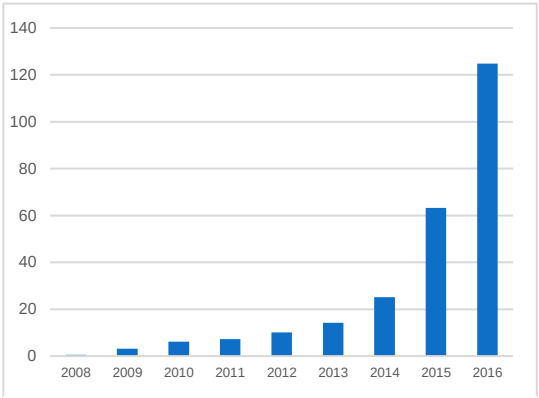


Figure 2 Cumulative estimated capacity of PV modules entering Egyptian Market in (MW) from years 2008 to 2016 - CAPMAS DATA

[8] Egypt announced the FiT program in late 2014, having ambitious schemes for both solar and wind. The initial plan was to host up to 2300 MW of solar, 2000 MW of wind. Only three developers reached financial closure in round 1: FAS Energy, Infinite and Elf. The three developers were shortlisted out of 40 companies who participated in the first round while 9 others signed the PPA with EETC. Those who did not reach closure would be automatically moved to Round 02 of the FiT program (Riad, 2017). "Egypt Fit Program – Winning Developers in Round 1 Announced." Published: March 2017, Accessed: December 2017. http://www.riad-riad.com

[9] CAPMAS provides dollar value of Using the average PV module price per kW for respective years the PV kW imports were determined. The price of kW PV module based on the list of reports below

R K Suwal, "The downward trend in cost of solar PV: An opportunity to synergy of Hydro and Solar Power for Sustainable Renewable Energy in Nepal"Rentech Symposium Compendium, Volume 4, September 2014

ITRPV Working Group. "International Technology Roadmap for Photovoltaic (ITRPV) 2013 Results." (2014). Davidson, Carolyn, Ted L. James, Robert Margolis, Ran Fu, and David Feldman. *US Residential Photovoltaic (PV) System Prices, Q4 2013 Benchmarks: Cash Purchase, Fair Market Value, and Prepaid Lease Transaction Prices*. No. NREL/TP-6A20-62671. National Renewable Energy Laboratory (NREL), Golden, CO., 2014.

Investing in Climate Change, Deutsche Bank, 2012. Fu, Ran, David J. Feldman, Robert M. Margolis, Michael A. Woodhouse, and Kristen B. Ardani. US solar photovoltaic system cost benchmark: Q1 2017. No. NREL/TP-6A20-68925. National Renewable Energy Laboratory (NREL), Golden, CO (United States), 2017.

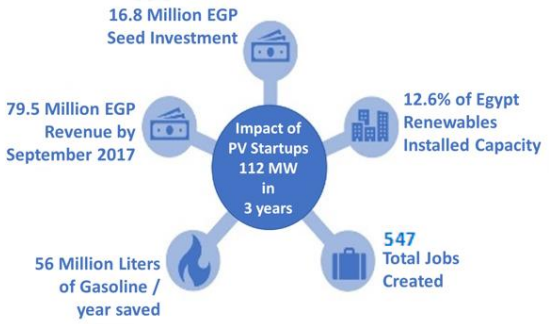


Figure 3: Impact of PV startups interviewed

Approximately 90% of Egypt decentralized PV market is dominated by startups; young companies which were established starting 2012 with limited capital or angel investments. This report analyzed the performance of 20 PV startups which have collectively installed 112 MW, 90% of Egypt PV systems, estimated to be 124MW based on PV imports recorded by CAPMAS[10]. These startups, with an average age of 3 years, and approximately EGP16.8 million in seed investment, achieved collectively revenues of EGP 79.5 million[11] in the first 9 months of 2017. The impact of systems installed by these startups can be translated into saving 56 million liters of Gasoline per year[12], and represents 12.6% of Egypt renewable energy installed capacity (excluding hydro)[13]. This saves the government in subsidies, also decreases the carbon foot print of the nation, and create sustainable jobs. The impact of the 20 startups analyzed in the report is summarized in Figure 3.

Clean Tech Startups are well positioned to unlock new market opportunities and support technology transfer in Egypt. The competitive edge of startups is in their agility and adaptability which allows them to develop new business models, introduce new technologies, identify niche market segments, and serve diverse client needs. For instance, an off-grid agriculture farm that wishes to utilize a solar water pumping solution, startups have used a variety of business model innovations in order to adapt to user requirements, these have included; power purchase agreements to provide solar energy for pump operation, financial models to sell water instead of power produced, or a simple technology innovation of a water storage tank to eliminate the use of batteries and save costs. Each of these solutions needed to be tailored to meet the end-user's needs, and startups continue to help define the *modus operandi* of this growing market. These small growing businesses, have been better positioned to innovate, take risk, and unlock PV than larger firms in Egypt. Hence, startups have succeeded in catalyzing the transition to renewable energy applications more than larger firms in Egypt to-date. Out of the 20 startups interviewed in the present work, 7 are on NREA list of qualified firms in the FiT scheme.

Farms have been the key customer of the rapidly growing PV startups in Egypt, however only a fraction of the potential market has been served. The survey analysis indicates that the agriculture sector represents 67% of sales of PV startups. These systems usually power pumping systems and energy needs of farms particularly in off-grid lands and those off the river valley. As the present work will demonstrate, PV applications in farming are diverse and serve diverse needs, from ease of utilization such as in PV powered pesticide sprayers or surface pumps to ensuring energy security and saving on diesel expenses. The innovation and agility of startups started to serve such various needs enabling to a surge in

[10] CAPMAS data captures PV dollar value imported by suppliers and traders, however values of imports that goes as capital assets or into large EPC projects (for instance the upcoming Solar Park in Benban) might not show in the CAPMAS data. Thus, the 124 MW are considered as the lower limit of the data, yet they also strongly represent decentralized PV where most startups are active.
[11] Revenue figures based on startup interviews. Revenue figure does not include revenues of from firms supplying to installers/EPC which would take the figure to 126.5 Million revenue in the first 9 months of 2017
[12] Calculation are conservative are on the lower side of gasoline saving, 1 kW solar panels are assumed to generate a net of 1500 kWh per year, gasoline engine efficiency is assumed as 30%, and the gasoline energy content is assumed to be 10 kWh/liter (US Energy Information Administration 2016 - .National Renewable Energy Laboratory (NREL) PVWATTS software
[13] Ministry of Electricity and Renewable Energy Data 2016.

growth experienced since 2013 in the PV market. While the growth achieved is notable, only a fraction of the potential market has been captured. To date, at best 4%[14] of the PV market size in the agriculture sector has been served. With the existence of a strong demand and large market size, and with the presence diverse innovative PV startups, the sector is poised for expansion. Yet in a business as usual scenario, startups may struggle to maintain their customer adoption rate as they may have picked the low-hanging fruit, early adopters in a market place which will become crowded with more competitors should it remain on the same trajectory. Thus, further effort is needed to catalyze and mainstream the market to engage in new market segments, such as small farmers. The report aims to provide an analysis of the Agri-solar market in Egypt in order to synthesize recommendations to unlock the PV market in Agriculture. This will not only positively impact the agriculture sector, but could catalyze a local flourishing PV industry that becomes a source of sustainable job creation and economic value.

1.3. Methodology and approach to analyze the PV market in agriculture

To capture the dynamics of new and emerging market, diverse research methods and analysis tools were utilized. The methodology relied on extensive and detailed surveys with key elements of the market. The surveys were geographically diverse and representative of the market. Primary data collection by direct communications with relevant entities through individual interviews and group workshop/working sessions were a cornerstone in the present work. Secondary data collection through CAPMAS and Trademap was used along with other databases available to stakeholders and a review of published. Value chain mapping and analysis were utilized. Market opportunity mapping and pre-feasibility analysis were utilized to assess technologies and opportunities for investments. Workshops and co-working sessions with stakeholders were used to validate findings.

The researched was carried out over a four month period, June 2017 to September 2017, in a phased approach.

Phase one, the research design phase, developed templates for the following group of stakeholders:

- PV Startups
- Ecosystem Stakeholders
- Market Enablers Stakeholders
- Financial Technology Startups
- Financial Institutions

Phase two of the research consisted of reviewing recent literature and identifying the gaps within it. Most of the literature items consisted of country reports on either solar energy applications, entrepreneurship in Egypt, the energy status of the agricultural sector, as well as market related reports on PV startup growth internationally. The reviewed literature tries to link international trends, with current local practices. Recent secondary data were obtained from: World Bank, FAO, RCREEE, IRENA, and IEA reports. As for the technical applications of solar in agriculture, academic journals were reviewed.

The focus of international literature on the subject is the PV module manufacturing value chain which is not the focus in the Egyptian scenario. Rather, the focus is on assembling the system. The main application

[14] The 4% is calculated based on the minimum estimate of the PV farming market size of 2000 MW when only considering non-portable pumping irrigation needs and a potential PV penetration rate of 60% according to “Diesel to Solar Transformation, 2016, UNDP, RCREEE” and assuming that the 124 MW of PV in Egypt are 67% installed in farms which is the percentage of PV in farms in systems installed by interviewed startups.

being solar water pumping; and installing it on-site. The farm's solar application can be either on-grid or off-grid. However, off-grid locations have higher potential for solar applications due to the added overhead of diesel transportation and the challenges of sourcing and storing diesel, as well as prices fluctuation in diesel fuel in the informal market.

The visual provided for mapping-out the PV value chain in the agriculture sector is based on the consultant's experience in addition to supporting references – e.g. published by RCREEE; and was later validated by a diverse set of solar energy stakeholders – both startups and public institutions. [15]

Phase three surveys and field visits were conducted. The assessment is based on a survey strategy for a specific target population composed of PV startups, agri-waste businesses, fin-techs, ecosystem stakeholders, market enablers, financial institutions, investors as well as support initiatives.

A total of 100 surveys were conducted to obtain the primary data, 20 of those are the solar energy startups –Figure 4.

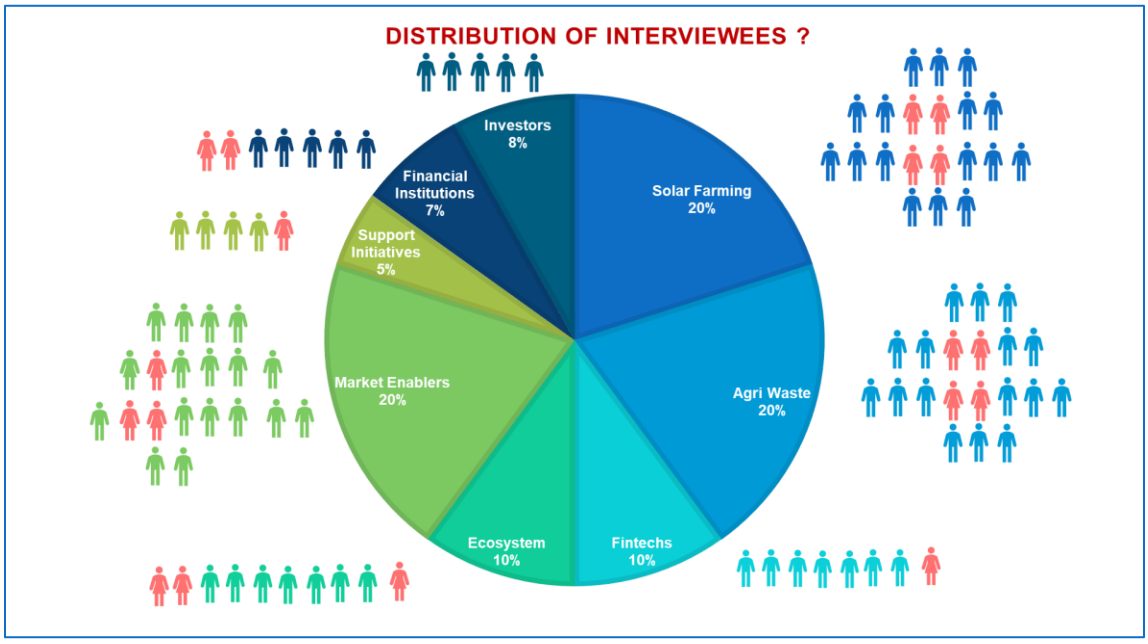


Figure 4: Distribution of interviewees in the present study per type entity they represent

For each group of stakeholders' survey questions were prepared covering the following topics: business profile, perceived barriers and opportunities, applications in the identified sub-sectors, and the experience in dealing with financial institutions and investors. The surveys were conducted mainly face to face. In case of unavailability, to update information, or collect further data with the startups, phone interviews were conducted. The average survey length was 60 minutes. Surveys were conducted in Cairo and 9 other governorates. Figure 5 shows the geographical distribution of the surveys of PV startups, and Figure 5 shows the geographical distribution of the entire sample.

[15] Regional Center for Renewable Energy and Energy Efficiency (RCREE) 2016. "Diesel to Solar Transformation Accelerating Achievement of SDG 7 on Sustainable Energy: Assessing Untapped Solar Potential in Existing Off-Grid Systems in the Arab Region." RCREEE.
RCREEE 2017. "Market Assessment Study of Socio-Economic Impacts of Solar Farming Systems." Cairo, Egypt: RCREEE. http://rcreee.org/sites/default/files/socio-economic_final_for_web_19-10-2017.pdf.

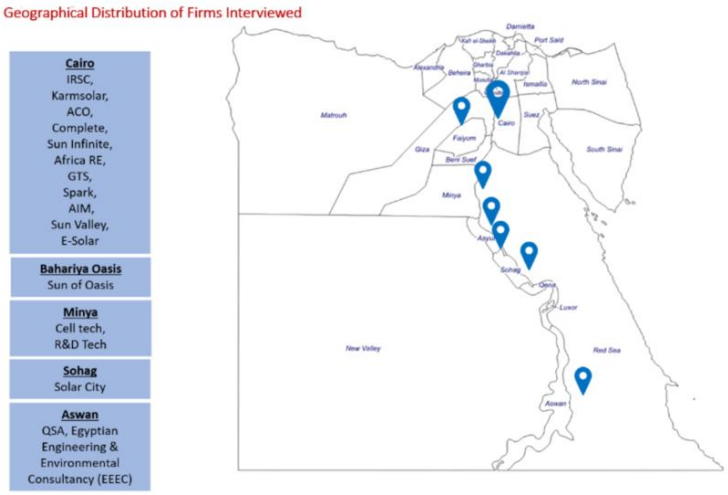


Figure 5: Geographical distribution of 20 interviewed PV startups

Phase four, following the data collection phase, a database for stakeholders was designed on excel, and a business model canvas was modeled in order to facilitate data entry. The result of which is communicated through this report where charts and tables are generated setting the foundations for the baseline assessment of PV related entrepreneurial activities.

A full day workshop, with breakout sessions, and a networking event with panel discussions were held to present the findings of the study and validate the results with subsector stakeholders. The report takes into account the feedback received during the two occasions.

2. PV and the Agriculture Sector

This chapter offers an overview on energy consumption in the agriculture sector with the aim of providing the context of the broader market for PV firms. The chapter highlights the role of the agriculture sector in Egypt's economy and the role energy plays in the sector. It then reviews current energy consumption patterns in the sector as well as challenges faced. Finally, the impact of PV on the agriculture sector is highlighted.

2.1. Energy consumption and spending in the agriculture sector

While energy consumption in the agriculture sector represents a smaller share of Egypt's total energy consumption, energy's contribution to the agriculture sector is significant. The agriculture sector in Egypt represents 6%[16] of the total energy consumption in Egypt. About 2139 ktoe[17] of fuel were consumed mostly in the form of diesel compared to 416 ktoe of electricity in 2016[18]. From 2007 to 2017 the spending on energy in agriculture averaged at 7.6 Billion EGP/year which is approximately 15% of net contribution of the sector to the economy[19].

Energy consumption in farming is highly reliant on diesel, both for direct use for equipment (i.e. pumps), or the generation of electricity. Agricultural processes and applications require energy, in the form of electrical and mechanical power for many uses including land preparation, seeding, irrigation, delivery of pesticides, and harvesting among others***.*** Ensuring sustainable, secure, stable, and competitive energy supply is of major importance to the sector. In off-grid farms, the main source of energy used in farming is diesel. However, for on-grid farms diesel is also used to power generator sets (gensets) and diesel pumps on parts of the farm which lack access to electrical distribution network.

The following table builds on a study carried out by RCREEE on the opportunity for Solar to replace diesel applications in Egypt[20]. The study breaks down the use of diesel pumps by type (fixed or portable), size (horsepower), number, and tons of diesel consumed annually. Based on these estimates, and the current subsidized prices of diesel EGP 3.65 / litter, it is estimated that EGP 2.9 billion is spent annually on diesel for off-grid pump use in Egypt.

[16] RCREEE, Energy Efficiency Country Profile, Egypt, 2012

[17] Kilotonne of Oil Equivalent (ktoe). The ton of oil equivalent (toe) is a unit of energy defined as the amount of energy released by burning one ton of crude oil.

18 The energy consumption data of the agriculture sector was based on EgyptERA data published in 2010. Energy consumption per unit production in the agriculture sector was assumed constant as per 2010. The consumption per unit production was then used to reduce energy consumption in other years. In 2016, the agriculture production was equivalent to that in 2010 and thus, the energy consumption values of 2010 can also be representative of those of 2016.

[19]EgyptERA published the diesel consumption and electricity consumption in 2010, also the net contribution of the agriculture sector from 2006 to 2016 from world bank data (agriculture sector value added), assuming the ratio of energy consumption and agriculture value added is constant, and using electricity and diesel prices from 2017 as well as the average agriculture sector value added, the average spending on energy in the agriculture sector can be calculated and referred to average agriculture sector value added.

[20] RCREEE 2016. "Diesel to Solar Transformation Accelerating Achievement of SDG 7 on Sustainable Energy: Assessing Untapped Solar Potential in Existing Off-Grid Systems in the Arab Region." RCREEE. Used Size, # of Pumps, & Diesel tonnes data from RCREEE, however applied more conservative assumption of diesel pump use to 1200 hours per year rather than 6000 hours per year.

Portable Pumps - Annual Expenditures											
Size	# pumps	Total Diesel tonnes	liters / tonne	Total Liters	Liters/ Pump	Cost of Diesel (subsidized) EGP	Cost of Diesel (unsubsidized) EGP	Exp/ Pump used (subsidized diesel)	Exp/ Pump used (unsubsidized diesel)	Annual Exp (subsidized diesel)	Annual Exp (unsubsidized diesel)
<5 HP	45,599	73,500	846	62,181,000	1,364	3.65	6.75	4,977	9,205	226,960,650	419,721,750
6-9HP	89,951	271,500	846	229,689,000	2,553	3.65	6.75	9,320	17,236	838,364,850	1,550,400,750
10-12HP	36,178	137,250	846	116,113,500	3,210	3.65	6.75	11,715	21,664	423,814,275	783,766,125
>12 HP	15,467	62,250	846	52,663,500	3,405	3.65	6.75	12,428	22,983	192,221,775	355,478,625
Total	**187,195**	**544,500**		**460,647,000**						**1,681,361,550**	**3,109,367,250**
Fixed Pumps - Annual Expenditures											
< 15 HP	27,549	79,250	846	67,045,500	2,434	3.65	6.75	8,883	16,427	244,716,075	452,557,125
16-25HP	24,716	127,000	846	107,442,000	4,347	3.65	6.75	15,867	29,343	392,163,300	725,233,500
26-45HP	8,597	76,000	846	64,296,000	7,479	3.65	6.75	27,298	50,482	234,680,400	433,998,000
>45 HP	10,182	117,000	846	98,982,000	9,721	3.65	6.75	35,483	65,619	361,284,300	668,128,500
Total	**71,044**	**399,250**		**337,765,500**						**1,232,844,075**	**2,279,917,125**
Total Fixed and Portable	**258,239**	**943,750**		**798,412,500**						**2,914,205,625**	**5,389,284,375**

Diesel pumping, and diesel gensets are commonly used to generate electricity for agricultural processes in off-grid farming; e.g. in Egypt's desert and off the Nile Valley particularly in Upper Egypt. The diesel gensets providing power can be either centralized (forming a mini-grid) or decentralized. The aim of centralized stations is to provide electricity for the whole farm through major power units. Centralized genset stations are larger generators which feed the whole farm, simulating a mini-grid. This option is more popular with large-scale farms which have the capacity to invest in infrastructure. In addition to the cost factor, the main risk with centralized genset stations is that any disruptions in the main station result in loss of power for all farm operations. The decentralized system on the other hand relies on small units, either power stations or irrigation systems which are scattered along the farm for specific uses; e.g. a diesel gen-set per pump. The key challenge with the decentralized system is with the operation and maintenance of several equipment. It is important to note that both, electricity from the grid as well as electricity produced through gensets and diesel pumping can be replaced by PV applications.

PV farming can be defined as the utilization of PV energy applications within the agricultural value chain. PV systems have multiple uses in the farming. PV systems can be used to power equipment such as pumps, to produce electric power for lighting, for spraying pesticides, powering shredders, in addition to water heating and produce drying. This report focuses on solar photovoltaic applications in its wider prospects but also touches on other solar applications that can have a positive impact such as solar thermal heating and solar food drying. When PV technology is deployed with a user-centric application and business model it can provide the agriculture sector with cost competitive, reliable, easy to use, sustainable energy.

On-grid PV electricity levelized cost of energy is yet to reach grid parity after the devaluation of the Egyptian pound in 2016. A recent study by the World Bank identified off-grid applications as the most promising pathway for PV energy, the majority of which is for use in farming.[21]

PV farming enables Egypt to expand its agriculture footprint by facilitating desert farming. The area of agricultural land in Egypt is limited 3.8% out of the total, otherwise desert land area according to 2014 World Bank data. For Egypt to meet its increasing food consumption desert farming and desalination practices would need to be expanded in addition to improving efficient farming practices. PV can facilitate this by providing energy for desalination and underground pumping. Extending the grid to cover new desert farming

[21] Dalia Sakr - World Bank Group. 2016. "Scaling up Distributed Solar in Egypt." Roundtable Discussion presented at the Scaling Up Distributed Solar in Egypt, Cairo, Egypt, February 28.

land would require extensive investment in infrastructure placing a significant burden on the government budget. Accordingly, PV systems and decentralized energy will be a key to enable growth in the sector.

2.2. PV applications in agriculture: Market sizing and segmentation

This section aims to estimate the market size of mainly solar PV applications in agriculture. The subsequent subsection draws attention to the gap found between the prevalent solar technologies in the market, and international experience, technologies, business models, and financing innovations that could be utilized.

As of September 2017, it is estimated that 124MW of PV have been installed in Egypt

Market size data for PV applications in the agriculture sector, and the role of clean tech startups in Egypt is limited. In order to understand the evolution of this sub-sector, it required bringing together and analyzing data points from multiple institutions, sectors, and technologies available in Egypt.[22]

PV Installed Capacity in Egypt – 124 MW as of September 2017

- Estimated PV Systems by Private Sector = 100-130 MW
- Estimated Market Size (CAPMAS Data) = 124 MW
- Estimated Market Size (Trademap.org) = 114 MW
- Installed Capacity by interviewed firms = 112 MW
- Installed capacity in farms by interviewed firms = 75 MW

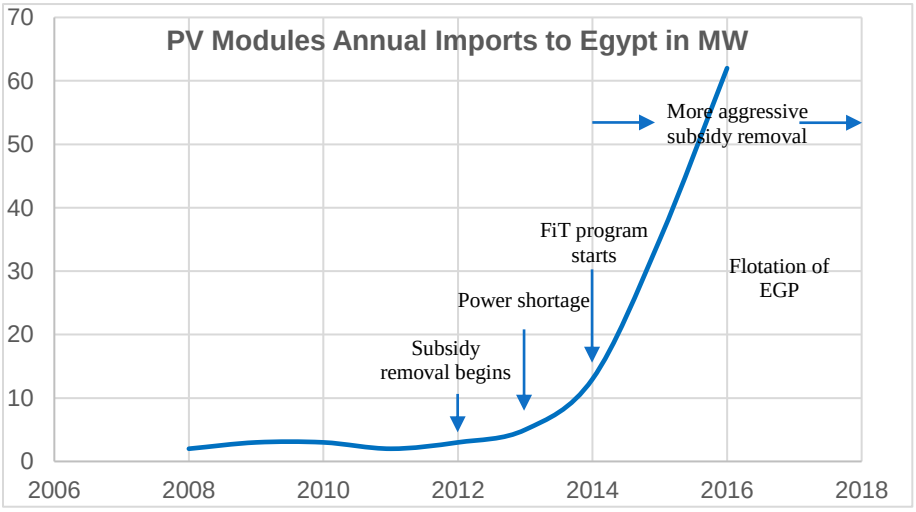


Figure 6: Total PV module imported to Egypt by year in MW (CAPMAS data USD Imports of PV, translated into MW)

[22] 124 MW represents the import value based on CAPMAS data since 2008. This was cross-referenced with data from the 20 surveyed startups who provided estimates ranging from 100 to 130 MW on installed PV systems in Egypt. In addition, the startups provided the system sizing of each of their operations which amounted to 112 MW. Finally, the battery technology associated with PV off-grid systems imports were determined through CAPMAS and they show the same growth trend of PV modules.

However, despite this rapid increase in PV applications in agriculture, only a fraction of the market opportunity has been covered. Replacing diesel with PV for water pumping alone, has a potential of 2000 MW of PV capacity.[23] Only 4% of this capacity has been covered at the time of this study. 2000 MW is the lower limit of the market size as it focuses only on PV pumping and does not take into account other applications like PV standalone systems for farm electrical power and other PV powered equipment for example. As electricity prices continue to increase and PV systems' cost declines making PV more competitive, the market opportunity would increase, and more providers would likely enter into the market. While the rapid growth in Figure 6 is a positive signal, it is important to realize that the PV sector in Egypt has to evolve to be able to meet a considerable market opportunity and the needs of the various end users. The farming sector in particular has various client segments, each has needs and challenges which needs to be addressed.

A customer segment focus is needed for deeper vertical and horizontal penetration of PV systems. Carrying out a market segmentation is important to understand the market opportunities for each customer segment. It is also important to reflect on how various startups and their characteristics, enabled them to penetrate a particular market segment. Based on field visits and surveys, customer segments can be broken into three main categories; farms less than five feddans[24] (small), farms from five to twenty feddans (medium) farms larger than twenty feddans (large). Each of these categories have varying characteristics and requirements.

PV Farming Penetration is Mainly in Large Farms

Out of 112 MW installed by firms surveyed in the present study the installed PV capacity by farms size is as follows

- Farms < 5 Feddans surveyed startups installed approx. 0.15 MW
- Farms between 5 - 20 Feddans surveyed startups installed approx. 15.00 MW
- Farms >20 Feddans surveyed startups installed 59.00 MW

70% of farms in Egypt are less than 5 Feddans in size[25] representing nearly 4.9 million farmers. This percentage is decreasing due to the change in the geographical map of agriculture in Egypt, as a result of the increasing amount of desert land reclamation. A national project launched by the government aims at reclaiming 1.5 million Feddans of desert land, mostly located in the Western desert. Small farms engage directly with agricultural cooperatives, and non-governmental organizations. Small farm holders rely on cooperatives for essential agricultural supplies such as compost and rental of machinery. PV startups have had limited success in penetrating the small farm segment, even though they represent the largest market segment by size.

Small Scale Systems

Farms under 5 Feddans served by surveyed PV firms are located mostly in Aswan and the Western Desert. These were served by QSA and Sun of Oasis startups which are based in Aswan and Baharya Oasis. Their success can be attributed to their proximity to the customer, investing time in marketing and business development, providing after sales support and gaining customer confidence and assurance by being close physically.

Out of the 112 MW installed by firms surveyed in the study 0.15 MW were installed in farms under 5 feddans, 15 MW were installed in farms between 5-20 feddans and 59 MW were installed in farms

[23] RCREEE 2016. "Diesel to Solar Transformation Accelerating Achievement of SDG 7 on Sustainable Energy: Assessing Untapped Solar Potential in Existing Off-Grid Systems in the Arab Region." RCREEE.
[24] 1 Feddan = 1.03 Acres
[25] Knowledge Economy Foundation, 2017

above 20 feddans. Small farms could benefit from PV systems for surface pumping particularly in Upper Egypt where water levels are relatively shallow. Startups responding to the survey, stressed that there is willingness among smaller farms to purchase PV systems. A key challenge faced is reducing / eliminating the initial financial burden and risk which directly impacts the decision-making process. Additional challenges are related to technology acceptance and hesitance to change. It is also important to consider that customer needs in this segment might also be intermittent, requiring irrigation for limited hours per day or limited days per week. The frequency of irrigation depends on the crops which in many cases do not require daily irrigation particularly for lands close to the Nile valley. The opportunity is for startups to develop a business model tailored to the farmer needs in order to grow the market. A rough estimate for timeframe needed for farmers of this scale to cover the payment of the system is more than five years which requires a long-term finance option. To date, the vast majority of this market segment has not been accessed by PV firms. Typically, such farmers require systems in the range of 1 to 5 kW. Less than 150 kW has reached this market from the 112 MW identified in this study. Accordingly, distribution logistics to reach this customer segment has been challenging, and equally so, managing recurring small-scale cash-based transactions stretched along a wide geographic scope. Innovative marketing and awareness raising for innovative business models to address customer needs is key to growing this market segment.

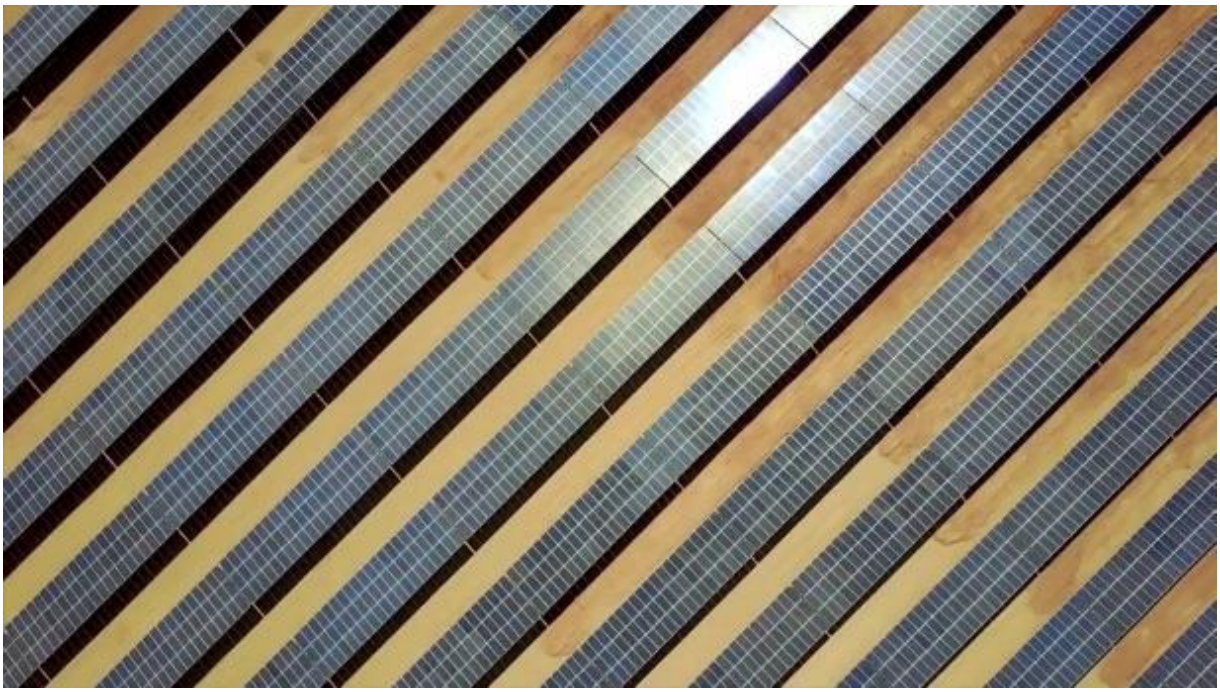
Growth in the medium sized farms segment has mostly been led by PV startups in the agriculture sector at the governorate level (i.e. startups outside Cairo). Due to their geographical proximity, these companies are uniquely positioned, understand the seasonality of the farm-owners' business and can find suitable arrangements to mitigate the risks associated with agricultural practices. A market scan shows that farm owners at this scale are willing to shift to PV with the right finance scheme. About 15 MW of 75 MW implemented by the surveyed startups has reached the medium size farm market segment. The demand and awareness as well as willingness is highest among such farms. The business case for investment in PV is compelling for the medium size farm segment and would significantly reduce farming costs particularly in off-grid farms. However, there remain challenges in the customer finance scheme for the medium size farms as only few can afford paying for the system in full upfront. Off-grid medium size farms customers are willing to pay for PV systems in installments distributed over 3 to 5 years as the field visits have indicated. Medium scale farms require systems 5 to 10 kW mostly for pumping. Given the land size they own, more frequent irrigation is needed than in small farms. This increases the utilization factor and thus the feasibility of PV investment in medium size farms compared to large ones.

Currently, large farms are the main customers for the Cairo based PV startups, who have been successful at identifying early-adopters. These are farms seeking reliable solutions, which can tailor the services and products to their own needs. These large farms are focused on export or are tied to food and beverage industrial entities, where solar PV solutions are better understood and valued by company management or their supply chain. Additionally, some of the larger farms connected at medium voltage experience higher electricity tariffs which makes PV more favorable as an option. Large farms are capable of self-financing or have access to finance that allows them to purchase the PV systems. Also, the scale of energy consumption per farm makes them attractive to PV startups as client. Very few of these farms are in the 100s of Feddans

Early Adopters in Large Farms

Complete Energy Solutions (CES) has developed and commissioned Egypt biggest PV system of 20 MW for a large farm in Toushka on December 2017. The system operates on the net-metering scheme and not the FiT. The case has also opened the door for large scale systems in the net-metering. The system covers a significant amount of the client energy consumption. The agri sector has been an early adopter in the PV market in Egypt. CES is the market leader in PV with a staggering 52 MW track record, most of which in agriculture sector.

size. The larger size of the range usually needs a centralized energy system to serve pumping needs but also energy utilization for housing of workers and administrative buildings. These farms constitute the majority of PV systems installed by surveyed startups, reaching about 59 MW of 75 MW[26].



Egypt Largest PV Power Plant in Toushka by CES – photo provided by CES

2.3. Current PV application use in the agriculture sector

There is limited diversity in PV application in the agriculture sector. The current study identified the below documented applications of solar energy in the Egyptian agriculture sector.[27] (Figure 7)

- **Off- Grid Solar Water Pumping** is considered a gateway to decrease the dependency on diesel which might not be readily available. Particularly important to agricultural farms, irrigation is the core of the business. Most systems that are documented are off the Nile valley whether in the western desert Oases or desert backland expansions and land reclamation projects.[28]The widely-used application of solar water pumping is confirmed by both literature findings and implemented projects.[29]

[26] Note: CES's 20MW plant is not included in the 75MW as it was installed after the survey was carried out in September 2017.
[27] RCREEE 2016. "Diesel to Solar Transformation Accelerating Achievement of SDG 7 on Sustainable Energy: Assessing Untapped Solar Potential in Existing Off-Grid Systems in the Arab Region." RCREEE.
GIZ, and Cleantech Arabia. 2017. "GROWTH MANAGEMENT FOR SUSTAINABLE ENERGY SMALL GROWING BUSINESSES (GM4SESGB) Program. The Seed for a Sustainable Energy Cluster in Egypt Planting the Seed for a Sustainable Energy Cluster in Egypt – Final Report." Unpublished Report. Cairo, Egypt: GIZ.
UNIDO-GTI. 2017. "Green Trade Initiative - Tomatoes Solar Drying in Luxor." Project Report. Cairo, Egypt: UNIDO.
[28] GIZ and Cleantech Arabia 2017.
[29] UNIDO-GTI 2017. "Green Trade Initiative."
GIZ, and Cleantech Arabia. 2017.

- **Off-Grid PV Systems.** These are systems that are off grid and aim at providing the farm with electrical energy for general purpose use in administrative buildings, housing, inventory, and lighting. PV off-grid systems require batteries in case no alternative energy source is present. It is the most expensive form of deploying PV but essential in the absence of the grid. PV pumping can be fed through the off-grid PV system.
- **Off-Grid Hybrid-PV Systems.** These are systems that are off grid and aim at providing the farm with electrical energy for general purpose use in a complementary manner with electric energy generated by diesel systems. This either assists the diesel system simultaneously or covers energy production during certain hours of the day.
- **On-Grid PV Systems** are connected to the grid where excess produced energy can be sold to the government**.** In such cases, the farm invests in PV on-grid systems to generate extra revenues while capitalizing on land space they own. In this case, the farm is approaching the investment as a way to compensate its regular energy consumption from the grid. In the case of the presence of the grid.
- **PV Lighting Systems.** These systems usually consist of LED lighting system fed on direct current (DC) directly connected with PV panels and batteries without the need of an inverter. They are deployed in both on grid and off grid farms.

Hybrid PV-Diesel

GTS solar is one of the PV firms that specializes in hybrid PV systems which provides clients with chance to gradually offset their diesel consumption through smaller investments in PV. They have deployed such hybrid systems for few farms in Egypt western desert in addition to few clients in the oil and gas sector. The founders mechanical engineering background and previous career in HVAC and diesel has evolved into a flourishing PV business with focus on hybrid. GTS is an example of how the PV market is attracting innovation from diverse angles. GTS continues to leverage its know-how in mechanical systems into a competitive edge. GTS is currently considering solar thermal cooling options.

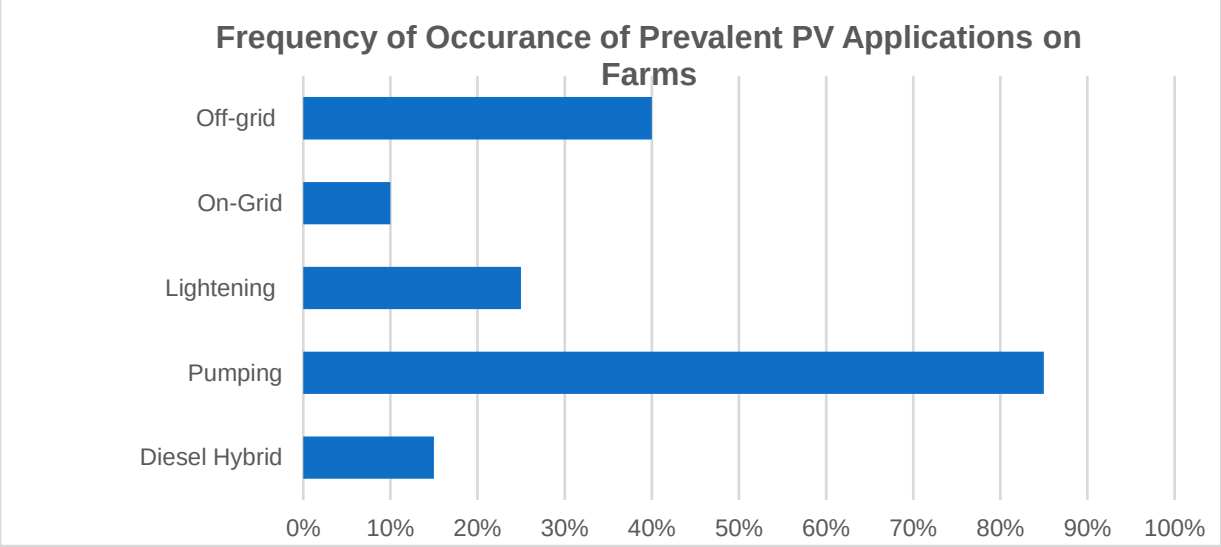


Figure 7: Prevalent PV applications in the farming sector as indicated by the 20 surveyed startups[30]

[30] Frequency of occurrence in percentage was calculated based on the number of times each application was mentioned in the interview as among the most prevalent in farming sector. Same method of calculating frequency of occurrence was followed in all similar figures in the rest of the document

There is considerable lack of diversity in PV applications in Egypt when compared to international trends and technologies in solar-farming. The PV applications provided by the 20 surveyed startups show that off-grid PV pumping is the most prevalent application of PV in Egypt followed by PV on-grid systems. The limited number of on-grid PV applications is related to the challenges the FiT scheme has faced.[31] PV lighting systems might be less utilized due to their limited power consumption and requirements for customization as well as relative complexity compared to other options.

PV Application in Agriculture: Market Summary

- Egypt has about 124 MW of PV installed capacity 67% of which are in farms
- The current PV market size in farms is 2 GW; less than 4% of the total installed
- Farms can be segmented into three categories, small < 5 Feddan, Medium 5-20 Feddans, Large > 20 Feddans
- Out of 75 MW installed by PV firms surveyed 0.15 MW is in small farms, 15 MW is in medium size farms and 59 MW are in large farms
- PV applications are mostly in pumping followed by PV off-grid systems with more limited applications in PV-diesel hybrid systems, lighting, and on-grid.

Startups indicated their customers are seeking 1) to control costs, 2) reliability, 3) ease of utilization / maintenance as motives for using a PV system. When startups were asked the question *"why are farm owners thinking of reverting to solar energy?"* and the perceived challenges associated with diesel gen-sets facing their clients , the reasons that stood out were: (i) the rising cost of diesel and the overheads of its transportation, (ii) reliability in terms of price fluctuations and challenges faced to source diesel in certain times of the year) and (iii) maintenance - see Figure 8. It is important to realize the multitude of motives farmer as end-users as it is key to penetrate deeper and more diverse market segments

Diesel Costs: The rising cost of diesel and the overheads of its transportation constitute a burden especially on small farm holders. In some cases, there are extra costs incurred when trying to source diesel in periods of shortage from the informal market. This falls under the wider issue of reliability of diesel as a fuel.

Reliability: The temporary absence of electrical power from the grid or its availability with low power quality that becomes problematic in operating equipment. Desert regions completely out of the grid network coverage, such as the reclaimed land just of the Valley in Upper Egypt, Western Desert, Sinai, and the south of the Red Sea regions, risk suffering fuel shortages. While such shortages are less frequent at present, it still represents a considerable risk to the agricultural process particularly in desert farming.

Efficiency and Maintenance of diesel gensets: Farmers also show interest in new technology solutions to avoid problems associated with maintaining existing diesel gen-sets. Most small farm owners purchase second-hand equipment for farming, including diesel gen-sets. While the initial cost of these equipment is cheaper, they have a shorter life-cycle and

The Myth of PV Complexity

Despite being a more advanced and newer technology compared to diesel engines, PV systems are simple to use and are more or less plug and play technology. Once setup, very little effort is needed to maintain and operate them. On average, a PV pumping system would require between 7-12% of cost to maintain and replace electronic components over 25 years of life time. However, diesel engines would require between 100-150% of cost to maintain and replace components over 10 years of life time, not taking into consideration the cost of fuel - *Kelley, Leah C., et al. "On the feasibility of solar-powered irrigation." Renewable and Sustainable Energy Reviews 14.9 (2010): 2669-2682.*

[31] According to the WBG study published in 2016 by Dalia Sakr et al., the FiT scheme launched in 2016 is unlikely to encourage further PV on-grid systems in farms since the increase in the tariff have been offset by the Egyptian Pound devaluation.

operate less efficiently meaning that their maintenance and running costs are significantly higher than PV on the long run.

Opportunities for startups reach beyond serving markets seeking to save energy. Startups mostly see their client challenges of using diesel are related to energy generation, reliability, and cost of maintance. However, intereviewed startups did not seem to take into consideratoin the customers' need for ease of use or worry from power quality and price fluctuations resulting from fuel shortages. In addition to being a tool for energy generation, PV's value for the market also lies in its ease of utilization. Analysis of market opportunities and survey with customers and startups shows that startups are missing out on the value of additional factors motivating farmers to switch to PV like ease of utilization and low maintenance cost compared to diesel and the electrical grid. For instance, in many cases PV powered devices such as lighting and pesticide sprayers are solely used due to their ease of utilization. In addition, the of extension of cables and transformers to power equipment at certain parts of the field particularly in the old farming land incurs significant costs which is yet an additional motive to resort to PV energy.

Cost of Distribution Network

Powering a 7.5 kW pump that is far from the electrical energy source in the field would require extension of cables and at times a step-down transformer. The cost of 100 meters of cables and transformer to extend the distribution network to reach the 7.5 kW pump would be similar to powering the pump through a PV system. Thus, the PV pump will provide saving on in energy spending and with a comparable initial investment to extending the distribution networking, rendering the PV option significantly more attractive.

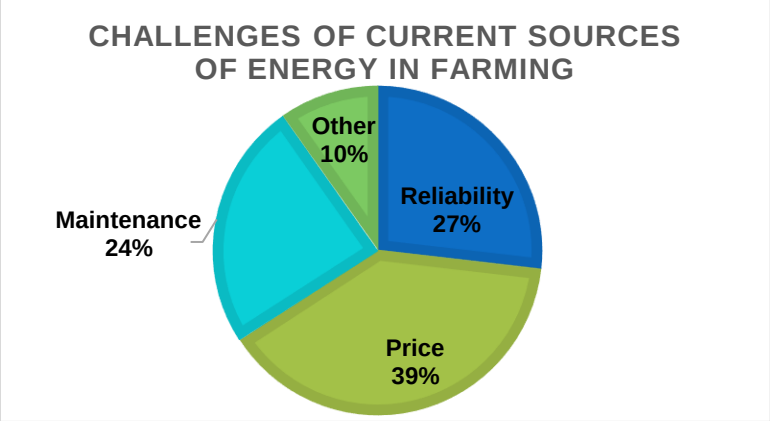


Figure 8: Perceived key challenges of current sources of energy in the agri sector based on 20 startups interviews[32]

[32] Percentage represent number of times the challenge was mentioned in interviews referred to the total number all challenges were mentioned in interviews

3. Anatomy of PV Startups in the Agriculture Sector

Startups, firms younger than 5 years of age, have contributed to about 90% of Egypt's currently operating PV systems. It is important to understand these key players if more systems are to be brought to PV market throughs startups and future firms entering the market. The aims to demonstrate the role of startups in the market and the opportunities or challenges they face. Startups can play an important role in catalyzing clean technology adoption through new business model development, accessing new customer segment, and stimulating market level change. While large firms are constrained by their existing products, technologies, skills and organization, firms that are small and young can more easily work outside dominant paradigms. Startups are better disposed than large firms to the type of innovative entrepreneurship required to address some of the challenges of climate change. They have the flexibility to experiment and take risks, and are not discouraged by small markets of early technology adopters.

3.1. The people behind the startups

PV startups in Egypt come from various backgrounds. Based on the surveyed sample, PV startup founders can be classified into three main groups; fresh graduates inspired by solar energy opportunities, more experienced founders with 5 to 10 years of experience in international corporations, successful entrepreneurs who have already established mature enterprises and decided to change the line of work or venture into the emerging PV industry. In line with the Egyptian entrepreneurial scene, the founders are mostly young (25- 35 years old) with University degrees. While many fresh graduates attempt to start companies in Egypt, few of them succeed. Based on a study carried out by Cleantech Arabia in 2017 of 65 clean tech startups, gaining business and market experience in established firms before starting an entrepreneurial endeavor increases the chances of success[33].

Sunutions Egypt

Sunutions was founded by students in their final year of university in 2014 and they present the youngest founders in the surveyed startups. Stimulated to launch out of university, and competing in INJAZ and RISEUP summit provided Sunutions mentorship (Pepsico and Mobinil), seed funding (award prizes) and exposure to get started. While they benefited from the support in the form of general business mentors, the depth of Egypt's ecosystem lacked the technical knowhow support and customer reach most relevant Sunutions product offering.

Interviewed startups rely on the founders in multiple activities including both managerial and technical roles to grow their firms. This lack of focus can limit the capacity of growth where decision making excessive reliance on founders create bottle necks. Startups with a team of 4-5 members usually play multiple roles in the business: managerial roles, technical input, procurement, sales, business development, and project management (Figure 9).

[33] Cleantech Arabia, 2017, 95% of successful 65 clean tech startups supported since 2013 had at least 4 years of professional experience before launching their startups

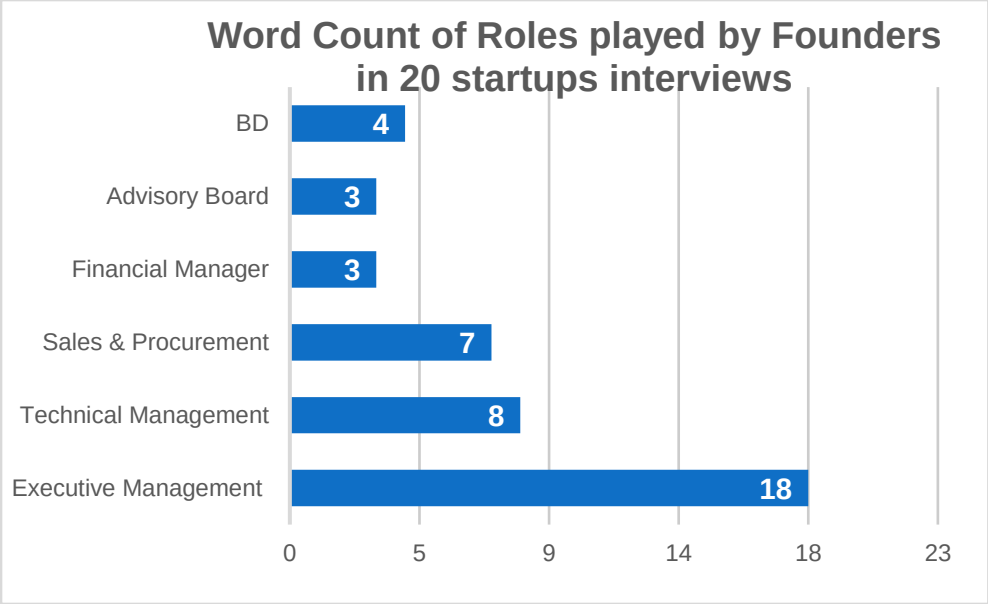


Figure 9: Roles played by founders as indicated by the 20 interviewed startups[34]

Egypt PV startups could benefit from a focus on organizational structure and governance where independent boards, advisors, or mentors can help guide founders' roles and competence needed for the firm to grow. The separation of roles of founders also would mean that their capacity is utilized in the best way possible. This will also free the founders to focus on what they can do best and acquire assistance of what they can't perfect themselves. The startup understandably as it launches will rely on its founders and would not have a board in place, however, after it starts to approach the growth phase (typically 2-3 years after they launch in the PV sector) the board, advisor, or committed mentor becomes crucial for the firm to manage its growth.

PV startups are creating skilled and semi-skilled employment opportunities across Egypt not limited to Cairo. The size of the company and the role played by founders influence the number of employees hired. University graduates tend to dominate office or operation positions (mainly in Cairo), and semi-skilled workers are employed for on-site PV installation and maintenance (frequently in governorates outside of Cairo). This hiring structure has a high social impact by creating jobs for workers from different educational backgrounds and thus providing a cross cutting impact in the job market.

The 20 interviewed startups have managed in total to create 547 jobs, 372 of which are full-time jobs. The jobs are spread over the skills and education spectrum, where 260 employees are university graduates (47%), 143 have a technical education (26%), and 144 are unskilled or semi-skilled workers (27%) (see Figure 10).

[34] Word count refers to the number of times the word was mentioned in answers by interviewees – same applies for the rest of the document

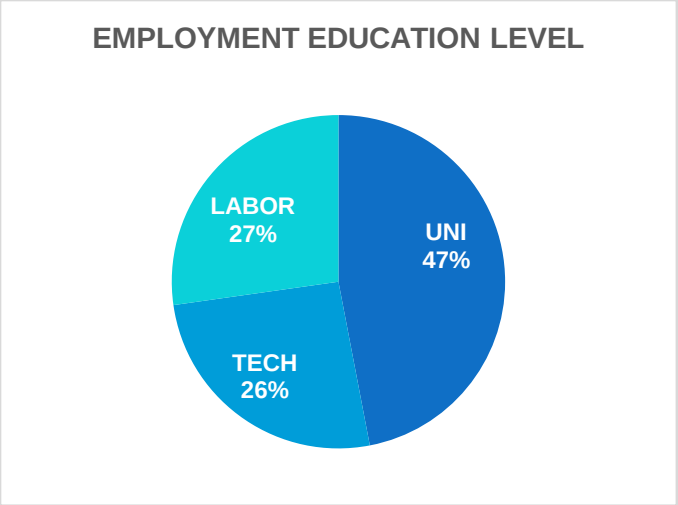


Figure 10: Employees percentage by educational level in 20 interviewed startups

Gender imbalance in PV Startups: While the majority of interviewed firms said that females receive equal or more support from the entrepreneurship ecosystem only 12% of the founders in the 20 PV startups are female. On average the female employees of the surveyed startups were 20% of the work force. This varied from 80% in one firm to zero percent in 5 firms. Only 4 out of the 20 respondents were women. Promoting a work environment that is sensitive to the needs of employees, including women, gives access to a wider pool of talent to support the firm growth and wider pool of innovators and entrepreneurs who may solve market failures.

The most prevalent barriers for women to work in the PV sector are (i) mobility and transportation logistics, (ii) difficult working conditions, and (iii) cultural barriers (see Figure 11). –By mobility, the respondents referred to the remote locations in which the PV systems are installed on farms. Since it is a startup, usually cost savings are reflected on the quality of accommodation and the travel logistics. Embedded within the phrase 'tough working conditions' are descriptions such as: the extreme weather conditions of arid environments, the physical labor involved in installation, as well as the long working hours. Respondents also pointed out that, for example, a key cultural barrier is the lack of familiarity or acceptance of female presence on the field by workers who are more accustomed to traditional gender roles rather than having women as site-engineers or technical consultants.

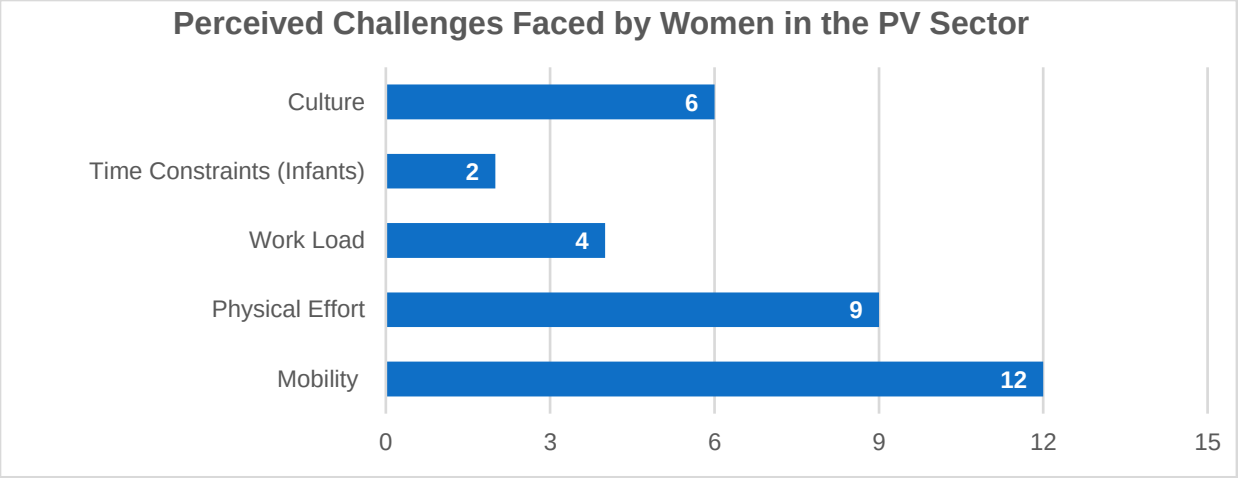


Figure 11: Perceived challenges faced by females working in the PV sector according to 20 interviewed startups

Further insights on the topic can be found in Annex I. While, barriers do exist for female entrepreneurs and employees in this sector, female entrepreneurship has proven to be a critical element for the growth of clean tech sectors in Egypt. The biogas sector for example has been partially shaped by two female lead firms, Elkhodiery Biogas and Biomix, where the two firms combined have delivered more than half the biogas systems in the Egyptian market and more importantly developed effective communication techniques and business models that have unlocked the market particularly of small farmers. The role of ACO in the PV sector is evident from the number of referrals to the firm in the document, again, a female lead startup.

Contribution of Female Entrepreneurs to the Sustainable Energy Sector in Egypt

The Clean tech sector, particularly within the sustainable energy subsector has seen examples of inspiring female entrepreneurs who have significantly contributed positively to changing the markets they operate in. In the Solar Sector, ACO, is led by a female entrepreneur has transformed the PV decentralized market by providing startups with PV components in a reliable manner and at the same time coupled with financial facility, a business model that has empowered several startups and PV firms in Egypt.

3.2. Startup financials

Securing investment to start a company is a key challenge for PV startups. The majority of investments of startups in the PV sector are personal – i.e. the startup capital is withdrawn from the founder's personal savings or close network of family and friends – see Figure 12. These results reflect a general trend in the Egyptian entrepreneurship scene with the exception of the ICT sector.[35] ICT startups typically have limited financial barriers to start their business as they are asset-light (mostly focused on programming time and customer engagement). PV startup's reliance on personal finance limits the opportunity to start a company to individuals who can afford to take the risk, and have access to resources to do so, namely 'friends and family'. PV firms in many cases need most of the capital to finance the projects and ensure they have enough stock or quick access to components to respond to the customers' needs.

[35] Global Entrepreneurship Monitor, Egypt National Report, 2016

Angel investors show interest in the sector but are usually deterred by absence of information and lack of familiarity with the sector and insufficient support from the entrepreneurship ecosystem.

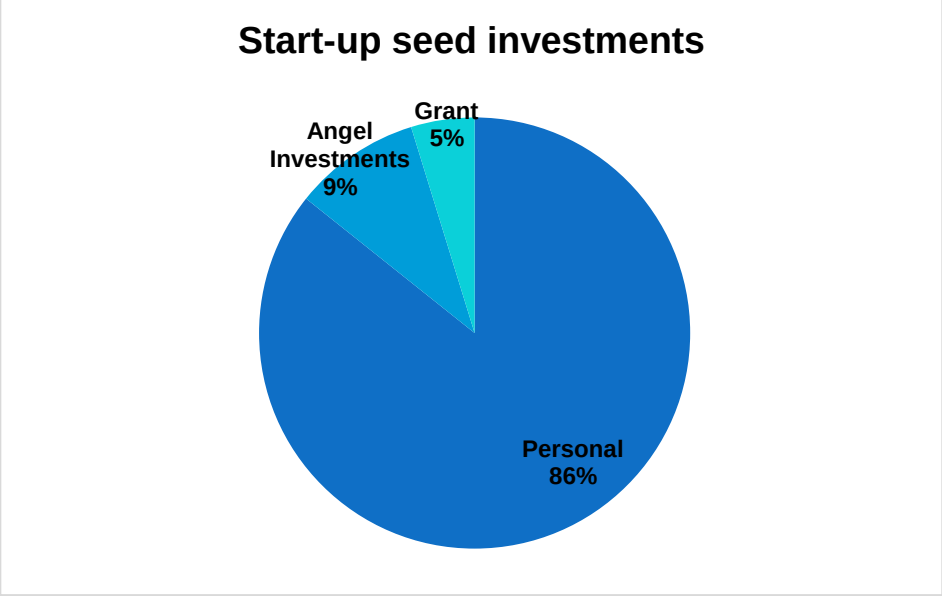


Figure 12:Start-Up seed investments by source for 20 startups interviewed

The absence of effective customer finance mechanisms creates additional capital burden on PV startups. Renewable energy systems usually require the customer to commit higher CAPEX up front with the promise of payback in the form of energy savings. While the profit may be attractive, securing the cash upfront to purchase the PV systems remains a barrier for customers across all small, medium, and large farm segments. Startups in many cases seek additional financing not for themselves, but rather to be able to provide better financing terms for their customers. Unlocking customer financing barriers could have a significant impact on growth in the sector.

There is a disconnect between banks who express their interest in providing finance to PV applications and their ability provide financing. Regardless of the type of entity there seem to be major barriers to financing PV. Of the sample of 10 financial institutions surveyed, only one case of funding provided to the solar firms has been documented despite the fact that 60% of respondents expressed their interest in providing their services (including loans) to the sector. On the other hand, solar firms gave a low satisfaction score (average 1.85 out of 7) when asked about services provided by financial institutions to their businesses. The top three barriers to access to finance in the sector are (i) informality of the sector, (ii) risk analysis issues and (iii) lack of awareness. 92% of respondents have mentioned at least one of these items as a barrier to finance.

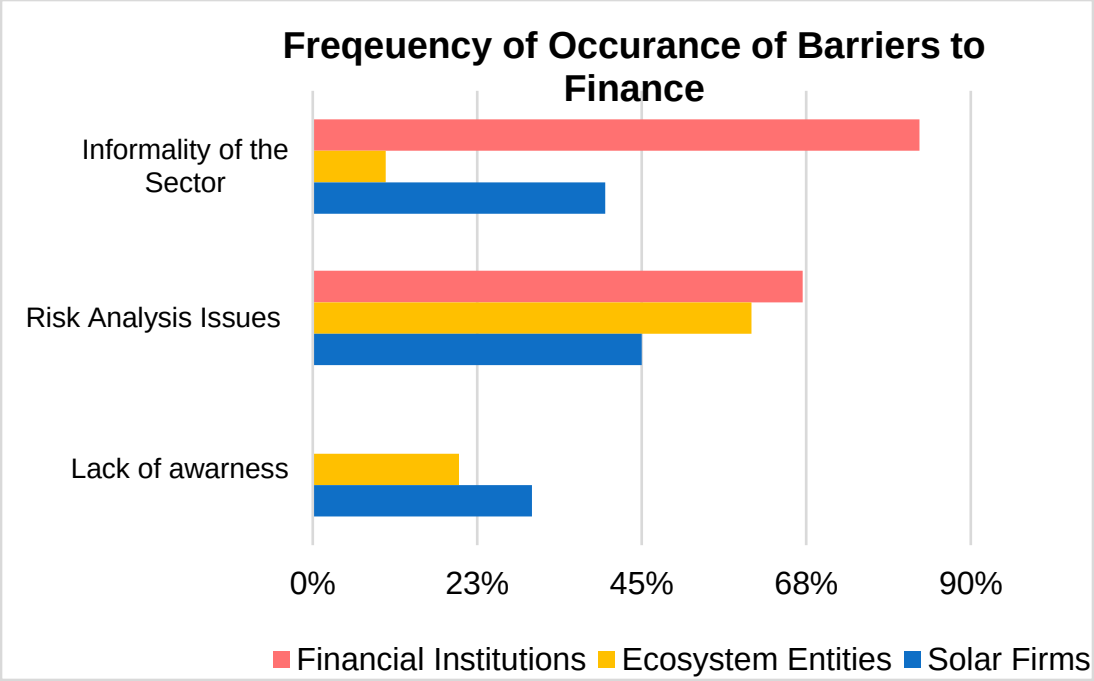


Figure 13: Perceived barriers to finance by various type of interviewee

Key challenges with access to finance

Informality of the sector in this context refers to the inability of some startups to provide all the required documents to financial institutions in order to gain access to finance. This issue should be addressed in the long run. However, due to the nature of the sector and business environment today the key solution to the access to finance issue could be providing financial schemes to the customer whether directly or through NGOs and agricultural co-ops. This could be a way around the informality issues as startups would not need to apply for credit themselves while still benefitting from the access to finance provided by those schemes.

Risk Analysis Issues. There are two main issues to address this issue of inability to analyze the risks of these firms'. First, there is insufficient data on the nascent solar application in the agriculture market in Egypt to provide baseline comparators and benchmarking thresholds. Consequently, working hand in hand with other players in the ecosystem could help mitigate the risk and provide access to finance. Secondly, risk analysis issues occur, as well, due to the lack of technical knowhow of the current technologies and their feasibility. If banks are to cooperate with market enablers and specialized consultants in providing them with the necessary knowhow, these issues could be addressed. While part of the risk can be mitigated by the knowledge and awareness regarding the technology, still the absence of track record of finance cases will constitute a risk for the bank.

Lack of Awareness. Solar firms and ecosystem entities identified lack of awareness as the third main barrier to finance. According to their narrative, financial institutions and investors still lack understanding of the solar sector and its difference than other well-established sectors and their financial modeling such as the real-estate sector. Eco-system entities can play a role in raising awareness and providing data and information that could help address this gap. Discussions and working session with PV firms and various financial institutions as well as the analysis points out to key interventions to increase access to finance for PV farming customers.

The surveyed firms showed a distribution in size, and revenue which largely reflect the market segment they are in. Figure 14 shows the average annual revenue of the interviewed startups. The distribution of startup revenue is a mix of the age of the startups and to the customer segment / focus of

the startups. For instance, younger startups particularly those targeting medium or small farms install smaller systems and hence have lower annual revenue, compared to the older Cairo based startups which tend to focus on large farms' individual transactions. In total, startups surveyed had a seed investment of a total of 16.8 Million EGP and they had revenues of 126.5 Million EGP by Sept 2017 (the time of conclusion of the interviews)[36]. This indicates a rapid growth and profitable investment opportunity.

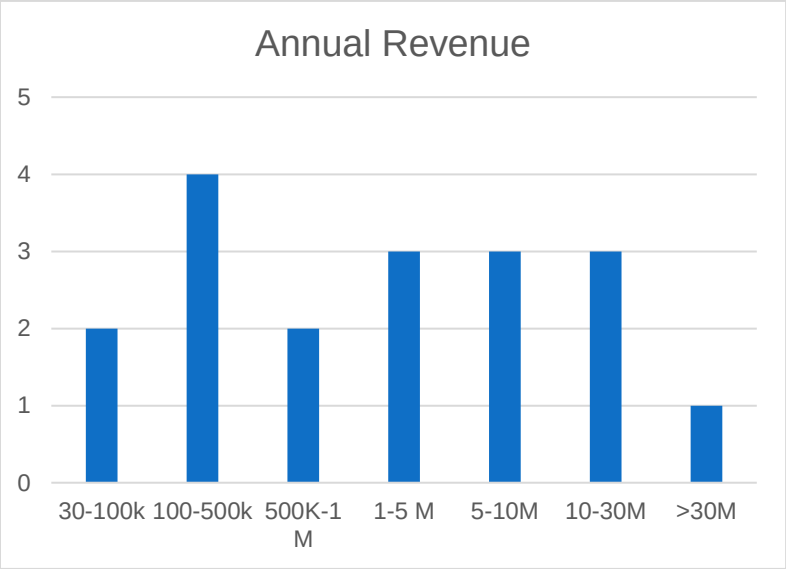


Figure 14: Number of interviewed startups by annual revenue bracket in the first three quarters of 2017

3.3. PV startup business models in Egypt

The business model governing how the products and service are delivered to the customer is a key element to market success. The following is a review of the PV startups business models to determine success factors and potential areas of improvement. The implications of such business models on capacity to grow will be emphasized. Understanding of the business models helps to point out threats and opportunities for the sector. The PV startups have unique features in marketing relying on social media and direct contact with the clients. They also have flexible procurement models and achieve higher capacity of operations through outsourcing.

Marketing the value of their PV offering – lessons from rural based startups: The PV startups have a marketing approach that relies on direct communication with clients through word of mouth, direct marketing and online tools – see Figure 15. The effectiveness of the marketing method differs according to each model, and the target audience. Cairo based firms rely more on social media, however it is not clear that

[36] This includes revenues from suppliers who sell components to startups as well, if the revenue of suppliers is excluded, the number will go down to 79.5 Million EGP

this is an effective means to reach their largely agriculture based clientele, especially medium and small farmers. Very few startups had a clearly defined marketing strategy, and this largely relates to the development of their business model / value proposition. Word of mouth and demonstration projects are important methods for customer acquisition in farming communities and have been proven to be successful at the regional level (i.e. outside Cairo). Direct marketing and online marketing could represent a reflection of an international trend starting to favor these unorthodox methods, yet it could also represent a lack of conviction that investment in marketing outside the above two channels is useful. Few firms have marketing as central part of their operation and business model. The website of the startup or their social media channels rarely documents their achievements. Consequently, this might have partially contributed to the underestimation of the PV market size and its potential. Further investment in marketing is highly recommended to PV startups since it will help raise the market awareness of the sector; however, marketing needs to be tied to a specific customer segment and embedded into the business model of the startup (i.e. value proposition to the segment).

Sunway Menya – Effective Communications

The example of Sunway emphasis the importance of effective and direct communication in marketing. Sunway focus on letting their work and client speak about them. Through social gatherings organized by Sunway early clients mingle with potential customers where exchange of knowledge takes place. Potential customers are more convinced by seeing the experience of their peers than fancy marketing campaigns. Sunway realizes and capitalizes on this. It uses its previous projects as demonstration for potential clients.

A business development meeting for PV pumping in Luxor by Siraga Solar – through field visits and extended meetings with the customers in remote area (Luxor governorate) knowledge is transferred to the customers and awareness is raised. The above shows a case of multiple small-scale farmers sharing a diesel pumping system and considering switching to PV. The farmers motives were to cut energy cost but also to avoid maintenance and reliability issues associated with diesel pumps.

Figure 15: Marketing approach as mentioned by interviewed PV startups in percentage

Customer Segments: PV startups usually target multiple customer segments. Each might have a preferred client segment, yet most of the startups do not focus on a particular customer segment, largely because they are also in the process of market discovery. However, the majority of the interviewed startups view the agriculture sector as main customer segment. Startups do not refer to themselves as a "solar-farming" startup, they simply are solar energy companies who foresaw that the agricultural sector is a promising field to invest in, alongside other sectors: e.g. commercial, industrial and residential. Commercial at 26% namely represents the tourism sector in off-grid locations or its businesses which seek "green" certification systems. The industrial sector remains the least addressed customer segment due to the low electricity tariff and certain connection to the grid – see Figure 16.

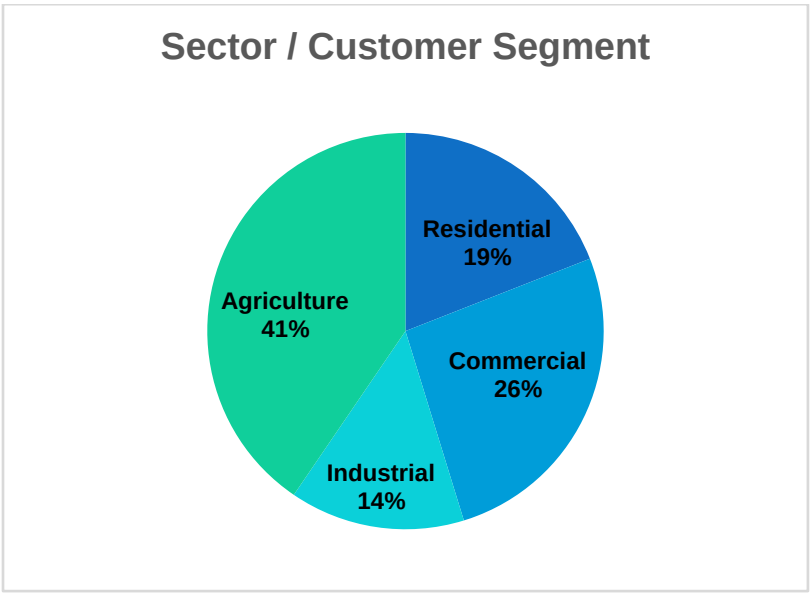
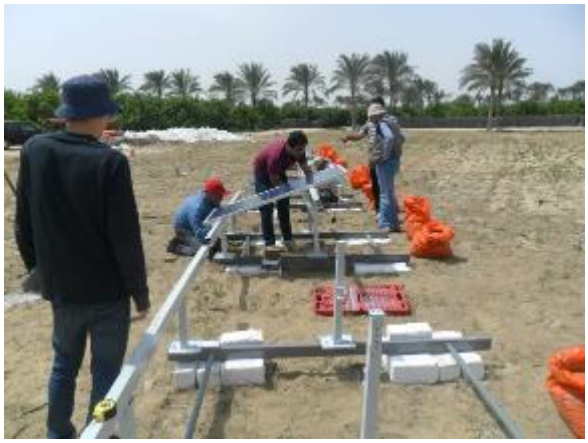


Figure 16: Percentages of customer segments targeted by interviewed PV startups

The above figure clearly reflects that agriculture is a key market for PV applications in Egypt. This can be attributed to the presence of a large off-grid potential where replacing diesel is financially attractive and the increased reliability of PV compared to diesel is acts as a strong market catalyst. Another factor is that for on-grid customers in industry, commercial and residential investment in PV do not see investment in PV as crucial part to their business model or finance as is the case for the agriculture sector where securing sustainable affordable energy is key for the process of agriculture. Another factor that might have increased the uptake of the PV in farming is that in many cases with the available land space PV can cover all the farm energy needs which is quite rare compared to residential, commercial, and industrial cases.



Mounting structure layout in a farm in Wadi Elnatroun -IRSC-ACO Product used by GTS Solar

Local component integration, innovation, and manufacturing / system customization: The PV market in Egypt relies almost solely on imported equipment - Figure 17. This means that the market is highly volatile due to fluctuating foreign currency exchange rates. The main components that are manufactured locally are cables and mounting systems. The cables of local manufacturers are not solely focused on PV, but they are part of a strong Egyptian cable industry. The mounting structure were in many cases built by workshops and recently two of the interviewed startups teamed up to establish a mounting structure facility which has served 4 MW of PV systems in its first quarter of operation (about 4% of all PV systems in Egypt). In other cases, the repetitive collaboration amongst PV startups and the workshops lead to a semi-formal contractual relationship between those two entities for outsourcing activities. This demonstrates the diverse and pragmatic ability of the startups to collaborate with established feeding industry of even smaller workshops. There is continuous debate about inclusion of local manufacturing in the PV value chain in a country like Egypt but it is usually focused on manufacturing PV cells. However, in the PV value chain other system components must be considered. The reliance of local PV market of locally manufactured cables and case of mounting structures demonstrates the importance and viability of considering manufacturing along the value chain. Along with cables and mounting structures, solar inverters as well as batteries present additional opportunities for local manufacturing outside the PV cells themselves.

Local Manufacturing of Mounting Structures – IRSC & ACO

Collaborative investment of IRS-C and ACO has led to establishing one of Egypt's fastest growing locally manufactured mounting structures. As per the founders "the vision is to create locally manufactured mounting structures with the highest quality and professionalism". This shows that local manufacturing can thrive in the PV value chain whenever it adds value. It also shows that a high quality, cost competitive local products can gain ground quickly. In a very short timespan and with strong business development, the newly established firm convinced leading PV firms in Egypt to switch from the imported product to the local product. The competitive edge does not only lie in the quality but also in building semi-connected structures that are fast and easy to deploy in the field; something not possible in the case of import.

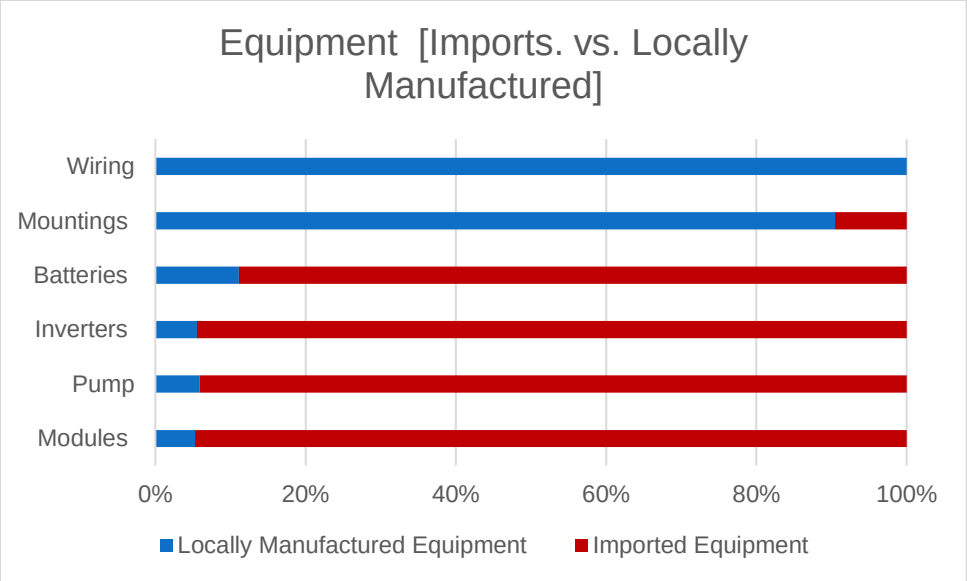


Figure 17: Source of component imported vs local as mentioned by 20 PV farming startups surveyed

Equally important for Sohag based Suncity's shared/mobile PV pumping system was system customization which included design, machining and high level of system integration. For example, Suncity developed mobile PV pumping system, required them to manufacture the mobile framework, source customized panel from Tiba solar, and integrate particular designs on inverters which are non-standard. The value added becomes in the customized system. The need of customization and careful procurement is due to the uniqueness of the application. For instance, there is a certain voltage and power required to be delivered from the limited PV area to drive the pump. This at times can not be met by market ready modules and inverters. Such was the case with Suncity where the firm competitive edge became in the capacity to customize panels and identify the right pump, inverters, and PV panels mix.

Suncity – designed for local needs

For Suncity to provide this solution to their customers, they needed to design foldable panels to minimize space taken and improve transport around the farms, rolling apparatus which can function in agriculture environment which cannot rely on paved roads, a towing mechanism where anything from a tractor to a donkey can move the product.

Suncity markets its PV pumps as:

- Ease of mobility
- 10 minutes to setup
- Can serve 15 acres
- Easily pulled or towed

Make or Buy; Outsourcing: Most of the business activities are done in house except for installation which about half of the surveyed startups outsource – see Figure 18. The outsourcing of installation, which is labor intensive process, indicates the role of PV firms in creating indirect jobs. These, indirect jobs are found in aluminum workshops, as well as among local electrical products and electricians. The diversity in outsourced activities might be a key factor for the rapid growth of the PV startups as they are capable of relying on small clusters of other businesses. Outsourcing/integration with other value chain players seems to be an important element for startups as it may provide a less resource intensive capacity to operate in various regions outside their home base and serve a rapidly evolving market. Yet, it could point to a

vulnerability in case quality and business linkages within the value chain aren't maintained at a strong level. The outsourcing of technical labor also indicates the importance of ensuring relevant skill availability continues for the growth of the industry. These skill sets would be needed at a rural level or would require to be mobile throughout the country in order to meet demand.

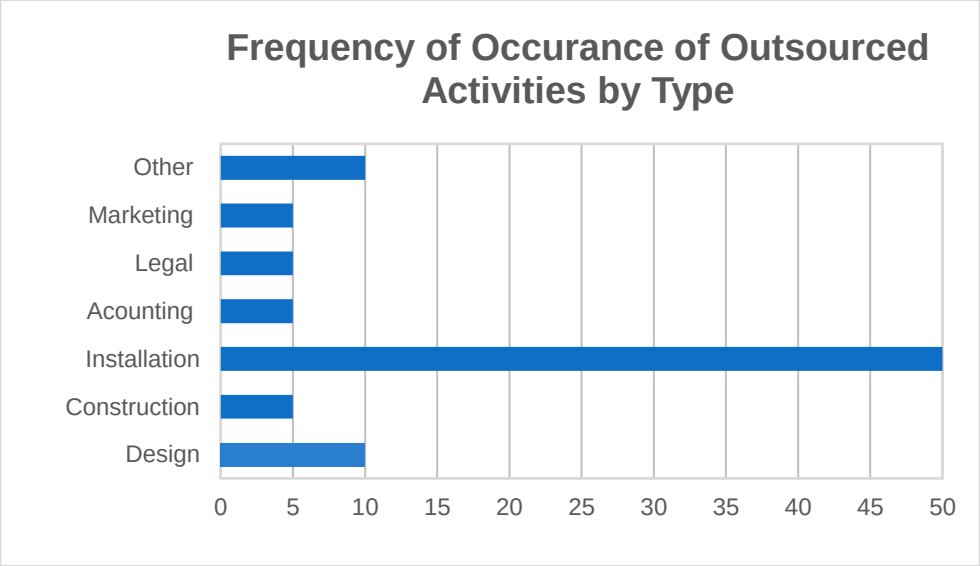


Figure 18: Outsourced activities as stated by PV farming startups

Financial transactions and payment schemes: The customer decision to purchase PV systems is in many cases reliant on the available payment methods. Figure 19 below demonstrates the financial transactions between PV firms and their customers as well as suppliers. It reflects that most transaction occurring in the sector are based on immediate cash payments. Only very limited cases offered the customer payment in installments or leasing. Customers purchasing through loans have not been recorded and only a single case of firm taking a loan to install the system and sell electricity to customer was indicated (Social Fund for Development financing Karm Solar PPA farm in western desert)

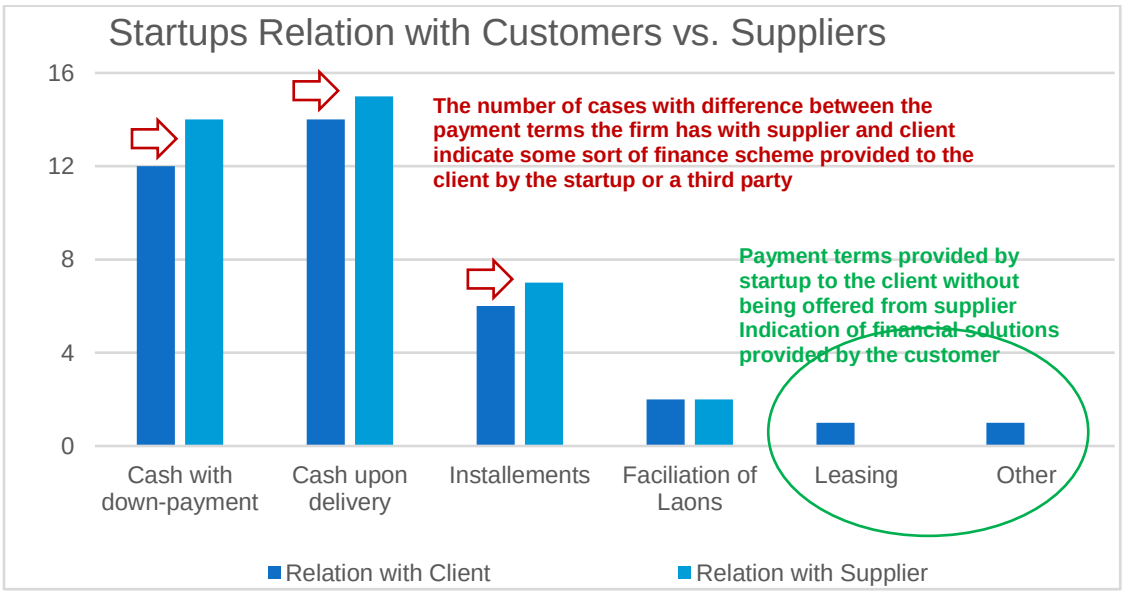


Figure 19: Startup financial transactions type with customers vs. suppliers

It is also important to note that there is a correlation between the terms of payment which the firm follows with the supplier and customer. As a result, PV firms do not provide financial solutions to the customer in most cases. This limits startups capacity to grow and serve larger clients or multiple small ones simultaneously due to need for cash since terms of payment presented by the supplier are then reflected on the payment terms offered to the end-customer of the PV firm.

Karm Solar - PPA

Karm Solar has worked with the Social Fund for Development (SFD) to acquire a to build and own a PV power plant the energy of which is sold to the client in a power purchase agreement. In this case Karm provided the client with a financial solution that changed their payment scheme into a long term small payment for energy rather than a bulk payment upon delivery of system

A significant amount of investment and cash requirements for PV startups is related to the need to finance the process of system components' procurement, integration, and commissioning after which the client pays in full. However, in most cases, the PV firm has to pay its supplier cash upon delivery or down payments upon delivery, it then requires the customer to work with similar terms. Renewable energy systems usually require the customer to commit higher CAPEX up front with the promise of payback in the form of energy savings. While the profit may be attractive, securing the cash upfront to purchase the PV systems remains a barrier for customers across all small, medium, and large farm segments. Figure 19 shows that 6% of startups provide payments in installments to clients when provided by suppliers and only 4% include a financial solution with long-term finance that is directly provided by the PV firm (facilitation of loans, leasing, and others). Only 20% of transaction including a short-term finance to allow payment in installments (of less than 6 month). More than 70% of transactions are based on cash and direct payment. Having a market based on direct cash transactions means that only a limited segment of the market is accessible, those with the capacity to spare such cash and pay for the system fully. International experience has shown that providing a financial solution with PV technology increase the uptake and penetration of PV considerably. In some cases, firms like ACO offer a solution for this problem by providing PV startups with PV components with flexible payment terms where startups pay for the components after they receive the payments from their customers. This flexibility enables more PV firms to operate and serve clients. ACO's flexible payment terms offered to startups allows them to grow faster and with less cash and capital requirements.

PV Startups Business Models

- Word of mouth, demonstration project, and building around the community have been important factors for rural startups penetration of the medium size farm market.
- Startups serve the residential, industrial and commercial clients; however, the leading customer segment is the agriculture sector.
- Local component integration and innovation are key to developing compelling business models to meet customer needs, stimulate business model innovation, and growing the market. Local manufacturing has higher potential in inverters, pumps, and monitoring and evaluation equipment more than in PV modules.
- Startups mainly outsource installation which shows the importance of presence of well-trained electricians and technicians and labor throughout Egypt for the growth of the PV sector.
- Payment schemes rely on immediate cash payment (payment upon delivery) and other long-term payment schemes are absent which limits the market. Linking to mobile payment applications and fintech solutions could be an important milestone in unlocking the small farm market segment.

3.4. Challenges to growth

After analyzing the features of the PV startups business models, challenges to growth were analyzed. Internal and external challenges to growth were determined based on the feedback received from the surveyed startups.

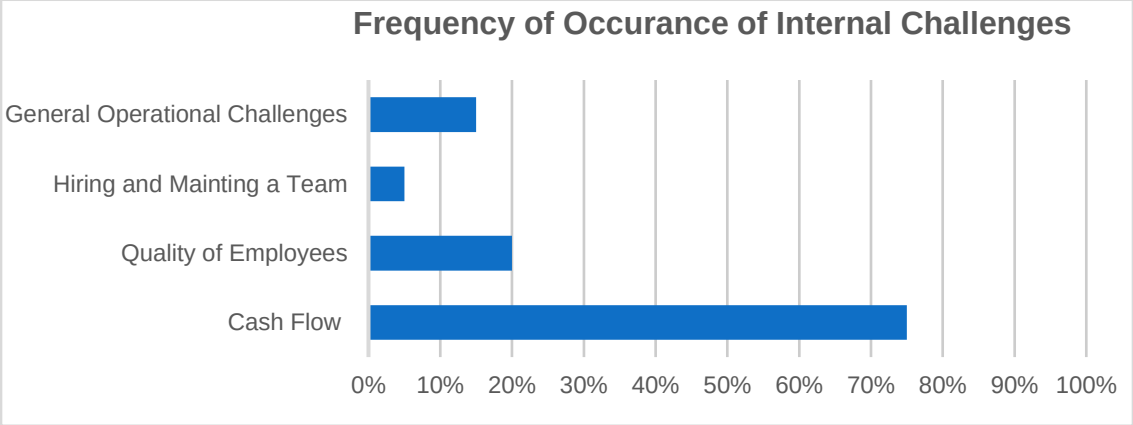


Figure 20: Internal challenges to growth mentioned by interviewed startups

***Cash flow management is the key challenge for PV startups – Suppliers are working within the value chain to improve growth potential*:** The summary of the findings is reflected in the below figure, where cash flow is by far the most prevalent perceived challenge/internal barrier to growth (Figure 20). Cash flow challenges come are a result of challenges with the firms' financial management in general. Cash flow stress is added to the company due to high requirements of project finance where there is a time gap between the startup's initial investment to acquire and install the PV system and the customer delivering full payment.

ACO Solar and Financial Services

ACO solar as a supplier of Suntech modules provides PV EPC startups with a finance facility and extended payment terms to enable them of operating and serving clients. In that sense ACO is a PV supplier and a financial service provider to other PV startups. ACO has empowered various startups and enabled them to grow by easing the cash and capital requirements to expand and finance their stressful cash conversion cycle.

ACO offers range of products that can support all needs of PV startups packaged with more flexible payment terms

Most of the components of PV systems are procured by startups from local suppliers or from the international market directly. The market generally operates with 25% down payment from customers at most. This means that the rest of the system cost must be covered by the startup until the PV system is commissioned. The larger the project, the more difficult the challenges are in financing the project. It is worth noting that only one of the startups which acts as a supplier provides others with a financing facility and credit lines to be able to source components and finance Engineering, Procurement and Construction (EPC) activities. Such financial services can mitigate cash flow problems. However, further involvement by the financial sector (which is discussed under Annex II) and utilization of diverse finance mechanisms can also provide a solution to these challenges. On an internal level, startups

could use stronger financial management and analysis. Reliance on more accurate financial models, developing diligent cash flow models for projects and for firm operation, and cost structure analysis remain as key elements that must be integrated in the operations of firms in the sector.

The PV startups face few but crucial external challenges to growth. Shown in Figure 21 are the external barriers to growth mentioned by various stakeholders. There is a consensus among the views of the financial institutions, PV startups, and ecosystem players that the key external barrier to growth is the limited access to finance which will be discussed in further details in Chapter 5.

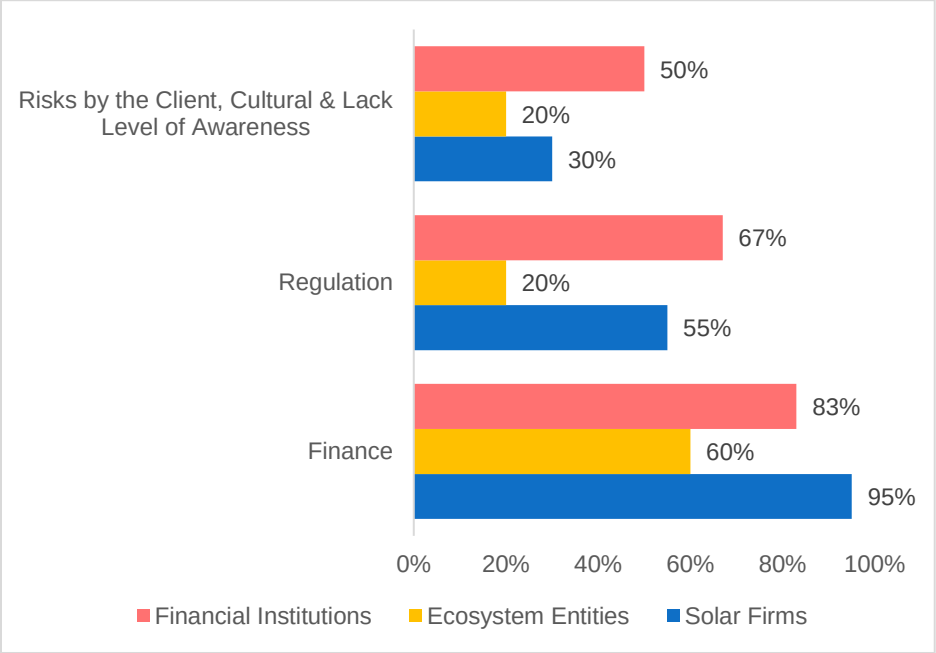


Figure 21: Frequency of occurrence of external challenges to growth mentioned by various types of interviewed entities

The key regulatory barriers mentioned in the interviews are related to land tenure. A large number of agricultural lands in Egypt is not formally registered/owned and thus farmers cannot access loans where the land serves as collateral in addition to risking land confiscation. This limits the farmers' capacity to take risk. Other regulatory barriers include absence of strong quality control of products. This means that low quality products can reach the market at reduced prices and may eventually result in decreased consumer confidence in PV technology as a result of malfunctioning low quality products. The absence of certification of designers and technicians also means that substandard designs can be built even by certified firms. Although there is certification of PV firms conducted by NREA for on-grid PV firms, there is no certification of PV firms serving the off-grid market. Again, this means that startups and firms adhering to best practices in design and installations can face unfair competition with firms offering client systems that are cheap but fail or do not perform as required due to deficiency in designs for instance.

Quality Control and Monitoring - Workshop Insights

The discussion with stakeholders on local manufacturing of system components swiftly turned into a discussion on the lack of quality control mechanisms to monitor products and services in the solar agri-market. Suggestions and recommendations to enhance monitoring included:

- Provision of certificates e.g. by NREA or RCREEE to system installers in off-grid. The current certification schemes whether by the regulator or NREA is for large scale on-grid systems.
- Another saw that it is the case with any starting market, and time is a filter for reputable quality of companies.
- An example was provided from Kenya, M-KOPA, where the M-KOPA removed the customers perceived quality risk by using a PAYGO business model where you simply pay for energy consumed, hence there is no quality risk because if the system breaks down there is no significant financial impact on the consumer. The quality perception risk is eliminated because the company, M-KOPA, has a stake in ensuring quality control to ensure it can continue to provide a recurring service which its customers then pay for.
- A Fintech suggested to have a "knowledge block" – an online platform – by a private sector company – to issue quarterly data on the installed systems, as well as a release a rating for companies who carried out the work. Many of the participants were concerned that the private sector could not be an objective entity to issue such reports. Other participants were also weary of the public-sector ability to effectively certify and control quality.

Limited Client awareness and risk aversion was also a commonly mentioned external barrier. In the farming sector, knowledge of PV technology is still limited. While large scale farm owners and medium scale are somewhat aware of the technology, its details and economics are still not fully understood. This is especially true for small scale farmers who have more limited awareness about PV as an option they can use. While acceptance is feasible once the customer gets introduced to the technology, few customers received that exposure. This limits the market penetration. In many cases in the field visits, it was observed that the presence of PV in certain areas is a matter of the community experiencing PV technology through a demonstration project or an early adopter in the community. Neighboring villages close by could vary significantly in their awareness of PV technology simply because one village is exposed to the technology while the other is not. Client awareness is currently the responsibility of the PV firms however this scale is not sufficient to create a large-scale impact on public awareness of PV. Other channels need to be activated to raise awareness and familiarity of farmers with PV systems. This can be done by various market enablers as will be discussed later.

Internal Challenges

- Weak cash flow management
- Reliance on cash upon delivery immediate payment schemes and absence of financial solutions that enables customers to have deferred payments
- Absence of a formal quality control
- Weak strategic planning

External Challenges

- Limited access to finance
- Absence of market control
- Absence of off-grid firm certification
- Absence of individual certification for engineers and technicians
- Low client awareness

Access to skilled labor and talent Is a major challenge for startups: This perhaps the key internal challenge indicated by the startups themselves. Access to talent, whether it is in attracting or retaining individuals is collectively the second most mentioned challenge by startups – see Figure 20. Indeed, this might also act as a barrier to the growth of the sector as a whole. With the increasing market demand, the talent pool needs to match this growth. Investment in streamlining PV education in Universities and technical/vocational education is strategic for the sector. This is further underscored by high reliance on outsourcing installation

Formal quality control processes can help the sector. Most startups offer after sales support when the customer is in crisis and not in a regular manner. However, there is minimal formal quality control on equipment, design, installation, or other parts of the process. It is recommended to further invest in regular after sales support as well as putting a standardized quality control process to be able to build a stronger customer base based on trust and strengthen the growth of the market through increasing customers' confidence in PV technology.

4. Business Model Innovation & Applications for Further PV Penetration

While there are many elements of the market which require support ranging from value chain development to financing schemes, ultimately the PV market growth will rely on innovation and the persistence of startups to push forward this frontier market. As mentioned earlier in the report, PV startups have succeeded in meeting initial demand of niche large and medium scale farms off-grid. However, the small farm segment in particular has not experienced significant penetration. Further market penetration can take place through developing new PV applications and business models to address new customer segments. Accessing more customers can take place through developing new PV applications that meet the customers' needs or developing business models that better address the customer business case. When startups were asked about opportunities which they perceived to be worth investing in; their responses were mostly geared towards developing new business models with the exception of manufacturing of parts of the system components as seen in Figure 22.

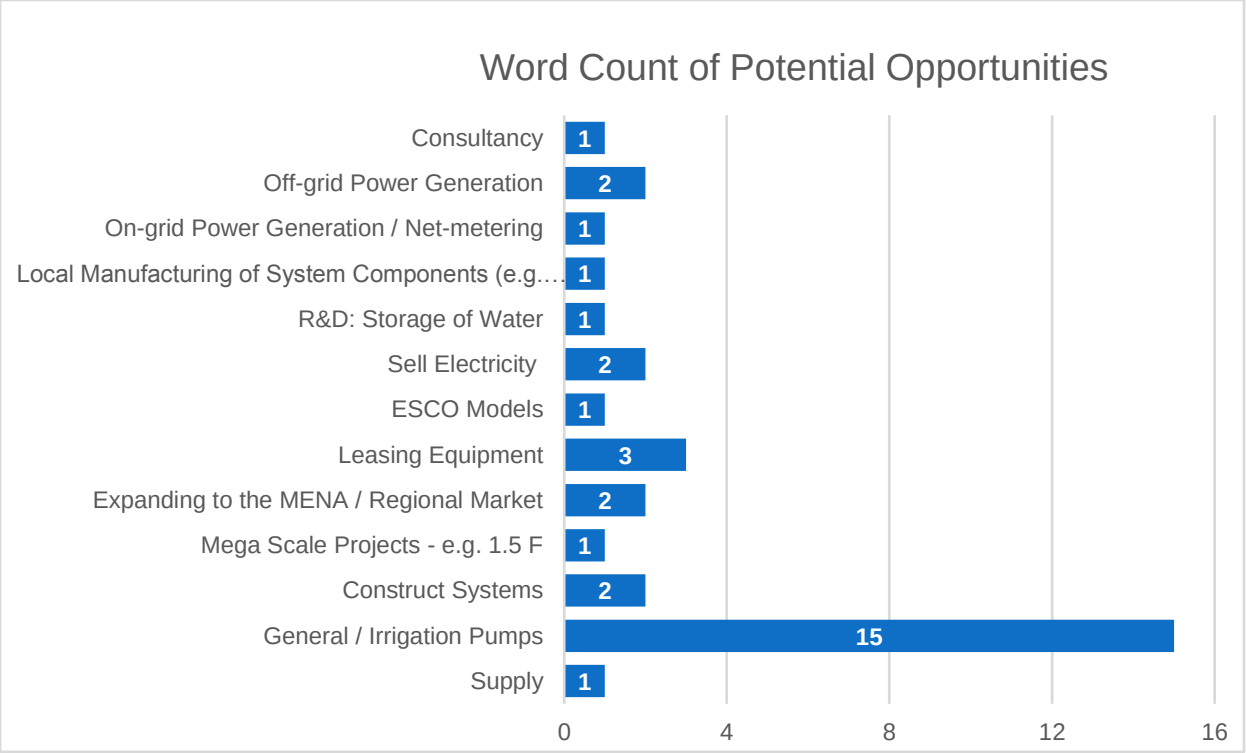


Figure 22: Word count of opportunities worthy of investment mentioned in 20 startups interviews

Building on the above, the present chapter addresses market opportunities and business models that could meet client needs. The presented opportunities were validated with PV firms and they are intended to shed light on aspects which startups and entrepreneurs may analyze further and leverage if possible.

Market opportunities are centered on understanding customer needs, barriers, and business case. An overview of the PV market segments, how well they are addressed, and what is needed to unlock them is carried out below. As shown in Figure 23 customers can be seen not only in terms of farm size (small,

medium, large) but also in terms of grid connectivity. The following 6 key segments each has a particular need and barriers the business model needs to address.

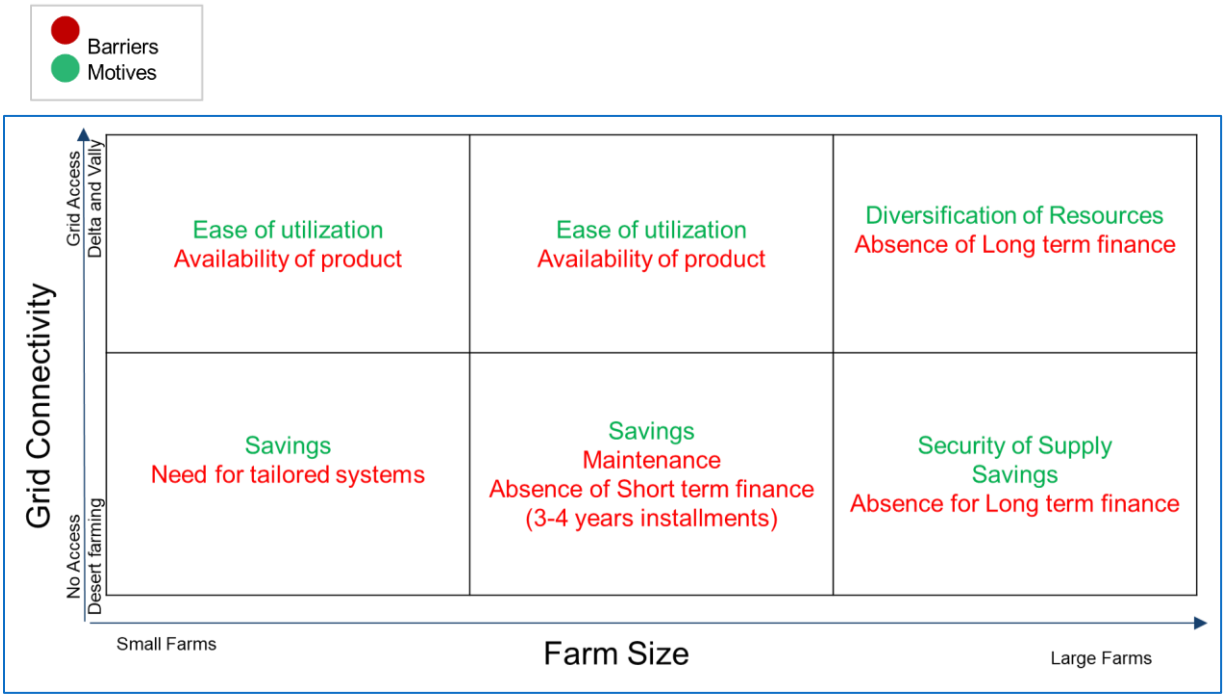


Figure 23: Market breakdown by customer segments motives and barriers

Small and Medium Farms on-grid; ease of utilization as a key motive: Startups usually target farms by focusing on the savings which they can provide to the client as well as energy security. This eliminates a key market segments of medium and small farms which are connected to the grid. Accordingly, a considerable part of Egypt's farming land in the delta and close to the Nile valley would be overlooked as a customer base. However, financial motives are not the only reason for purchasing PV applications. Such customers' interest in PV is mainly for the ease of utilization and to avoid the cost of electrical distribution system in case new investment is needed to extended electricity to a certain part of the farm. In many cases, the cost and hassle of extending cables and distribution transformers to reach certain parts of the field can justify the investment in PV. This is particularly relevant for farmers with small land where extending the distribution network would require in many cases coordination with various other farmers. Another example is having to raise the water level slightly for surface pumping in Upper Egypt where the grid can be close by, but the point of pumping is more accessible with a diesel pump. When ease of utilization becomes the key value proposition, enabling surface water pumping to become a viable option which would have been less compelling otherwise. Ease of utilization can also be associated with multitude of PV powered devices to be discussed later.

Medium and small off-grid farms: Key barriers are related to access to finance and low utilization rates. Access to finance is a recurring challenge, to be able to develop the best financial solution for customers, their business case requires further analysis by startups and financial institutions. Most of off-grid medium size farms would not seek long term finance. Based on the typical required cost of PV pumping system and diesel cost, medium size farms would look for a finance period of 3-4 years or less. This requirement can be addressed through leasing models powered by Fintech (mobile or digital based payment systems). Small scale farmers are rarely off-grid however as the farm size gets smaller, a barrier related to utilization factor arises. The irrigation would be needed for a few days per week or in certain parts of the season such that the pump for instance will be not utilized most of the year, for instance and sharing model may address this

barrier. Some of the above segments can be grown through innovative business models and new PV applications as discussed later.

New business models are needed to integrate financial solutions with the product. These can address large scale on-grid farms and small and medium farms in the off-grid scheme. The market of large on-grid farms can be unlocked by providing long term finance options or PPA. Medium farms off-grid require a finance mechanism that allows them to pay the system cost in 3-4 years. Small farmers off-grid requires the inclusion of Fintech solutions as well as other traditional finance mechanism. However, shared PV systems can also address various market opportunities for small scale farming. In all of the above, the PV firms in Egypt must see stakeholders such as lending institutions and Fintech firms are key partners. PV firms should re-evaluate their role and redefine their service. The survey results and workshops demonstrate that most stakeholders realize the importance of such models to the market.

Sun of Oasis & Local Produce Traders: Co-Financing of PV System with Agriculture Produce

Sun of Oasis have devised a scheme where traders of agriculture produce such as dates would be the financier of the PV pumping system. The trader then collects the system cost from the farmer with a margin as agriculture produce. This ensures that collection takes place at times where the farmers have the means (at harvest time) and also it utilizes an efficient collection channel. While the potential to scale up such mechanisms are to be determined, they hint at the spectrum available for innovation and at the importance of understanding the customer business case and mode of operation in order to unlock market potential. The trader has a unique role which the startup needed filled 1) the trader understands the cashflow characteristics of the customer (crop seasonality), 2) the trader has a sense of the credit worthiness of the customer based on past business experience (i.e. reliability/trustworthiness), 3) the trader has existing / future business relationship which include a financial transaction (i.e. will buy next season's crop from customer).

Two Egyptian startups have attempted unique business models based on principles of the shared economy which allows PV system sharing catering to grid connect small and medium size farms. Sharing solves the utilization rate problem and allows small farmers to benefit from PV pumping applications for instance. Suncity, operating in Sohaj, based their model on selling mobile PV pumping systems for surface pumping which can be shared by small scale farmers. The system was piloted with success but faced challenges after the floatation of the EGP. Dynergy developed a model in Suez where they own the mobile pump and provide irrigation as a service to large number of firms. Such innovative models included a considerable part of local manufacturing and innovation. Pricing scheme becomes challenging; however, the successful pilots show the power of the business model in unlocking market segments that could seem inaccessible otherwise.

Dynergy - Suncity – PV Sharing Systems

Dynergy is an Egyptian startup based in Suez region. The firm developed a business model where it owns a mobile PV pumping system and provides irrigation as a service for various small and medium size farms allowing multiple firms to share the PV pumping capacity.

Suncity operating in Sohaj have piloted selling mobile pumps to be shared among small scale farmers on sharing bases. Dynergy provides the service of irrigation in exchange of a per hour rate

PV applications to unlock the market as previously mentioned, unlocking market segments can require the introduction of new technology. PV applications and solar technologies in the market are limited. Egypt does not have the diversity of solar applications that are available in other developing countries. Following the methodology discussed in Annex III identifies applications that are worth further exploration by startups in Egypt are presented.

Sun of Oasis – PV Pumping System – Photo provided by Sun of Oasis

Table 1: International trends of PV Farming Applications

Applications	Description	Status
Water Desalination	Producing pure water for domestic uses or irrigation where the available water contains large amounts of salts	Off-the-shelf
Electric power	Generating electric energy in conjunction with the grid or off grid to run the facility	Off-the-shelf
PV pumps	Irrigation pumps	Off-the-shelf
Ventilation	PV powered PV fans	Off-the-shelf
Lighting	PV powered lights	Off-the-shelf
Soil Sensors	Soil PH, moisture sensors powered by small PV panels and sending data to a monitoring system via a wireless network	Off-the-shelf
Pesticide spray pump	Portable pesticide spray pump powered by a small PV panel instead of the conventional manually charged pumps	Experimental
Pesticide spray car	A PV powered intelligent vehicle for spraying pesticide in vine yards	Experimental

Promising PV applications for agriculture in Egypt: Using a systematic market driven approach, few technologies are particularly highlighted for startups to further investigate. As a start market needs and demands were determined through a mix of desk research, surveys, and expert focus groups. Technologies that may address such needs were determined and financial screening was carried out to determine if the deployment of such opportunities is financially viable or not. Finally, the technologies were validated with 12 geographically diverse solar firms and are listed below.

Simple PV Powered Devices as Marketing a Tool / Increasing Confidence in PV

Dynergy for over 2 years has successfully provided customers with a range of handheld powered PV devices that are easy to use and are extremely affordable. Dynergy sees such devices as a marketing tool as much as source of revenue. Green Eagle based in Sohaj has pilot sales in PV powered pest control devices with remarkable success.

1. PV Pumping for irrigation (it remains one of the opportunities with highest potential)
2. PV powered lighting/ ventilation systems for poultry farms
3. Solar thermal heating powered ventilation system for poultry farms/ greenhouse
4. Off-Grid PV systems for farms
5. Solar dryers for agriculture
6. PV RO desalination system
7. PV powered pesticide/ fertilizer carts for vine yards
8. Solar thermal egg incubator
9. PV powered cooling for fruit and milk preservation
10. Thermal powered cooling for fruit and milk preservation

The main realization above is that PV technology can be deployed in various applications. PV for producing electricity and pumping would represent the highest market share, however, PV powered devices and systems such as lighting, pesticide sprayers and carts, cooling, ventilation systems, and desalination could serve particular clients and collectively would have reasonable market size. Local firms can have an edge in this application where the high level of engineering and customization can provide an edge over imported devices. Circuitry can be designed and manufactured locally. These diverse technologies and applications can address different market segments as shown in Figure 24 and can open up the PV market as a whole. Aside from PV technology there are other technologies that rely on solar energy but for heating such as water heating and food drying. These are worth further exploration by startups. For these opportunities to be realized and the uptake of existing applications to increase new firms will enter the market and the existing ones would need support in growth and scaling up.

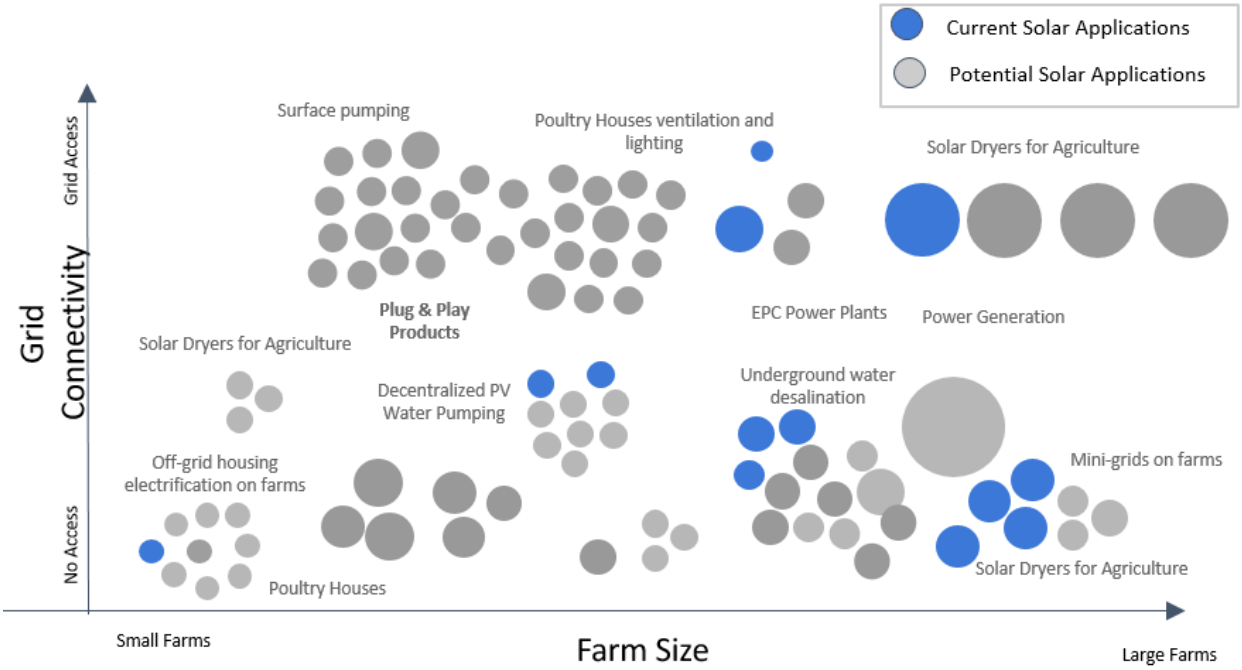


Figure 24: Sample innovative application based on product customization and integration needed to address all market segments versus existing ones

5. Enabling Customer Finance

5.1. Outlook on access to finance for PV applications in agriculture

Access to finance is a key challenge for PV applications in agriculture. 94% of the surveyed sample mentioned finance as a main barrier to the growth of the sectors. For PV application in the agriculture market to grow to its full potential size, access to finance challenges at the customer level in particular need to be addressed. This chapter aims to understand the current state of financing schemes and entities relevant to the market to develop recommendations on how to improve access to finance for both the startup and their customers. In many cases, PV powered farming makes clear financial sense, however the payback, even if only a few years, can pose enough of a deterrent as limited number of customers are willing to spare the upfront capital cost of the PV system. As in most renewable energy systems the customer has to pay capital in the promise of medium-long terms saving.

Diverse financial tools and channels needs to be used. As shown in Figure 25 there are various financial tools that could be beneficial in transactions between investors and financial institutions on one side and firms on the other side. However, finance schemes are implemented in the market remain limited. Finance can be required to support the firm growth in terms of hiring or production capacity etc. This can be provided to the firm through investors on equity basis or through a lending institution or financial service provider.

Solarize Egypt – PV finance as core business

Solarize Egypt positions itself as a PV firm with financial solutions offered to the client as part of its core business. It couples the system with financial support schemes mixing of low interest loans and leasing models. Note: Solarize's original financing partner, Barclays Egypt, has recently been acquired by another international bank.

Solarize has developed partnerships with institutions to provide its clients with leasing options.

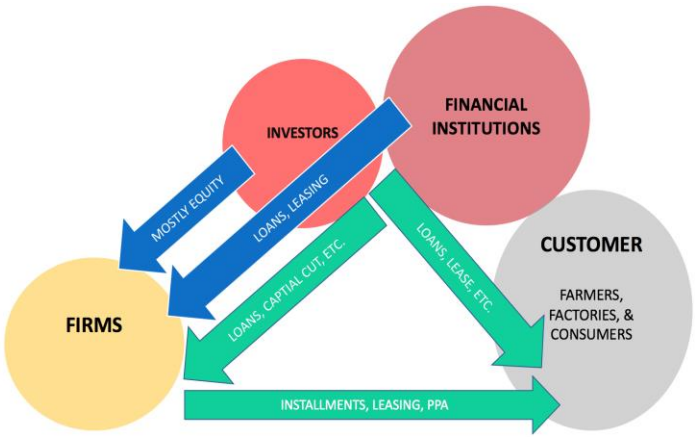


Figure 25: Map of Financial tools in the Agricultural Sector

Based on the surveys carried out, finance to support firm growth is not the biggest challenge faced by startups. Rather, finance to support the customer through distributing payments over time, is the biggest challenge. Figure 26 shows that around 62% of purchases from PV firms are limited to immediate payment upon delivery or down payment schemes. Another 17% is done through installments of about 3 to 6 months at most. This means that about 80% of customers must have the purchasing power to pay for the system in full upfront. This limits the customer base to those who have such purchasing power, although, with the right payment schemes this situation can change unlocking the market to more customers.

There are limitations in terms of customer finance in the PV farming sector due to various barriers. It is worth noting that customer finance can be done indirectly through the startup which may acquire finance and offer it to the customer. For instance, the firm can use a loan to offer the customer a leasing option or a purchase power agreement (PPA) in which the customer pays for their energy consumption.

Another limitation for the PV farming sector is the absence of utilization of diverse finance mechanisms. In most cases attention is given to low interest loans that are available in the market and mechanisms such as factoring, leasing, and overdraft. Each of these tools can serve a combination of startups with a particular business model and certain customer needs. In all cases, despite all financial institutions interviews showed interest in PV, there remains multiple barriers that needs to be managed.

Seeing as the main problem facing cleantech entrepreneurs in Egypt is funding, especially client oriented funding, and bearing in mind the limitations facing clients in accessing traditional funding/loans due to previously discussed bankability limitations, innovative solutions are necessary to fill the funding gap. Based on international experience, financial technology (Fintech) solutions have been used to address similar challenges.

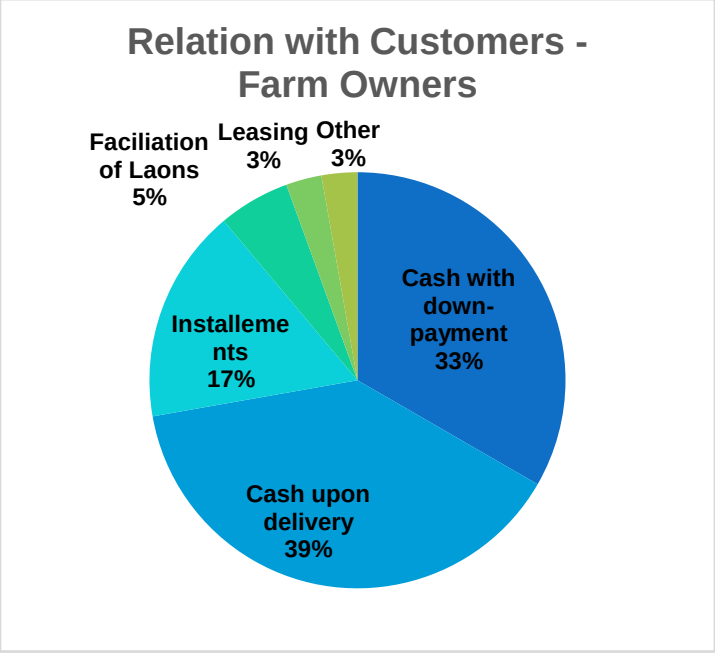


Figure 26: Type of payment method by percentage for the customers of 20 PV startups

5.2. Fintech solutions for PV internationally

Globally, there have been successful pay-as-you-go models which the Egyptian market can learn from. Fintech integration enables PV and other markets to serve large number of small customers. M-Kopa is a Kenyan company that provides solar solutions with facilitated installment-based financial schemes through M-Pesa mobile payments technology. Eighty percent of M-Kopa's customers live under $2 a day. M-Kopa sells a $200 basic solar power system that replace kerosene and require a $35 down payment then 45 cents daily for a year paid through fintech.[37] According to M-Kopa's website, as of May 2017, M-Kopa has connected over 500,000 homes to affordable solar power with 500 new homes being added every day. Current customers will make projected savings of USD 375 million over the next four years. M-Kopa now operates in three different Sub-Saharan Countries. Kenya One Acre Fund (OAF), working with poor farmers, replaced cash with digital payments. Some of the loans were used in solar applications in agriculture (Solar lights) and other uses of loans include agricultural inputs such as fertilizers.[38] The existing cash collection systems suffered uncertainty, inefficiency, insecurity, leakages, and high costs. This created a barrier in the capacity to serve customers in rural areas and reliance on installments (or leasing) in selling a product that is best suited for such payments. The introduction of digital payments through mobile phone (M-Pesa) systems solved these problems with a high customer satisfaction. The fintech enabled business model lowered repayment fraud and enabled faster processing times. It also allowed the firms to serve a larger customer base in a cost competitive manner. For instance, only 4 employees were needed to handle payments instead of 56.[39] While these innovations cannot be adopted directly into Egypt, these concepts and technologies need to be highlighted and experimented with by startups, financial infrastructure providers, and institutions in order to develop models which meet the needs of existing customer segments.

5.3. Fintech opportunity in Egypt

Growing fintech sector in Egypt. The following firms were interviewed; PayMob, Winmore, Pay Me, Vodafone Cash, Masary, and CIB ewallet. The average number of years of operation of the 6 surveyed fintech companies is 4.3 years. These figures reflect a fast-growing market with high potential. Furthermore, less than 33% of citizens who are 15 years old or older have an account with a financial institution.[40] The percentage drops to 26.9% among females. Credit card owners make up less than 4% of Egyptians over 15 years old.[41] Egypt ranks second place after the United Arab Emirates (UAE) in being a hub for fintech startups based in MENA.[42] In this context, Egypt's rising fintech startups have the opportunity to fill this critical gap and offer service to a substantial segment of the Egyptian

Fawry – Transforming E-Payment in Egypt

In 9 years since it was founded in 2007, Fawry has grown to achieve the following in 2016.

- 65,000 Terminals across Egypt
- 1.5 Million transactions per year
- 20 Million Egyptians Served

[37] Faris, S., 2015. The Solar Company Making a Profit on Poor Africans. Bloomberg.
[38] Waldron, D., Amusen, E., 2017. How Digitizing Agricultural Input Payments in Rural Kenya Is Tackling Poverty: The Case of One Acre Fund. The Better Than Cash Alliance (BTA), Kenya.
[39] Waldron and Amusen, 2017.
[40] World Bank, 2017. Global Financial Inclusion.
[41] Ibid.
[42] Feller, J., Boustani, E., Faycal, T., Giorgetti, E., 2016. FINTECH IN MENA: Unbundling the financial services industry. Wamda & PayFort.

population with financial services appropriate for the needs of the sector no serves by traditional financial institutions. Fintech startups can not only bring lower transaction costs to the market through innovative technological solutions for the financial sector, but they can also provide access to new financial services for large segments of the unbanked Egyptian population.

There are no documented uses of fintech in clean tech markets in Egypt. There is a literature gap when it comes to assessing the role of fintech startups in solar-farming and agri-waste in Egypt. The absence of focus on the linkages between fintech and PV in Egypt could be due to multiple reasons. First, Egypt's fintech sector is young[43] and has yet to explore and expand in providing solutions to different industries in Egypt. Second, solar-farming is also at a nascent stage and has yet to reach its full potential. Firms in PV might not be aware of the services that they may benefit from in the fintech field and fintech firms might not be aware of the opportunities available in the rapidly growing markets of agriwaste and PV applications in agriculture. International experience shows that these opportunities exist. There have been valuable and successful experiences documented in other parts of the world that highlight the involvement and potential role that fintech could have and expand on when it comes to solar-farming (Subsection 2.5.10). Penetrating the agricultural sector could be a win-win situation for both the fintech and agricultural sector as a whole.

5.4. Barriers faced by fintech startups in Egypt

Analysis of key barriers of fintech startups shows a diverse set. Figure 27 demonstrate the main barriers to growth that the surveyed Fintech firms identified. The following lines analyze the dynamics of the top three identified barriers.

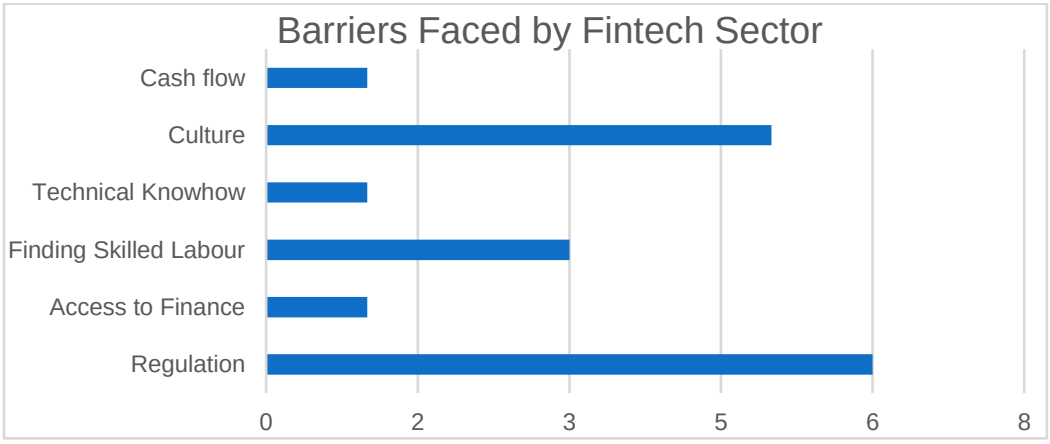


Figure 27: Word count of barriers faced by the Fintech Sector in Egypt as mentioned by 6 interviewed firms

Regulation. The regulatory framework[44] in Egypt limits fintech startups ability to manage financial transactions. Consequently, fintech companies need to partner with financial institutions such as banks through which they offer their services.[45] While partnerships with banks could be a very useful tool for

43 Half of all MENA based Fintech startups were established after 2012 (Feller et al., 2016).
[44] Capital Market Law 95/1992, 1992.
[45] Feller, J., Boustani, E., Faycal, T., Giorgetti, E., 2016. FINTECH IN MENA: Unbundling the financial services industry. Wamda & PayFort.

building on an already well-established customer base, it can hinder their potential of reaching out to Egypt's unbanked population, especially if banks resist non-traditional fintech innovations.

Finding skilled labor. Due to the nature of the industry, local fintech startups, which usually start out with limited capital, face high competition for hiring and maintaining highly demanded high-skilled labor such as programmers.[46]

Culture. From large financial institutions such as banks passing through companies and merchants, reaching phone and application users, Egypt maintains a strong cash culture.[47] A mindset change continues to be key for further adoption of fintech solutions.

Paymob – Fintech startup

Paymob, founded in 2014, is one of Egypt fastest growing Fintech startups, they offer diverse services including

- Online Payment
- Card-on-delivery
- Mobile wallet payments
- In store payments
- Standalone checkout

PayMob has developed their own technology for card on delivery with pending patent and over 350 Million Transactions.

5.5. Fintech potential in Egypt's PV market

PV and Fintech Startups interviewed see high potential for collaboration. Both solar firms and fintech firms indicated in the interviews their wish to collaborate. International experience and value chain analysis shows that fintech has a role to play in the PV farming sector. Fintech startups' main interest is to work with customer segements which will eventually lead to high volumes of transactions. The PV firms are mainly looking for a method to facilitate collection fees in case they are small and distributed among. Thus, the integration of fintech with the solar market would take place to serve medium and small farms, in particular.

Fintech offers various technologies some of which are acceesible to most farmers in Egypt including small scale. There are several payment methods and technologies in which Fintech could reach out to small agri-farm holders (figure 28). Low-tech requirements – such as SMS services and Point of Sale (PoS) terminals could prove to be early entry points to develop adoptable solutions in agriculture markets. For example farmers with regular mobile phones (not smartphones) can access SMS services and farmers who do not have mobile phones could rely on PoS terminals[48]. Thus, having a smart phone, or even a phone, or a bank account is not pre-requeusit to developing fintech enabled

Fintech-PV Pilots in Egypt

IRSC is one of a few PV firms, experimenting with using Fawry terminals to collect payments from remote customers to facilitates payments and decreases cost of collection.

Solarize Egypt is developing a pilot for a pay as you go system.

[46] Ibid.

[47] Nasr, S., Pearce, D., 2012. SMEs for Job Creation in the Arab World, SME Access to Financial Service. The World Bank, Washington DC.

[48] Point of Sale terminals refer to retail points where people can make payments for bills or other services through point of sale machines (similar to ones used in credit card transactions).

solution. These low-tech solutions will help serve the millions outside the banking system and can potentially address medium and small farms customers barriers.

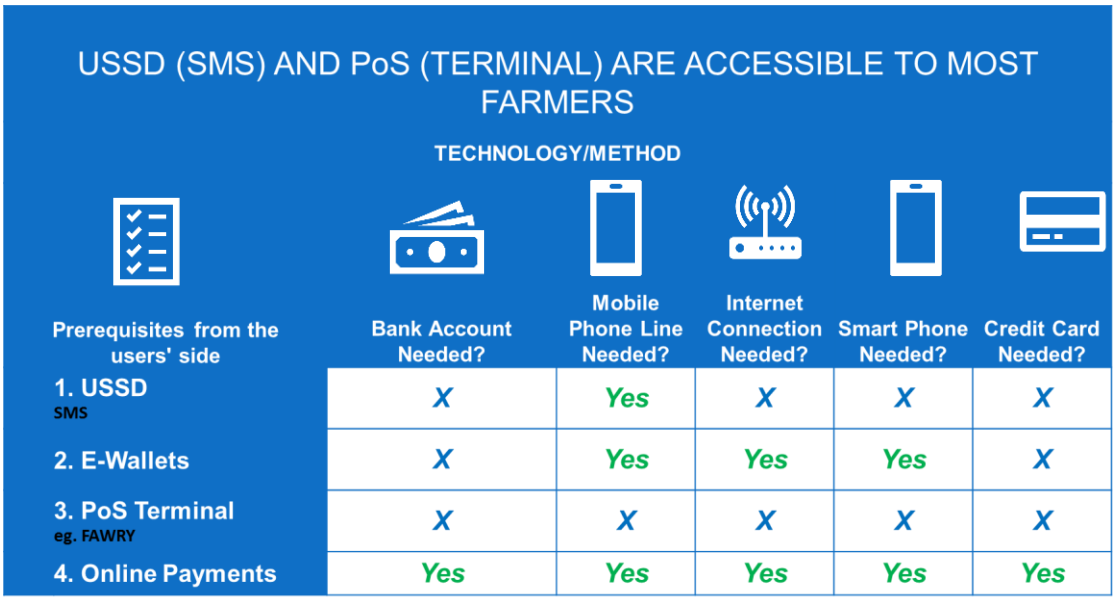


Figure 28: Fintech payment technologies / methods

Fintech startups may facilitate financial transactions between firm and customers or between financial institutions and customers. While M-KOPA connects the firms to the costomer, other successful international examples is FarMart which connects intermediares and financial institutions to the farmer such as FarMart India and Atik Insurance Rwanda. Fintech firms can play both roles in the Egyptian market. It can help coops, NGOs, and microfinance entities to reach a wider client base by decreasing the cost of collection and monitoring/data recording and analysis.

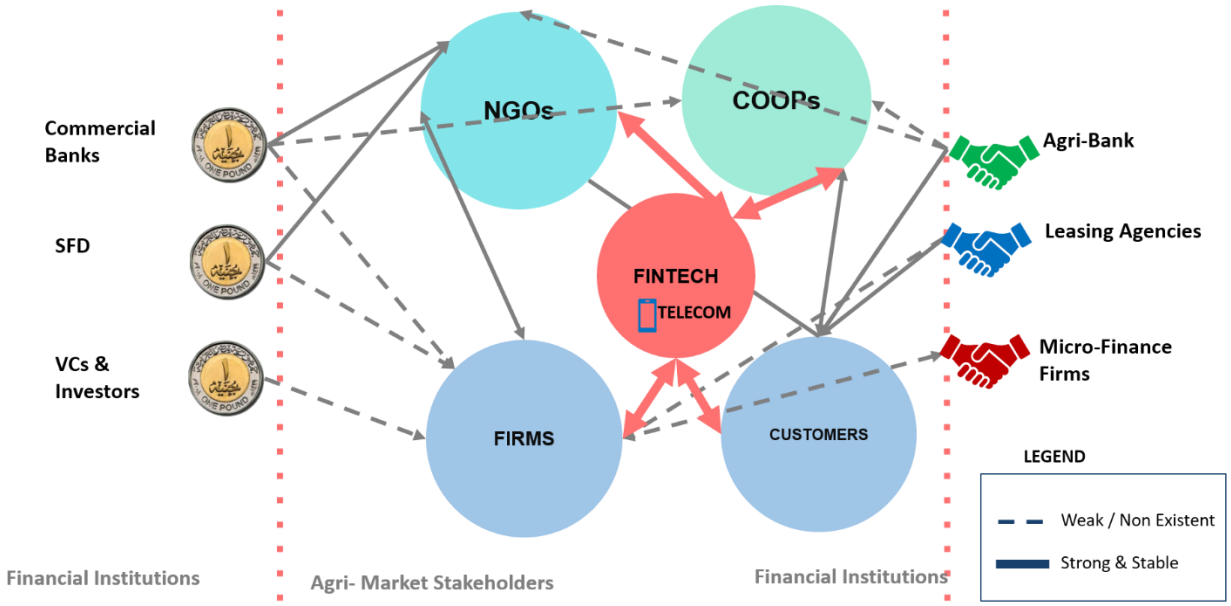


Figure 29: Financial services and channels in the farming sector showing strength of channel

Fintech can act as intermediary between PV startups and farmers or between traditional high-risk financing players and farmers. Fintech startups may facilitate financial transactions between firm and customers or between financial institutions and customers. While Fintech firms indicate the cap on the transaction as a major challenge to work with the PV farming sector, they are still encouraged to work on building a feasible model. Disussions between some PV and Fintech firms were inittiated as as a result of the networking efforts linked to this project. A local grown Egyptian model is yet to be developed, however the potential Fintech firms have, in filling the existing gap shown in Figure 29, offered a solution that will have a significant impact on the PV market. As a result of preliminary workshops and engagement, some Egyptian Fintech startups are already working with PV startups to develop a viable solution. As well, at least one Fintech startup is exploring how to engage with financial intermidiarries to develop a solution that would be a key to unlcoking the market for medium and small farms which remians the least served. Fintech can help solve one of the keychallenges faced by PV startups, the cost of payment collection. It is worth noting that while mobile penetration is high in Egypt, transitioning segments of the population from a cash society to to digital payment methods is a challenge that should not be overlooked.

6. PV Market Development Through Value Chain Analysis

In order to support PV startup growth, it is important to look beyond direct support to these entrepreneurs, but rather understand the markets they are operating in. It is important to understand the value chain they form and operate within. This section discusses the interlinkages between the supply network: suppliers, manufacturers, solar energy companies, as well as the agri-customers. Analyses aims to point out where the strong linkages are to capitalize-on, and which are the weak interlinkages that would need further support.

6.1. PV Value chain in the agriculture sector

A PV system consists of various elements including solar panels, cables, mounting structures, inverters, batteries, and in some cases peripheral equipment powered by the PV system such as LED lighting and pumps. These various components flow from international market and local feeding industries to EPC PV firms or system installers directly or through suppliers and distributors to finally reaches end users. There are various entities that enable and regulate the process of a PV system installed at the customer premise by a PV firm. As shown in Figure 30, PV firms can get components from international manufacturers or local manufacturers directly. PV firms can get the components also from suppliers (local branches of international manufacturers) or distributors (local firms who are exclusive or open certified distributors of international manufacturers). Various market enablers provide firms and or customers with finance and knowledge. Other market players regulate various aspects of the value chain. PV panels are largely imported. Only a handful of firms import PV cells and fabricate the panels locally such as Tiba Solar. All inverters are imported as well as the majority of batteries. Cables are mainly manufactured locally, while mounting structures have recently seen more local manufacturing since the EGP devaluation.

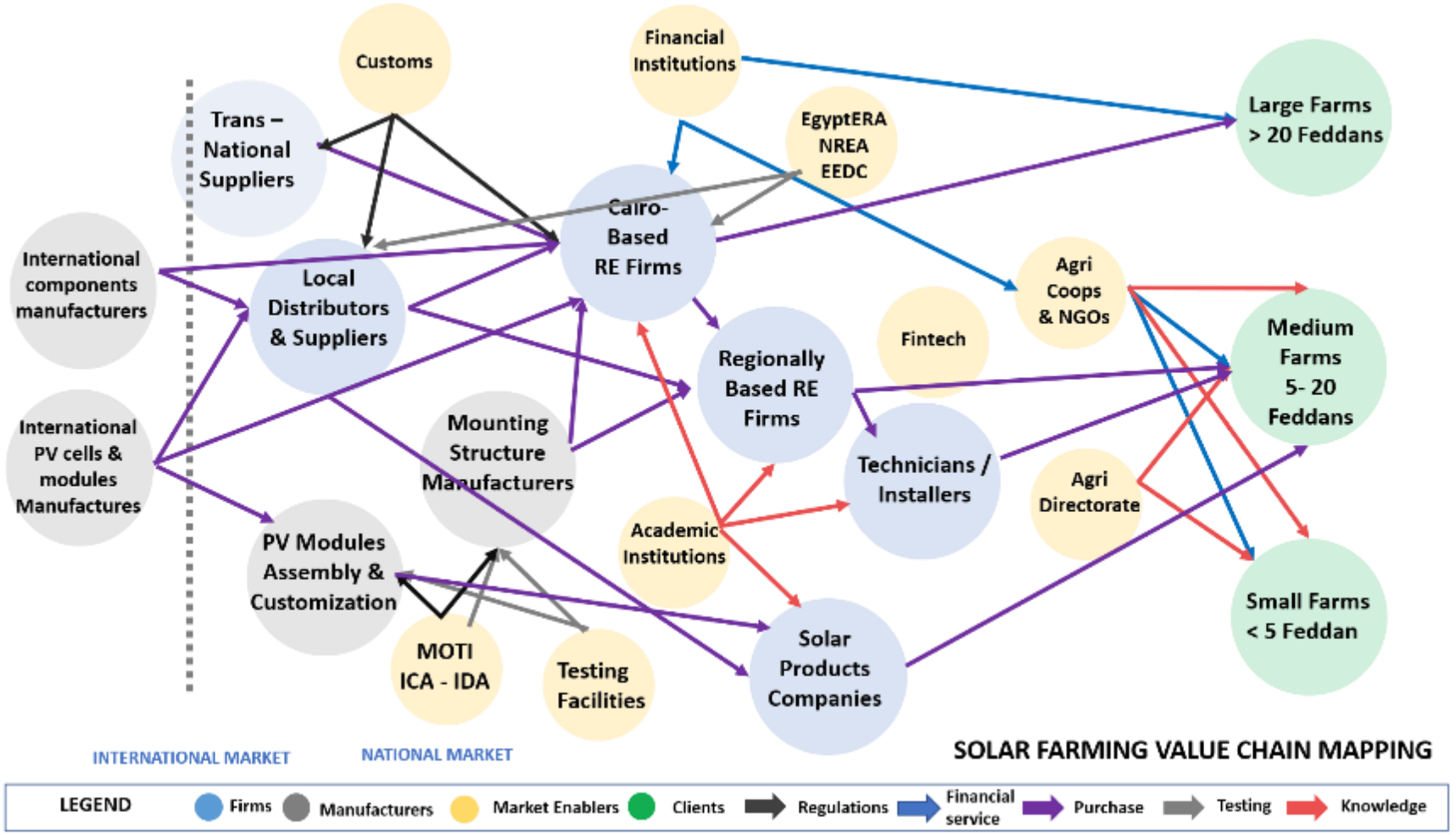


Figure 30: PV Value Chain in Agriculture Mapping shows type of interactions between various entities in the value chain. The yellow circles refer to a market enabler, the light blue refers to manufacturers, dark blue to supplier and distributors and the green to PV firms which are mostly EPC firms. The type of interaction is characterized by the color of arrows as indicated in the bottom left corner to the figure.

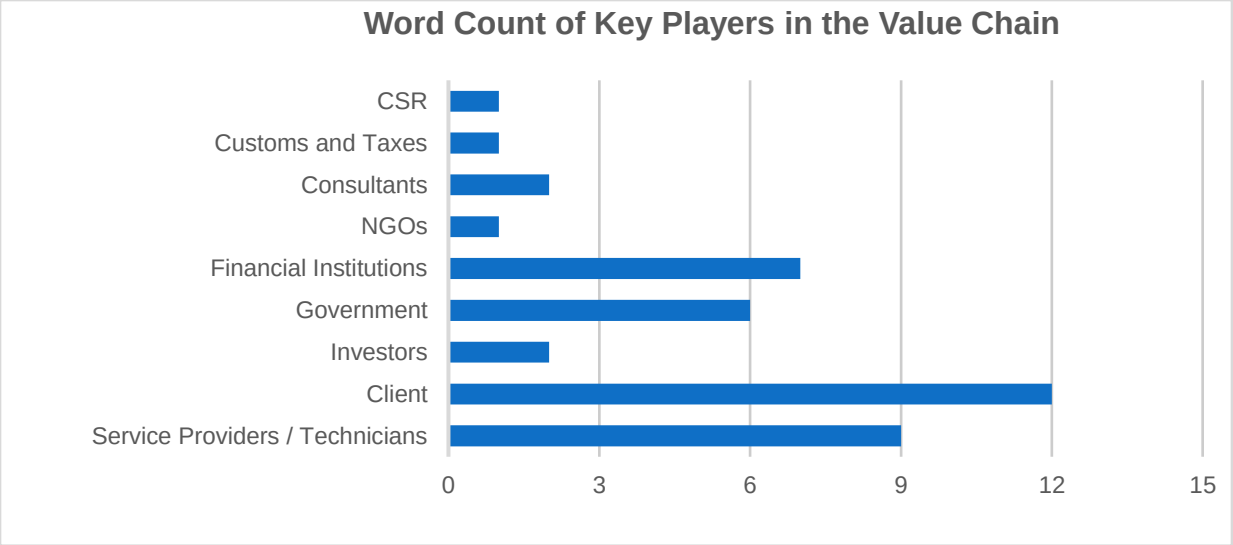


Figure 31: Word count of value chain entity as a key market influencer from 20 startups interviews

Market Enablers are entities that shape the dynamics between the startup and their customers directly and indirectly. These include financial institutions such as banks, investors, microfinance companies. It also includes entities which are not yet part of the PV market, such as Fintech firms and payment infrastructure. Agriculture directorates and agriculture coops are also a key player that provide farmers with knowledge and awareness. Agriculture coops may engage in customer finance activities. NREA is the key entity that regulates the PV sector, yet it also provides testing facilities. Since the market relies on large amount of imports, the ministry of finance and industry are responsible for setting customs and GOEIC is responsible for enforcing them. Finally, universities and technical schools provides PV firms with their skilled employees. Further details are presented regarding each market enabler. According to the interviewed solar energy companies, which stakeholders they consider vital to their business, it is primarily the customers, secondly the suppliers, and labor, and thirdly it is the financial institutions.

Table 2: Value Chain Entities Description

Entity	Description	Role and Responsibility
International Market of Manufacturers and Suppliers	- multinational companies and distributors	The international market represents the global contribution to manufacturing solar components and equipment. This market is part of the industrial value chain in which local distributors of the firm themselves provide solar components to the Egyptian market
Trans-National Suppliers	- Trans-National Corporations (TNCs)	TNCs are responsible for regional supply of products and equipment. Relative to Egypt, they either supply to the MENA Region, Gulf Countries, and the African Market. Their business activities are highly dependent on shipping logistics and they may distribute through Egypt to other countries

Local Distributors	- LLCs - Joint Ventures… etc. - Traders that procure and sell locally	Same as the TNCs, but on a local level; local distributors business activities mainly include: components storage, shipping logistics, warranty provision, and retail logistics. They also procure from importers or distributors
Local Manufacturers	- Factories - Industrial Enterprises - Local Workshops	The local manufacturers can be either formally through factories, or informally through local workshops. The quality and price of service / product highly depends on the manufacturers due diligence, and reputation. The four main existing PV manufacturers in Egypt are the military owned Arab International Optronic, Benha Electronics Company, the government owned Arab RE company (WB, 2016).
Solar Energy Companies	- System Integrators (Cairo-based Startups) - System installers (rural startups)	Formal and informal corporate entities carry-out the entrepreneurial activities of solar-farming applications.
	- Local Technicians	Local technicians have trained on site with the electrical engineers installing the PV systems for Agri purposes. They are either graduates of technical schools or previously worked in the construction industry.
Agriculture End-Users	- Agricultural Farms - Fisheries - Livestock Farms - Poultry Houses	End Users in the agri-business value-chain who spot relevant PV applications to enhance their agricultural produce. Depending on the farming specialization: crops harvesting, food processing, livestock farming, fisheries or poultry houses; they belong to different value chain supply and demand.

The market enablers and stakeholders in the sector that can play a key role in shaping the market. For instance, financial institutions can play an essential role in enabling project finance in the sector. In the case of small agricultural holders, agricultural cooperatives play an important role as an aggregator of small holder farmers, and linking them to startups, financial institutions, and service providers.

Furthermore, the extent of the regulatory practice depends on whether the farm is located on-grid or off-grid. The policy-making group: Regulatory Agency, Transmission Company, Distribution Company, as well as the New and Renewable Energy Agency; play a significant role when the farm is on the grid. Their roles range between setting the tariff for Renewable Energy (RE) power generation through the Power-Purchase Agreement (PPA) – regulator, transactions of wheeling charges – EETC, as well as purchasing of RE power in some cases – NREA. However, the on-grid power generation scenario is least likely in solar applications due to the subsidized tariff for the agriculture sector. On the other hand, the off-grid power generation, and

solar system installation is unregulated. Solutions and regulations on how to further develop the PV market will be discussed in the following sections.

Table 3: Market Enablers Roles and Responsibilities

Stakeholder	Description	Current Role
Customs and Regulations	- Exports and Imports Control Authority - Shipping Companies	Impose regulations, taxes, and inspection on imported products and equipment to guarantee the quality standards of equipment. The logistics of imports are either handled by the local supplier, or trans-national supplier as per the contractual agreement.
Financial Institutions	- Commercial banks - SFD - Leasing companies - Micro Finance Institutions - Angel investors - VCs	Financing entities who provide loans – or soft loans – as well as other financial service to either the agri-businesses or startups to utilize solar energy applications. Moreover, non-profits, NGOs, and associations provide support to farmers through different schemes.
Government and Public Entities	- SMEDA - MoERE – NREA - MALR - MoTI – IMC, ENCPC - Ministry of Irrigation - FEI	Public institutions who are in charge of regulations and monitoring of either the agricultural activities, SMEs or renewable energy generation.
International Organizations and Donors	- UNIDO - RCREEE - WB / IFC - GIZ - ILO - JCEEE - MED-ENIC	International organizations and donors who support the RE transition in Egypt. On the local level, agricultural directorates provide farmers with technology updates and business support.

	- Agricultural directorates	
Academic Institutions	- Research Institutions - Private and Public Universities	Academic institutions who provide technical support to startups working in the PV / Agri sector.
Entrepreneurship support entities	- Cleantech Arabia - GESR - HU entrepreneurship center - NM - Flat6Labs - AUC Vlabs	Supporting startups

6.2. Improving product development and business models through startup linkages and partnerships

In this section solutions and recommendations to develop the PV farming market will be presented. First, recommendations to develop the value chain through stronger interactions among firms will be presented. Followed by a discussion on enhanced access to finance and market opportunities that can expand the penetration, and finally, the role of various market enablers will be analyzed.

Local component manufacturing. Analysis of the value chain above in terms of local manufacturing versus imports shows high level of reliance on imports with exception of mounting structures and cables. Various entities have considered and are considering local manufacturing of PV panels locally. However, the current market size and level of competition does not warrant the investment. The current manufacturing economics of PV favors large scale facilities that can overcome long shipment costs. Alternatively, collaborative investment from startups such as of IRSC and ACO has led to establishing one of Egypt's fastest growing locally manufacturer mounting structures. In a very short manner and with strong business development support, the newly established firm convinced leading PV firms in Egypt to switch to the local product from imported one. The competitive edge does not only lie in the quality but also in building semi-connected structures that are fast and easy to deploy in the field, something not possible in the case of import.

Tiba Solar

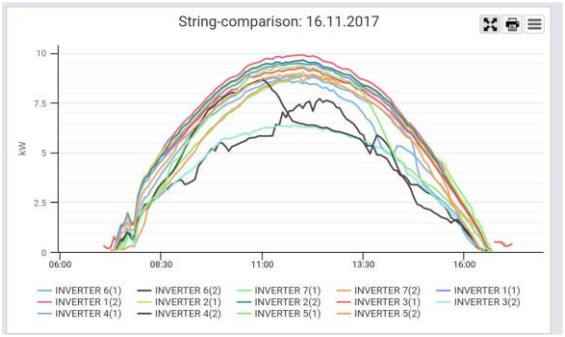
Tiba solar imports PV cells and produce PV panels locally. In cases, Tiba solar produce custom designed PV modules to meet unique and specific customer demands. In many cases, non-standard voltage and currents are required from the PV system in certain applications. Such customization can play a major role in designing and producing PV powered applications such as LED lights, pesticide sprayers and powering other agree equipment. For instance, SunCity mobile PV pumps required customized system to deliver pumps voltage and power in the limited space available.
Cairo University E-golf cars photo below

Linkages to catalyze product innovation and systems integration. With the continuous focus on manufacturing PV modules and panels, various components with higher potential for local manufacturing are forgotten. Mounting structures for instance can be fully manufactured locally. Few workshops have been working on this, either independently or through agreements with some local PV firms. Recently, two of the interviewed startups established a large scale high quality facility for mounting structures and have experienced increasing market success. There is a high potential for dominant local manufacturing of mounting structures. Egypt has a reasonable capacity to design and build electronic circuits such as those used in inverters such Dynergy building small charge controllers. This is another opportunity that needs to be considered. Importing PV cells (modules) and manufacturing panels may find a room in customized applications such as powering specific electrical equipment.

The recommendation is to consider local manufacturing in other parts of the system beyond the PV cells, modules and panels, focused on innovation of the integrated product.

Innovation can also take place by integrating PV solutions with enabling technology such as in the case of ICT. Emeco-Egypt stands out in the market by having offered its 20 clients (1.5 MW in total) with 3G based monitoring system which allows client to watch and record system key performance parameters. The system sends live updates and alarms about the system status to Emeco-Egypt and enables them to provide an instantaneous maintenance service. ICT enables Emeco-Egypt to promise its clients that system errors are restored even before the client notices at times. The data also allowed emeco to build knowledge on best designs and best practices.

Emeco – Monitory & Data Analytics



6.3. Improving market access and tech transfer through startup linkages and partnerships

Stronger rural linkages needed along the value chain to penetrate medium and small farmer customer segments: Another key part of developing the PV value chain in order to deepen market penetration is to analyze it along the type of PV firms and their market reach. The PV farming segments have been divided into the three categories previously discussed; small < 5 Feddans, Medium 5 to 20 Feddans and Large > 20 Feddans. Small farms are the category less addressed by the market. Few medium farms are served and most of the PV systems still goes into large farms. Within the larger block of PV firms there are various subcategories of firms based on business model. Some of the local suppliers and distributors serve customers directly, however they are mostly focused on large farms. Larger Cairo based startups have had successful track record in reaching large firms. These Cairo based startups have in cases served medium farms however by relying on local technicians in the respective regions. These local technicians tend to operate independently targeting medium farms, and have transformed from local technicians to full service providers independent of the Cairo based startup such as Sun of Oasis startup. They usually operate to serve small to small-medium farms building systems less than 5 kW at most of the times and up to 50 kW. They are extremely effective in marketing to customers in their vicinity and have effective cash collection mechanisms.

Opportunity and value behind linking Cairo based startups to rural startups. There are relatively large numbers of firms based in governorates outside of Cairo. These firms are characterized by a smaller starting capital and smaller size of operations compared to those that are Cairo based. Yet, they have stronger connections with customers and can serve the medium size farms more effectively. They have been successful at raising customer awareness and technology adopting levels by using a community approach. They have the greatest understanding who are the key influences in their local communities, they are able to build trust within their community to demonstrate or test products, and word of mouth of firsthand experience can effectively address risk perception often associated with PV products. However, these rural startups are not able to operate in isolation. They usually purchase components from firms based in Cairo. They also don't have access to the same depth of technology, or business support programs (i.e. incubators/accelerators) in the same way their Cairo counterparts do. They face challenges in procuring

components and financing projects. Shown in Figure 32 is an analysis of these firms' interactions and customer reach. Cairo based companies are strongly connected to local suppliers and distributors and less connected to international suppliers and are strongly linked to large farms at the market side. Cairo based firms also tend to have much better access to entrepreneurship ecosystem support program (i.e. acceleration, mentorship, specialized training, angel investment, access to test facilities). Large governorate based firms have a medium connection with local technicians which they incorporate in installation processes. Rural based firms on the other hand are strongly linked to medium farms and local technicians and have medium connection to local distributors and suppliers. They have a weak connection to international markets and to Cairo based firms. To simplify, the Cairo based firms have stronger backward linkages and weak forward ones to medium and small farms. The rural based firms have generally weaker backward linkages and stronger forward ones to medium and potentially small farms. Arguably, a stronger collaboration between the two types of firms (Cairo based and rural based) will allow further penetration of PV in medium farms.

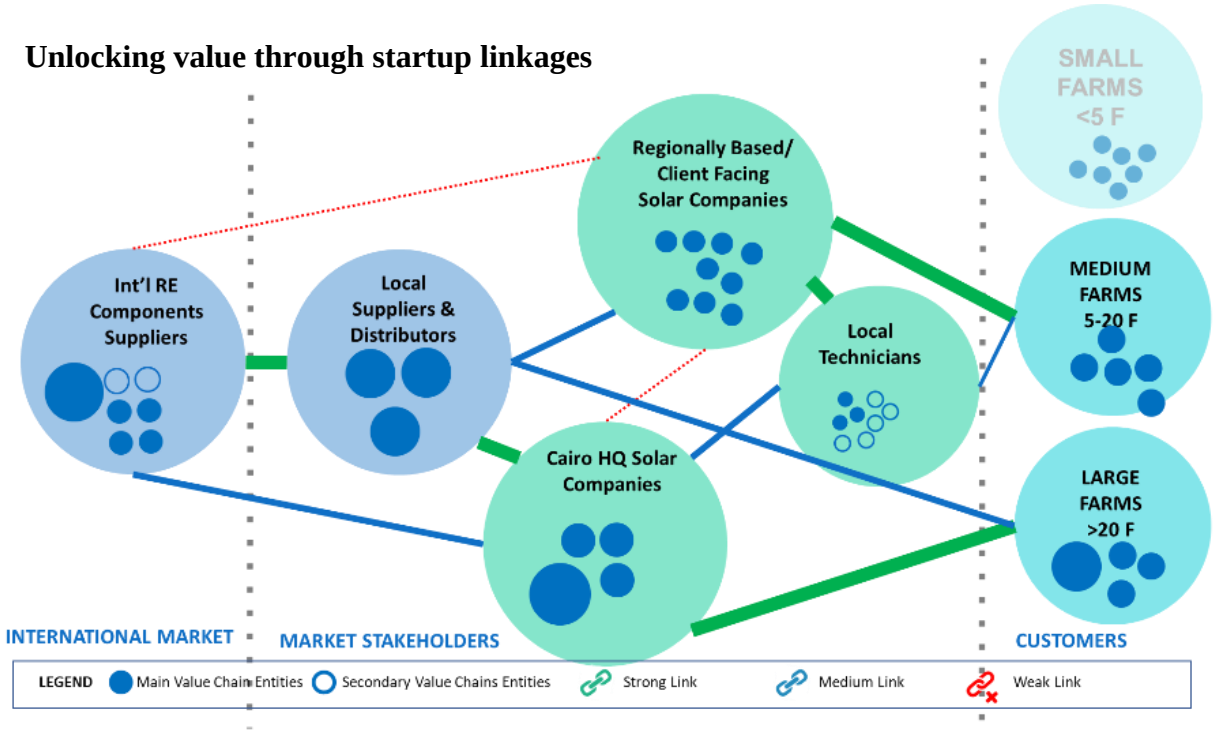


Figure 32: Unlocking value through startup linkages.

The uniqueness of the Cairo-based companies and rural based PV companies the and importance of collaboration were well received by participants in the data validation workshop (Figure 32). Cairo based, and rural based firms have complimentary characteristics which allow for room for collaboration. This distinction between the Cairo based and governorate based companies was analyzed in terms of competitive advantages and weaknesses to determine opportunities for collaboration (Figure 32). The analysis shows that a complimentary relationship can occur between them. Both type of firms addresses different market segments. The benefits of cooperation include a faster rate of penetration to the market, effective customer communication, and improvements to the quality of products and services provided, Cairo based startups are well positioned to offer rural startups support in access to know how, components, as well as project finance. On the other hand, Cairo based startups can get stronger access to medium size

firms and cut down on expenses of business development and after sales support when working with larger farms through collaboration with rural firms.

Table 4: Perceived Typologies of Solar Energy Companies Operating in Egypt

Cairo Based	Rural / Regionally Based
• They have a strong presence in Cairo. • They have access to Cairo services (i.e. technology, accelerators, infrastructure) • Services and products are branded as innovative. • Founders are of a high level educational degree > masters. • Both the technical and business development teams are driving the company. • They receive a stronger support from the eco-system. • They dominate the networking events of support institutions and initiatives. • They have stronger ties to the international market. • They target high-end customers who need tailor made solutions. • High overheads due to business operations in other governorates. • They rely on high quality imported system components	• They have a strong presence in governorates. • They operate where the customers exist. • Services and products are branded as quick solutions to immediate needs - thus less innovative than system integrators. • Founders have received a university degree, or depend on previous work experience. • They target small farm owners, or local businesses. • They have lower overheads. • They highly dependent on local equipment whenever possible. • They have weaker ties with the international market.

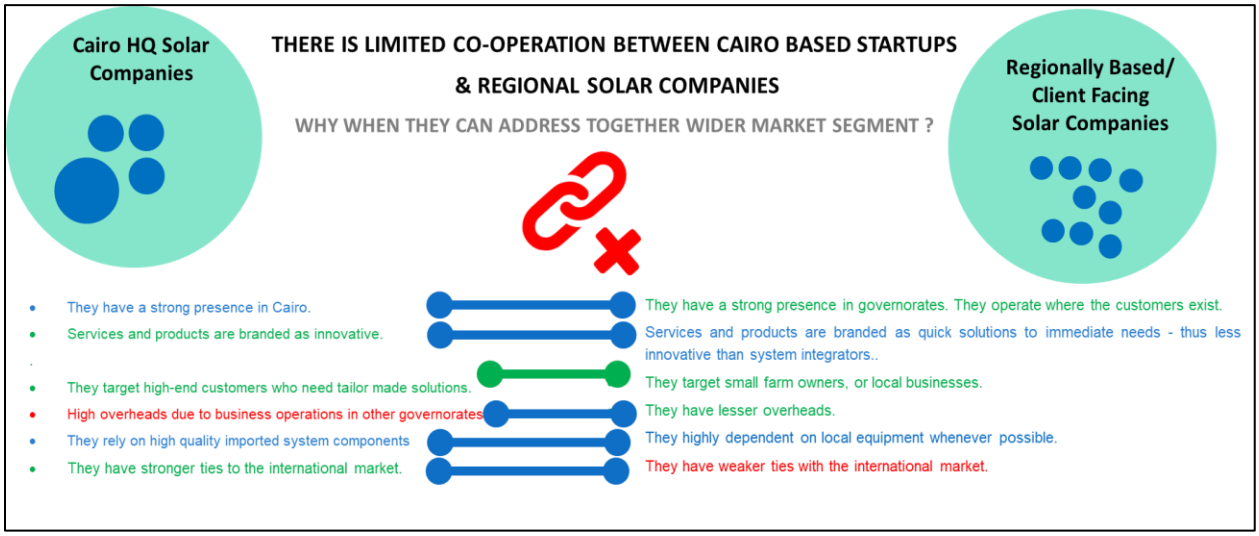


Figure 33: Complementary relationship exists between Cairo based and rural startups

Based on similar forms of collaboration between rural and Cairo based startups, two proposed models for should be considered; 1) the integrator model 2) the distributor model. The integrated model is based making the rural startup the key implementer to all medium size farms in a certain region and the Cairo based one as the key as the key implementer to all large farms in the area. Each startup could use its marketing channels to reach both customers, but referral of leads will be divided between them based on the farm size. In this case the Cairo based startup could provide technical, and financial support to the rural startup if needed as well as components. The rural firm would provide access to diverse client and on ground/after sales support with large farms. A distributor model could be used where the rural companies take a commission when distributing the Cairo based firm systems while most of the implementation is handled by the Cairo based one – see Figure 34; Figure 35.

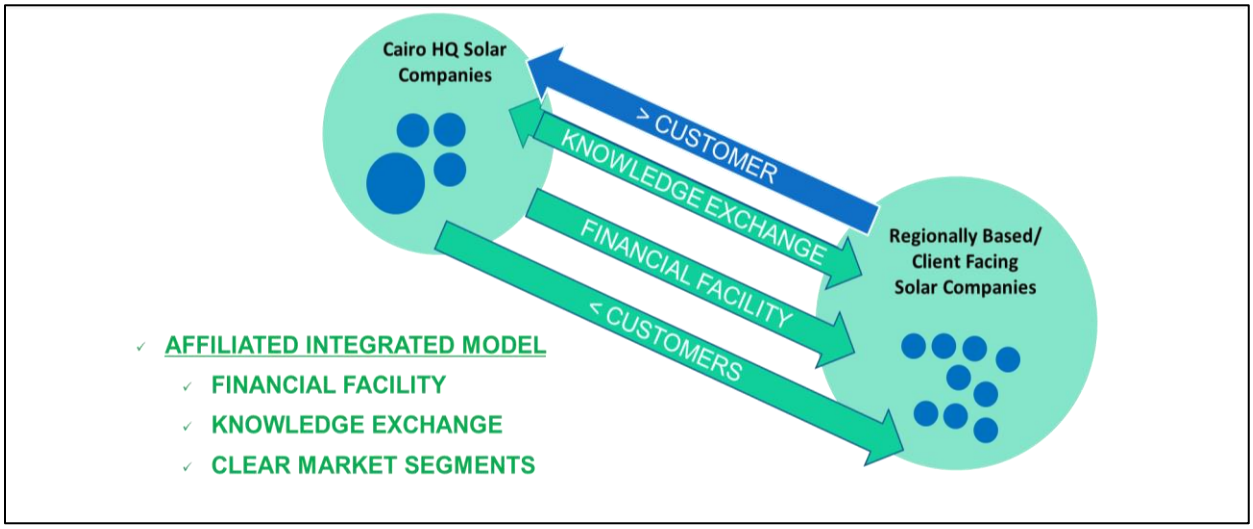


Figure 34: Integrator model for collaboration between Cairo based and rural startups

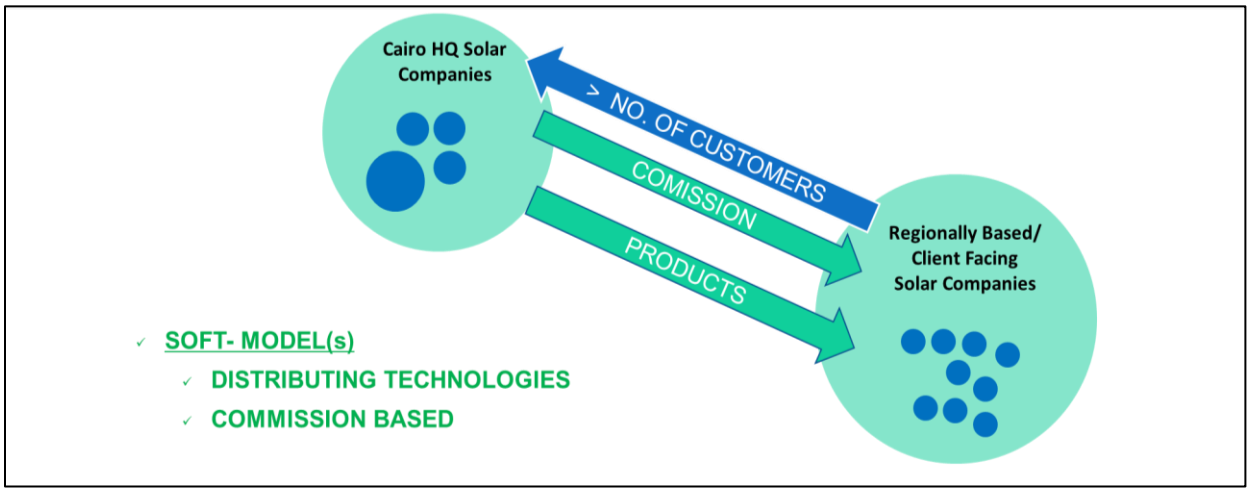


Figure 35: Distributor model for collaboration between Cairo based and rural startups

These models need to be explored further with Cairo and governorate based startups, where ultimately, they will find a model which works best for them. However, it is clear that these initiatives need to be

stimulated in the same way that IT and other types of startups are encouraging to look at joint ventures and partnerships in order to growth their market reach.

Various other forms for collaboration can be developed and will emerge. The key message here is that this collaboration is needed, and welcomed based on the validation workshop and analysis of features of each type of firm. Supporting entities should promote such connections and work on strengthening the value chain collaboration. This is expected to have a high impact of PV penetration in farms. The above also hints to the importance of supporting entrepreneurship activities in various governorates as rural startups that are from, or focus on a geographical location have higher capacity to reach out to diverse clients and promote PV application in those agriculture communities. These startups understand the nature of their local economies and can adapt appropriate business models, payment schemes and communication strategies.

Sunway Egypt

Sunway is a PV firm based in Menya and mostly focus on serving PV pumping needs of medium desert farms off the valley while providing strong after sales support. It procures components from multiple Cairo based EPC firms and suppliers without a long-term agreement with any other firm. Sunway has to negotiate and procure components from multiple firms separately for each of its clients. In case a long term agreement is established between Sunway and a larger technology provider, Sunway will serve its clients faster and at lower cost.

6.4. Increasing access to finance through linkages and partnerships

Integration of traditional financial channels is needed to expand the market. The agriculture sector has diverse financing entities that function at various levels of capital. NGOs, coops, commercial banks, VCs & investors, SFD, micro-finance firms, agri-bank, and leasing agencies – see Figure 36. None of these entities is currently active in the sector. The strongest financing entities in terms of relation with small and medium scale farmers (customers) are typically NGOs, Microfinance institutions, and Cooperatives.

Larger entities such as banks and SFD do not often fund small and medium size farming directly but through intermediaries (NGOs and coops) which can manage these portfolios with multiple small transactions.

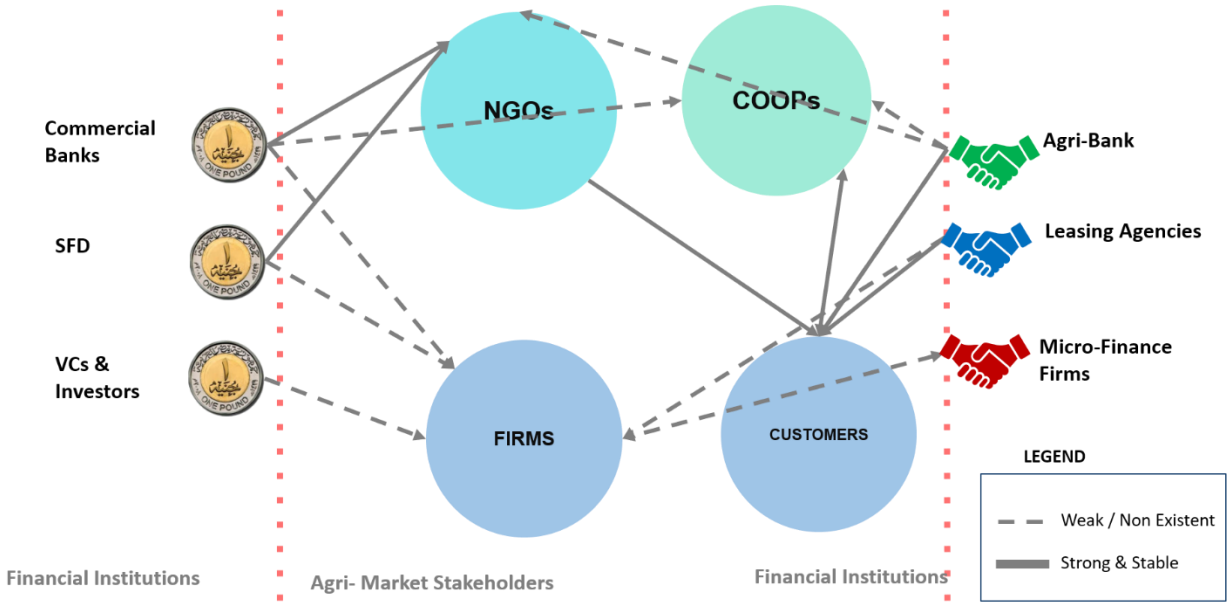


Figure 36: Finance flow in the agriculture sector

Barriers related to land ownership were not considered in the present work since it targets particular types of farms but more importantly because addressing it is complex and requires considering a multitude of legal and regulatory issues that are distributed within various public entities. Below are some guidelines to increase access to finance in PV farming.

Managing Risk. Risk can partially be mitigated through knowledge. Data should be made available to market players through government and international donor agencies. While PV firms need to present the business case properly to the financial institution, it is equally important for the financial institution to have a basic understanding the economics of a PV project. The absence of previous track record for PV projects at the bank for instance makes the assessment more difficult as compared to a car personal loan. One solution that was suggested by banks and received confirmation from stakeholders is to develop project briefs by a third party which describes various PV projects and typical finances of each. This would substitute the role of a consultant that the bank would hire to validate the project. Such intervention may mitigate some of the risks, however, not eliminate them from bank point of view. Project outlines with feasibility schemes/studies should be provided to banks and other creditors to help mitigate the risk of finance to the sector. These studies should address very specific issues that have to do with the different products available in the market, their performance, return on investment, useful life adjusted to different geographical locations and other factors that affects its financial feasibility. It is important to note that low interest mechanisms available in the Egyptian market does not address the bank risk. A financial support mechanism which would address bank risk is credit guarantees for instance. The recommendation for policy makers and international donors is to consider other financial support mechanisms in special finance of PV systems.

What type of knowledge is needed to lower risk

Risks of financing entities can be lowered by providing information on certified suppliers and project briefs (financial models of benchmark projects and systems). Information on price ranges are also useful. Financial support schemes which addresses risk are of major importance. Capacity building is also crucial for the financial sector to be able to assess PV projects

Leveraging existing finance tools available to farmers. Small scale farmers are provided with regular loans from Cooperatives, NGOs, and Agriculture banks for fertilizers, seedlings, and even diesel pumps. These institutions have a track record of selecting and managing risk with small scale farmers in a much better way. Yet, the play limited role in financing PV. There are some indications from the interviews carried out that some of these institutions particularly in Upper Egypt are willing to work on including PV to their lending portfolio. However, there remains a high degree of resistance in some entities as they may not see PV options are the most crucial ones for farming as of now. The advantage here, is being able to utilize an existing entity that can work with the sector well. The challenge is that PV is not yet seen as a priority for such institutions. On the level of a Cooperative or an NGO can move faster than the agriculture bank, however, the agriculture bank would have wider reach. Yet, it is a centralized organization and the development of a policy to finance PV would require focused and sustained efforts. This topic requires further in-depth investigation.

***Reliance on intermediary institutions to manage large number of customers using small transactions*.** One major challenge for banks is to manage large number of customers that might not have a proper banking credit for the sake of small transactions. Other institutions might be better in managing finance for large number of small farmers such as, microfinance entities, NGOs, or even leasing firms. The development of or expansions of existing ones to consider PV might be an effective solution. Recently, Fintech firms have proven their capacity to provide services for a large number of customers and managed to scale up. Furthermore, the access to large and continuously updated data allows them to assess creditworthiness of customers effectively. Many of these solutions also can operate without the need for a bank account.

Microfinance and PV – Reform is needed

Microfinance institutions have played a positive role in promoting small scale PV (for suburban homes and rural areas) in various countries. However, in Egypt the cap of microfinance is 100,000 EGP (would cover systems up to 5kW on average, namely targeting small farm use) and the borrower must have an office address. Extending this to farmers would be quite effective with PV farming (small/medium farms) but within the current regulatory framework it is not.

7. Building Clean Tech Entrepreneurship Ecosystem to Unlock PV Markets in Agriculture

7.1. The importance of shifting the current market trajectory

The previous sections identified the importance of addressing key market failures to unlock the PV Farming Market in Egypt by; (i) catalyzing business model innovations (ii) enabling customer finance innovations (iii) overcoming market access barriers at the customer and value chain level. This section aims to highlight the role of the Ecosystem to support and enable the growth of the PV market in Egypt.

Currently, clean tech startups have made significant headway in growing the PV market in Egypt, with most of the focus being on 'low hanging fruit', early adopters, and demand driven clients. They have faced a relatively uncontested new market place, successfully replicating known business models. Growth has largely been attributed to the large farmer market segment, however medium and small holder farms, representing a significant market opportunity, are untapped. Assuming these startups continue using the same business models and market segment focus on large farms, new firms will enter the market, competition will increase, and the market segment they are operating in will shift from moderate growth / low risk to low growth / high risk as shown in **Figure 37**[49].

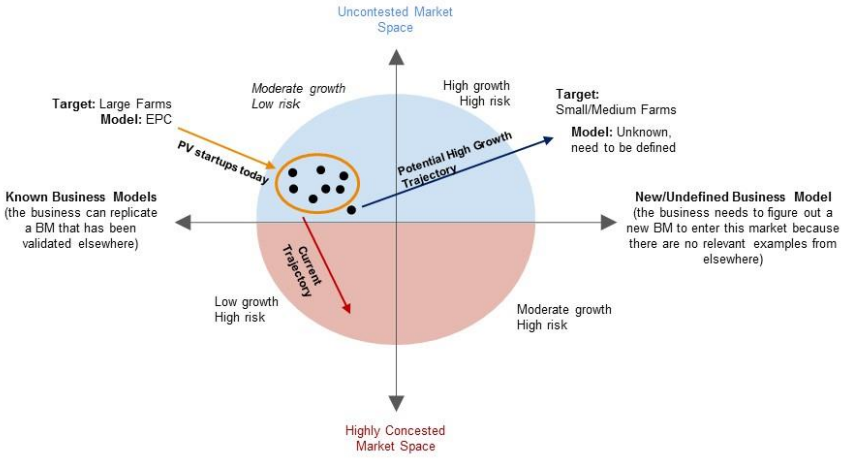


Figure 37 PV farming startups – current and target markets and business models

In order to open up high growth trajectory opportunity, PV startups need to pivot, both in their market segment focus and their business models. As mentioned earlier in the report, small holder farmers represent the main market opportunity for clean tech startups, however they are a challenging market segment to penetrate. Small holder farmers have limited financial means to purchase clean tech products, they lack access to financial products due to their legal status (i.e. informal land tenure). Startups also face challenges when engaging with small holder farmers, due to engrained practices on the farm, geographical diffusion, and logistical challenges related to product distribution/installation and manages multiple small transactions.

[49] Based on Blue Ocean Strategy marketing theory

7.2. A snapshot of the PV entrepreneurship and market ecosystem players and their role in unlocking PV farming market

In order to catalyze the changes needed to grow the PV farming market, it is important to work beyond usual linkages in the entrepreneurship support ecosystem. The following section breaks down the different layers of ecosystem partners from entrepreneurship support to market enablers, and provides a menu of actions to catalyze growth in the PV farming market.

The ecosystem in which the PV startups aim to serve the market constitutes of various types of entities, these can be summarized as:

1. **Startups Support Programs:** entities which aim to support startups by connecting them to resources through the various growth phases (i.e. incubators/accelerators, networks)
    - Clean Tech / social entrepreneurship support
    - General startup support
2. **Financial Support Entities:** entities which aim to financially support startups through the various growth phases
    - Startup Finance (i.e. Angel investors, Seed, VC,)
    - Program Finance (i.e. Donors, CSR)
3. **Value Chain Entities**: entities which engage with the startup and are key part of the startup's business, as a supplier, partner, or service provider.
    - Logistics/Distribution (i.e. firms/startups, service providers, associations, collection centers, suppliers)
    - Integrators: (i.e. technicians, installers, software integrators, manufacturing/customization)
    - Infrastructure: (i.e. payment infrastructure, mobile infrastructure, data connectivity)
4. **Market Enablers**: Entities which have a direct impact, key relationship, or interaction point with the startup's client.
    - Non-farming service providers: (i.e. NGOs providing services / support to the targeted farm)
    - Farming Aggregators: (i.e. Agricultural Directorates, Cooperatives, and medium/larger farmers working with smallholders)
    - Customer finance providers: (i.e. microfinance, leasing, Agriculture Commercial Development Bank/ ACDB)
    - Regulations: (i.e. land title regulation, mobile payment regulation, environmental regulation)

The above key players and their interactions are schematically presented in figure 38:

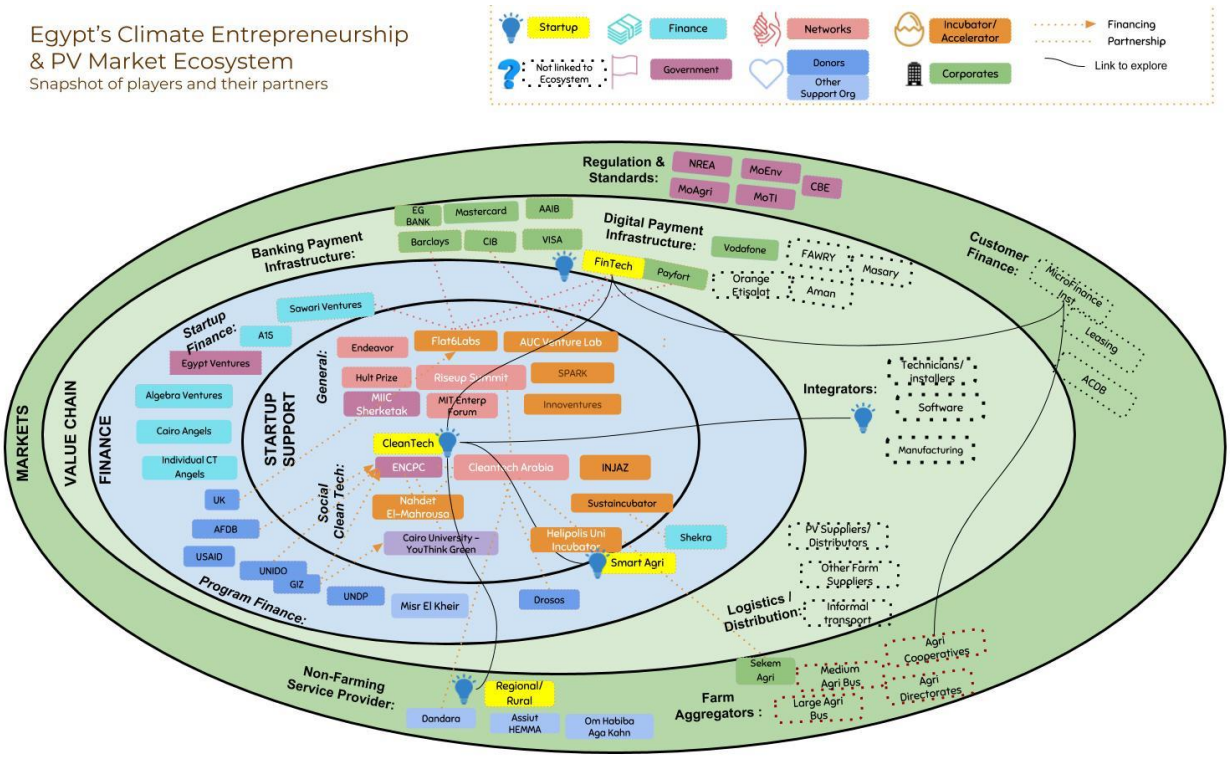


Figure 38 Egypt climate entrepreneurship and PV farming ecosystem

Instinctively, clean tech entrepreneurship programs tend to focus on startup support and financial support programs; however, they often miss the importance of engaging with value chain entities and market enablers.

Each of the above type of entities could benefit from support and can provide support to other players of the ecosystem in order to contribute in the best way possible to PV farming startups and market. However, the objective is not to simply engage with these other entities, it is equality important to understand what to engage them on and how to effectively engage with them?

7.3. Improving the effectiveness of startup support programs

Supporting programs and entities need to focus on tailoring their technical support to encourage not only startup growth, but ways of engaging to help grow the market. This includes new PV applications and business models, leveraging other platforms such as fintech, shared economy, data, and expanding their geographical focus. Startups working in manufacturing system components could also be supported as feeding entities to existing PV firms, which can help tailor products to customer segment needs.

There are limited sector specific incubators/accelerators in Egypt. Egyptian startup support entities are rarely sector focused. Unlike a rising international trend of sector specific support, Egypt incubators/accelerators tend to be generic. Generic incubators increase the pool of opportunities and can

address wider donors and funding entities. Yet, sector focused incubation allows supporting entities to be more effective and tune its offering to the exact needs of the sector of focus. Surveyed startup-support entities (incubators/Accelerators) could be divided into the following categories in terms of focus on renewable energy. The focus on PV farming would narrow the scope extremely since only 3 entities have worked with PV farming startups.

- Core subsector of focus
- Frequently supported (one in each cycle/program or year)
- Occasionally supported (less than in each cycle/program or year)
- Never

Out of 57 mapped startup support entities only 3 had renewable energy as a core sector of support as shown in Figure 39. However, 11 have worked with or supported renewable energy startups. These 11 entities were taken as the current renewable energy startup supporting ecosystem while the rest remain as potential supporter to be brought in the market.

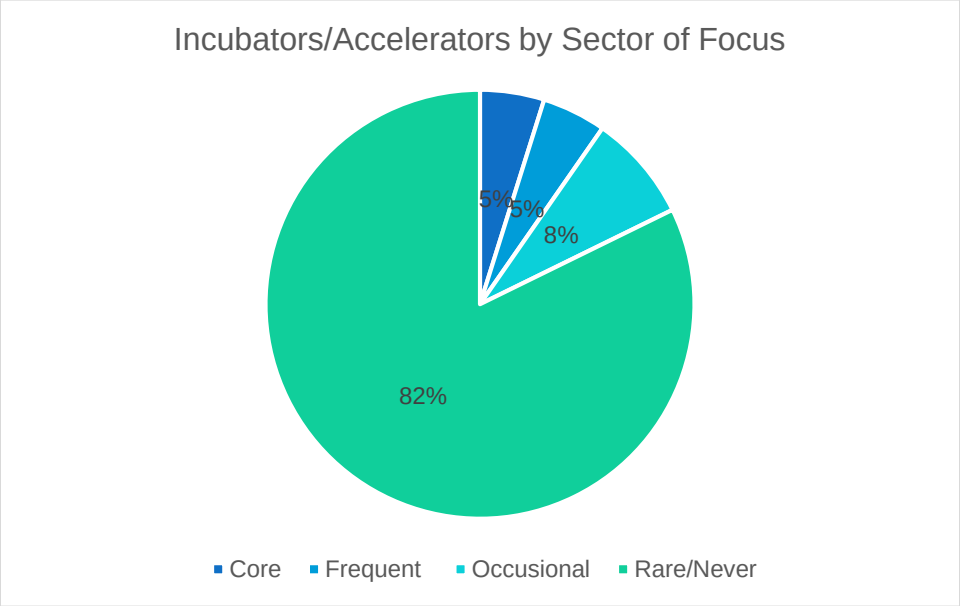


Figure 39: Percentage of incubators/accelerators by focus on renewable energy

In the cleantech sector in general few focused entities exist. In 2013, Egypt first cleantech focused support entity was established, Cleantech Arabia. Follows GESR incubator was established with focus including energy. Most recently, Egypt leading social entrepreneurship support entity, Nahdet Elmahrousa instituted “Green/Clean” as a subsector of focus. PriceWaterHouseCoopers (PWC) CSR program has focus on sustainability and ran in collaboration with GIZ, Cleantech Arabia, and MoTI Egypt first renewable energy focused incubation program.

The need for sector specific support in renewable energy can be deducted from startups stressing on the importance of technical support and consultations in addition to networking targeting suppliers, clients, and similar firms. An incubator/accelerator needs to develop the proper network that can support incubated firms. A sector focused incubator/accelerator can develop such network in a much more effective way and can easily provide a focused technical support. For a generic incubator to be able to provide such support to renewable energy firms it would require extensive resources. Developing the knowledge regarding the sector, its legislative and regulatory details, as well understanding of stakeholders by the incubator/accelerator would increase the success of its incubatees. More sector renewable energy

focused incubators/accelerators would add to the ecosystem. However, existing incubators/accelerators with generic support or supporting other sector can develop programs in collaboration with entities focusing on renewable energy. For instance, a V-Lab Fintech program focusing on renewable energy or Flat6Lab or EBNI program focusing on the intersection ICT and renewable energy would add diversity to the market and encourage new innovative businesses.

7.3.1. Stage of support

Startups needs vary across the life cycle stages of their growth. This include from idea to market (seed), from seed to stability (launch) and from launch to growth. Out of mapped 57 startup support entities, only endeavor has its core focus on growth stage. Cleantech Arabia, in collaboration with GIZ RIBH MENA has delivered the first growth management program for sustainable energy firms. Yet, no other programs have been offered to the sector. Most support programs are moving to focus on firms that recently launched (within their first year of operation) or at piloting stage and also avoid idea stage support particularly in the renewable energy sector. Entities prefer to focus on firms that have just launched or piloted, so market validation is provided.

Growth stage would involve helping startups build advanced management skills as well as strong access to specialized networks of clients and suppliers. This include management consultancy. The network provided to support startup would include access to key suppliers and support in developing business deals with major clients. Highly specialized technical support may be needed; however, this could be provided through linking startups to larger firms or experts. Access to investments and loans would be a major part of support. Firms in growth stage might need to adapt their business model or introduce new technology or enter new market, which means that the support would need to adapt to each firm needs. However, basics of strategic planning and financial management would be commonly needed. As indicated above, scaling up and growth management programs are highly needed for the PV Farming startups.

The GEM 2016 report, note that the Egyptian startup support ecosystem in general needs to gradually move to helping startup grow. Growth in Egypt is challenging where the economy has few medium size companies. In the GIZ growth support program provide effective in helping startups overcome stagnation that is experienced 2-3 years after launch.[50] Increase in idea stage programs and pre-incubation as well as growth programs are highly recommended.

7.3.2. Tailoring sector / technical offering to startups needs

Startups supporting entities in Egypt typically offer

- General business training based on business model canvas
- Mentoring
- Exposure
- Grants

The general business training serves the startups needs well as surveyed startups have received such training and do not express a need to expand it. Grants help idea stage and early stage startups to pilot and test the market. They are highly needed by startups and are well offered by supporting entities. The exposure is achieved effectively by supporting entities through events, social media, and press.

[50] GIZ, and Cleantech Arabia. 2017. “GROWTH MANAGEMENT FOR SUSTAINABLE ENERGY SMALL GROWING BUSINESSES (GM4SESGB) Program The Seed for a Sustainable Energy Cluster in Egypt Planting the Seed for a Sustainable Energy Cluster in Egypt – Final Report.” Unpublished Report. Cairo, Egypt: GIZ.

However, the general effectiveness of the startups support entities in the view of surveyed startups is average (3.5/7). This is mainly due to absence of three key elements which were deemed important by startups (see section 9.1);

- Investment and loans
- Technical training and consultations
- Business networking

A short coming of startup supporting entities in Egypt is related to the absence of partnerships and linkages to the relevant networks. Incubators through their historical development, went through the following three generations

- 1st Generation G1-Infrastrucutre Incubators: Offering office space and general administrative services
- 2nd Generation G2-Business Development Incubators: Offer office space with more focus on developing general business skills
- 3rd Generation G3-Network Incubators: which focus on providing access to networks and sector specific knowledge as well as general business skills

Network incubators, which is the latest generation of incubators, focus less on physical space and provide stronger access to networks. The incubator becomes a connector to resources. All the above shortcomings are partially related to the fact that Egyptian startups supporting entities have not made it yet to the 3rd Generation of incubators, network incubators. Incubators can provide better support to startups by developing connections with technical support entities, key industry associations, and angel investment networks or banks. This of course requires strong level of collaboration which might be a key to development of the cleantech startup support ecosystem.

Startup supporting programs and entities need to offer startup diverse support tools that vary along the startup life time. PV startups particularly might need longer time to launch their products and services. Each startup supporting entity or program would have its strengths and weaknesses. Each entity will have its networks and access to opportunities. Collaboration between entities and programs can offer startups more extended, diverse and thus effective support. Collaboration can take place on varying levels; from simple to complex.

Collaboration in coordination of program so as they may not synchronize and target the same applicants. Sharing plans about geographical expansion and programs focus can avoid crowding the scene in a certain time of the year or geography. Sharing information about runner ups that may find support in a different program could also be beneficial. Sharing information about supported firm that may collaborate in the market.

Parallel support of firms can also be extremely beneficial. Two or more entities can run support program in parallel and provide certain firms with support at the same time. This would mean startup will get more support which is particularly beneficial if offerings of the two entities are complimentary.

Running joint programs can also bring more interdisciplinary themes to the table. Firms at the intersection of energy and agriculture could be focused upon for instance. Or in other cases energy and fintech for example. The intersection of energy and ICT is also of key importance to various market applications.

Series support can ensure startups join consecutive programs where each address a stage of the firm progress. In case startups needs longer support, coordination can ensure they receive such extended support through coordination.

The key barriers to collaboration mentioned by interviewed entities are in Figure 40. The top two are lack of alignment and planning of activities and competition. Barrier to collaboration are put forth in the present report so entities may work on resolving them. There are cases of collaboration in the sector that may be replicated and expanded. This include, Cleantech Arabia collaboration with PWC, HU, NM, and GESR in running full programs both in parallel or series. It also includes collaborations between GESR and NM, NM and V-Lab.

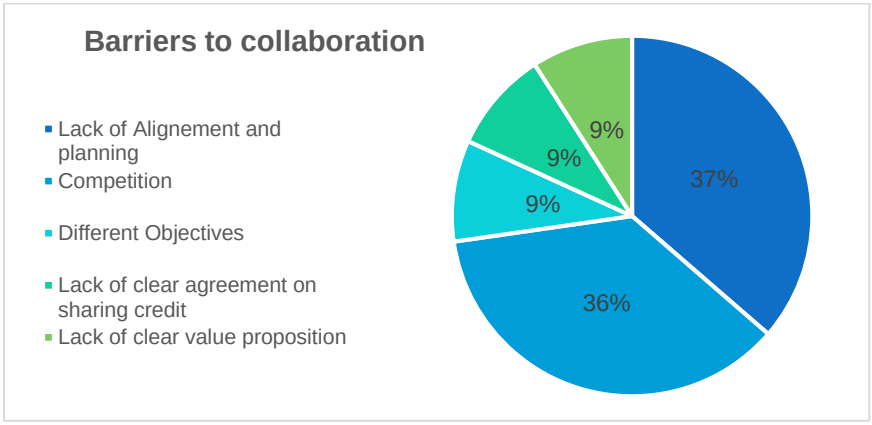


Figure 40 Barriers to collaboration mentioned by 11 supporting entities of renewable energy startups

7.4. Improving the effectiveness of finance support programs

When asked of the type of support needed, most solar firms answered investment, loans, and grants. This is not unusual. However, it is important to consider why the finance is being requested by solar startups. In most cases the objective of the startup is not to finance assets belonging to the startup, but rather to provide finance to their customers. Figure 41 breaks down the needs expressed by 20 PV startups interviewed.

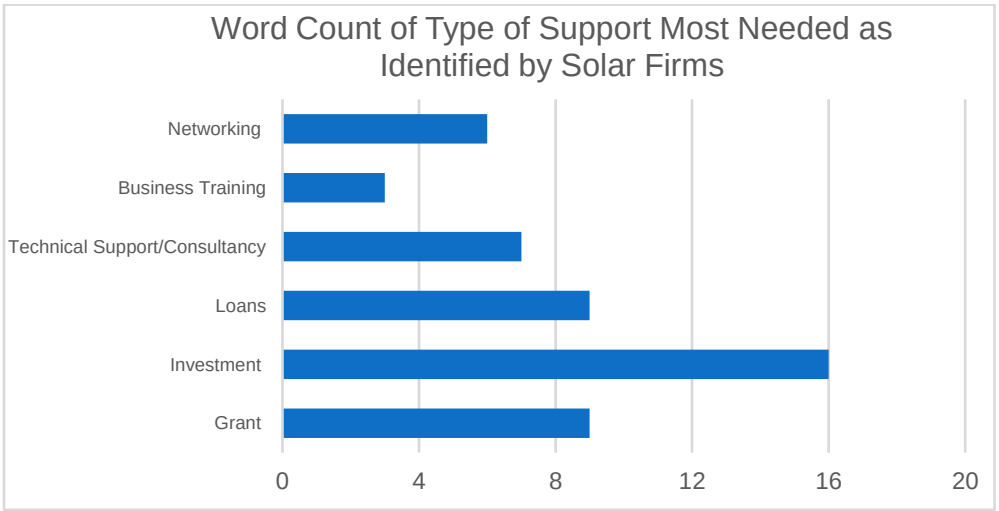


Figure 41: Type of support most needed as identified by PV startups

When the startups were asked about the aspects they need support with the most, investment and access to debt finance for their customers were a priority. Financial institutions which provide loans, generally showed intermediate to high interest in supporting the sector – see Figure 42. While they work with these small growing businesses once they have a proven track record, assets, and customer base, barriers continue to exist.

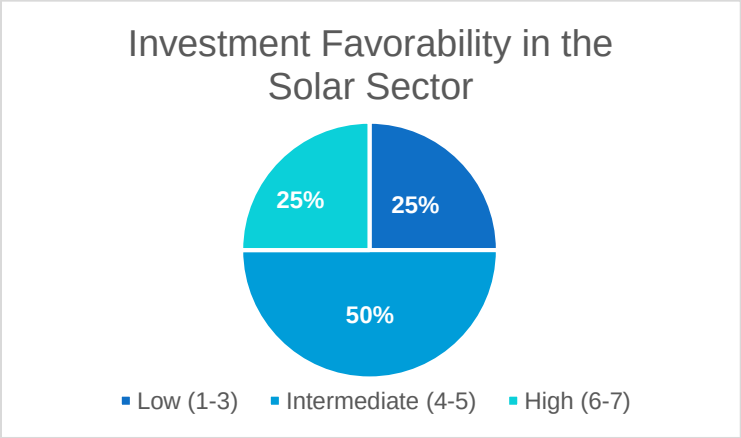


Figure 42: Financial institutions interest in financing the PV farming sector

Startup supporting entities need to engage with investors and financial institutions as a key stakeholder, and not simply as financiers. For instance, Cleantech Arabia engages its investors before the launch of programs and are strongly informed with the startup progress through the 1-year long program before investments are discussed. Most recently, UNIDO started providing support to banks in financing startups supported by the IMKAN program in Luxor through providing them with prefeasibility models as well as technical assistance in evaluating loan applications, this led to loans facilitated through the bank. The results of this remains to be assessed on a wider scale. Technical support and consultations can involve support in detailed technical aspects or market knowledge. This can only be provided by experts. Supporting entities can spare part of the program cost to hire such experts or achieve this by building partnerships with Universities and large firms which may provide such support. Business networking is crucial for firms to grow. This requires the supporting entities to have strong connection to market players (PV firms, suppliers, clients) and enablers. The linkages and interactions of the PV farming support entities are shown in Figure 43.

Financial institutions and non-clean tech angel investors are interested in the sector but expressed the need for trusted access to information, knowledge and financial vehicles based on risk sharing to encourage their engagement. Startup support programs, but also donors, can play an important role to build partnerships with these financial stakeholders to enable access to this information. International donors, industry associations (FEI, SEDA, etc.), public institutions (NREA, ENCPC, etc.) can also play an important role in sharing relevant data which are key for startups to identify the market opportunity, but also for financiers to measure the risk/opportunity of their investments. Donors and government can encourage the development of special finance vehicles to reduce risk and increase investment in the sector.

Financing Entities - Support Needed

- Information and knowledge to be offered potentially by
  - International donors, public sector (NREA, ENCPC, etc.), startups support programs and entities, associations (FEI, SEDA, etc.)
- Development of special finance vehicles for PV systems potentially by
  - International donors, government
- PV startups to have better cash flow management

Financing Entities Support to be Offered

- Invest in employees' capacity building and training in financial modeling of PV systems
- Invest time in developing benchmark cases with PV startups to finance their clients
- Start viewing finance of PV as a finance of a productive asset rather than a consumer product
- Develop partnerships with governmental institutions in create funds and schemes to support PV system finance
- Integrate PV finance within their agrisector finance portfolio

The Social Fund for Development's investment in Karm Solar, had a high learning curve, however in turn built its capacity for future PV investment. Financial institutions willing to expand in the sector can learn from the experience of their counterparts. Financial institutions can play an important role in sharing their experience with each other in order to improve confidence and investment decision making process in the sector.

Angel investors are interested in PV, however lack technical know-how, market data, and benchmarks to increase confidence. Angel investors in Egypt are limited in number.[51] Cairo Angles is the main formal angel investment network in the country that recently was join by Alex Angels. Cairo Angles has expressed a general interest in PV firms among other startups they support. Cleantech Arabia, the main clean technology support entity in Egypt, has a small network of angel investors that is highly focused on renewable energy investment and waste management. PV startups have higher satisfaction with angel investors than with financial institutions at a score of 4/7 compared 2/7 for financial institutions. Startups find it difficult to be assessed within a pool of other startups particularly in the ICT sector and creative industries. Angel investors realize the importance of the PV sector, however, similar to the challenge faced by commercial banks.[52] Angel investors also require further information and technical support to be able to assess investments in the sector. The absence of published industry standards and market data provides a challenge for angel investors. Cleantech Arabia, provides its investors with expert analysis and technical validation of startups investment decks which has increased investments in the clean technology sector in general Startups support entities and programs should provide angel investors with knowledge related to

Angel Investors Required Support

- Startups support programs and entities should invest in making information available to angel investors with regards to industry standards and the sector
- Availability of market data is key for angel investors to mitigate risk in investing in the sector
- Angel investors in Egypt are well aware of the potential of the PV sector

[51] Global Entrepreneurship Monitor, Egypt National Report, 2016
[52] Enhancing Youth Employability and Local Economic Development in Upper Egypt, UNIDO, 2014

the sector to increase angel investments. Startup support program and entities need to document the performance of their supported firms so as they grow industry investment standards can be slowly developed. VCs showed little interest in the PV sector mostly because few firms have demonstrated the ability grow exponentially to the size that interests' VCs in Egypt. Continued success of PV firms will likely slowly draw more investments to the sector.

7.5. Improving the effectiveness of value chain collaboration

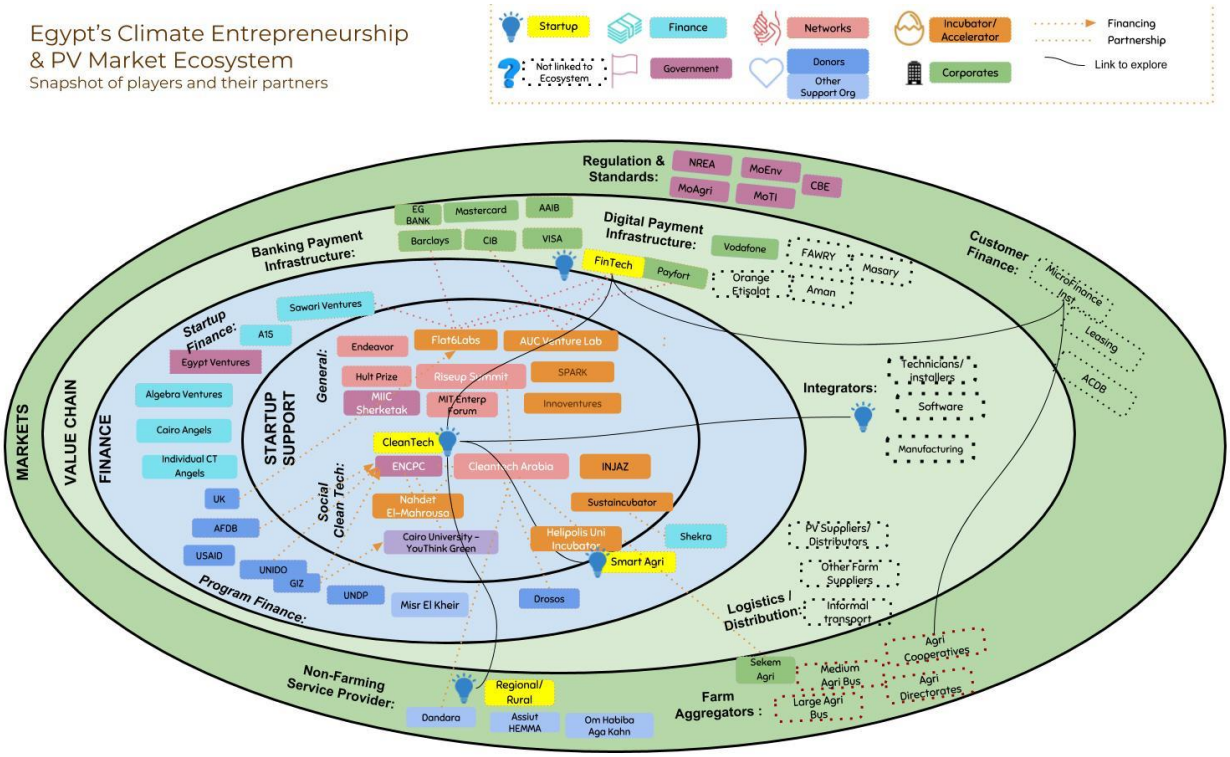


Figure 43: Startup supporting entities interactions and access to stakeholders

Value Chain Entities: entities which engage with the startup and are key part of the startup's business, as a supplier, partner, or service provider.

- Logistics/Distribution (i.e. firms/startups, service providers, associations, collection centers)
- Integrators: (i.e. technicians, installers, software integrators, manufacturing/customization)
- Infrastructure: (i.e. Banking payment infrastructure, Digital/mobile infrastructure, data connectivity)

7.5.1. Widening the geographical scope

Out of 11 interviewed incubators/accelerators with interest in supporting renewable energy sector 80% are based in Cairo and mainly support Cairo-based startups. Even though, all the entities in Cairo are open to receiving applicants nationwide and not necessarily exclusively from Cairo, there continues to be a huge gap between the number of startups supported from Cairo and Alexandria versus the rest of the nation. Those surveyed entities who were able to provide information on where the start-ups they worked with came from, the average percentage of start-ups from Cairo is 74% of all supported start-ups. It increases to 86% when adding start-ups based in Alexandria. While the entrepreneurship support system in Egypt in highly centralized in Cairo, there are few exceptions and changes in the making. The major problem with centralization goes beyond geographical location of the incubator resulting in centralized communication and outreach. Most incubation programs outreach is focused on Cairo and in many cases they reach only a niche of applicants within Cairo. Thus, even if programs are willing to accommodate startups from outside Cairo, startups are required to relocate to Cairo to receive the support in most cases. With the PV farming scope where the market is outside Cairo, startups have limited chances of receiving support.

Geographical diversity and the ecosystem's expansion outside of Cairo: Few entities have a focus outside Greater Cairo Area (GCA), Cleantech Arabia has 60% of its supported firms outside GCA, Hemma incubator in Assiut focus on firms from Assiut. There are a few recently established incubators with the mandate of focusing outside GCA and with interested in the Clean Technology Sector. The recently established Dandara Center Entrepreneurship support programs in collaboration with Cleantech Arabia and UNIDO, is focusing on Qena and Luxor and eventually Upper Egypt. Heliopolis University Entrepreneurship Center for Sustainable development which is established with support from Cleantech Arabia and USAID intends to focus on GCA but also Sharqia. Nahdet Elmahrousa, has clean technology support program focusing on the city of Suez. UNIDO has been running entrepreneurship support programs in Sohag, Qena, Luxor, and Aswan since 2014 most which included renewable energy. GIZ has also focused on Sohag. ILO has plans to focus on Menya and Luxor. All such programs have focus on PV farming. In PV farming, and clean technology in general, supporting entities should extend their support outside Cairo. This does not have to include geographical expansion, but it simply could include providing travel grants or extending support of the startup local. It is also beneficial to the sector that more incubators/accelerators are established outside Cairo. This will provide reach to wider innovation pool and serve startups close to their clients.

7.5.2. Engaging in non-clean tech sectors

Entrepreneurship programs should seek to engage with non-clean tech sector startups, in particularly those startups or firms which need to be integrated into the clean tech startups business model. As identified earlier in the report, the ability to customize products to meet customer needs is important for the further development of niche market segments. Whether they are manufacturing design workshops, or IT / programming solutions, programs should seek to further cultivate business to business relationships as they are a key part of the produce/service value chain. As well, linking Cairo based to rural / customer facing startups proves important to improve market access and tech transfer. A natural starting point for clean tech program is to engage with smart-agri focused support program in order to link into the knowledge and networks they have with relevant agri stakeholders. Similarly, in order to engage with the various digital/mobile technology payment infrastructure platforms which exist, support programs can engage directly with fintech startups or they support entities. Accordingly, clean tech entrepreneurship programs may choose to include in their programs non-clean tech firms which are related

to the value chain which PV startups operate in. This can go beyond business to business matchmaking goals, but rather can serve build a more structured value chain, but also a multi-sectoral approach can help develop a unique value proposition / business model to unlock niche segments – see Figure 44.

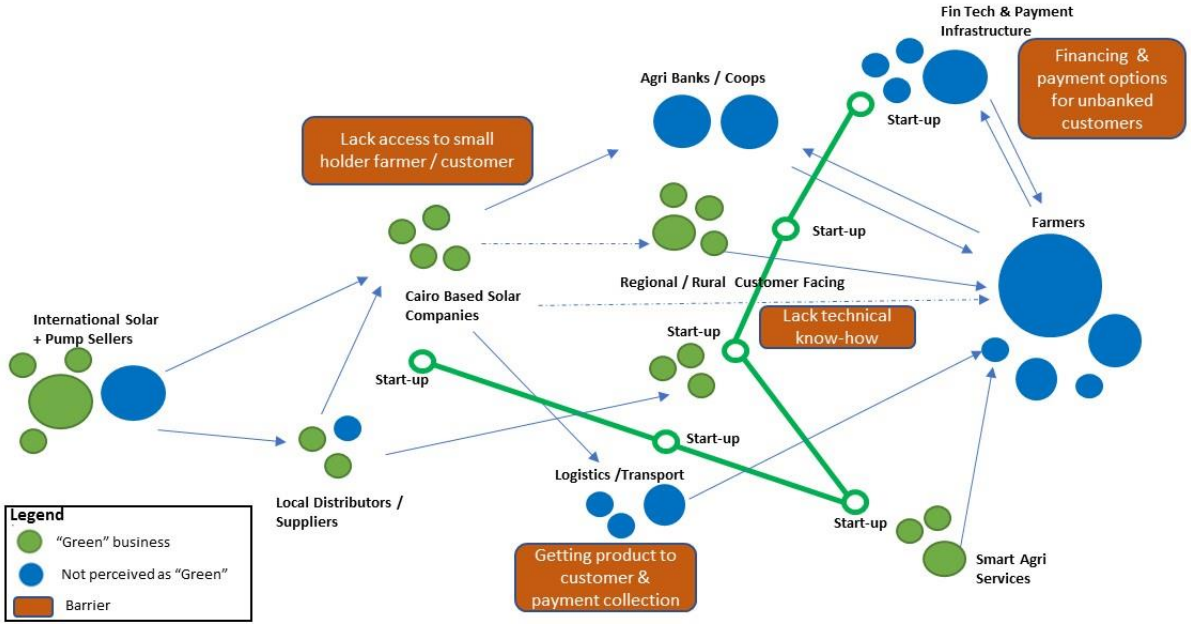


Figure 44 Value chain challenges and potential development

Engaging with payment or banking infrastructure entities through innovation programs
Mainstreaming fintech solutions for clean tech applications has proven successful for the pay-as-you-go model developed by M-Kopa. In order for both fin-tech and clean tech to have access to similar opportunities, they need to engage with a key value chain entity, the payment or banking infrastructure 'owner'. Entities such as Fawry, Orange Wallet, Banks looking to expand into the unbanked market are interested in benefiting for the innovative mindset and drive of entrepreneurs. However, the model to engage with them is not always clear. CIB and Barclays have setup FinTech programs with AUC Vlab and Flat6labs over the past few years which has help catalyze the Fintech sector in Egypt. Engaging with these entities would require a 'trusted' counterpart which can engage with multiple startups and structure a program which both caters to the payment infrastructure's needs as well as the startups needs. Payment infrastructure entities would have to provide their application program interface (API) and other relevant data which can help the entrepreneur develop their business model (i.e. Farwy POS terminal locations/density, type of mobile use SMS, Smartphone etc.) – see Figure 45.

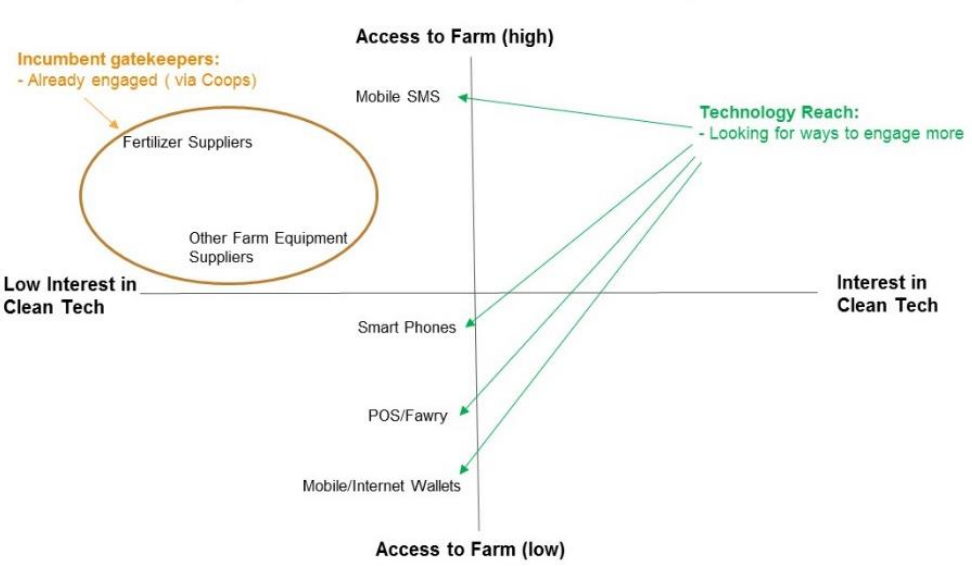


Figure 45 Value chain infrastructure and access to farms

Startup Support programs may find it initially difficult to engage with incumbent value chain and market level enablers – distinguishing between passive and active engagement. However, they should consider some key criteria, interest in the clean tech sector, access to the customer segment (i.e. farmers), and existing entry points. The figure above demonstrates that while incumbent players such as Cooperatives not only have high access to farmers, but also play a role in influencing fertilizer supplier and other equipment providers. While they would be a strong link in the value chain, they would most likely be 'passive engagers' as they are less likely to engaging time/resources in the clean technology startups and initiatives. On the other hand, mobile payment or fintech companies also have varying access to farms through their platforms. For instance, mobile SMS is prevalent throughout Egypt including agricultural communities, similarly Fawry POS terminal with 65,000 terminals in 300 cities across Egypt, whereas smart phone penetration in agricultural communities and use of credit cards is less prevalent. However, these entities are more likely to be 'active engagers' as they are seeking ways to engage/transact more with their potential customers, and have seen models which combine Cleantech and Fintech, such as M-Kopa, succeed abroad.

7.6. Market Enablers

Market enablers have a key role in supporting PV farming startups to flourish and to increase the uptake of PV in farming in general. This role can be played to achieve direct benefit for the market enabler, but it could also take place to achieve the mandate of the entity. There are various groups of market enablers including those from the agriculture sector and non-agriculture sectors.

Market Enablers: Entities which have a direct impact, key relationship, or interaction point with the startup's client.

- Non-farming service providers: (i.e. NGOs providing services / support to the targeted farm)

- Farming Aggregators: (i.e. Agricultural Directorates, Cooperatives, and medium/larger farmers working with smallholders)
- Customer finance providers: (i.e. microfinance, leasing, Agriculture Commercial Development Bank/ ACDB)
- Regulations: (i.e. land title regulation, mobile payment regulation, environmental regulation)

Policy Making and Market Regulations: Generally, the PV farming market does not require the introduction of transformative policies or regulations, barriers tend to be on a behavioral change level rather than a regulatory level. However, NREA has a key role in developing the renewable energy sector. NREA's is focused on the on-grid market as the off-grid market would not clearly in directly fall within its mandate. However, a key role it can play is to extend their current certification of PV firms to those operating in off-grid. Training and certification of engineers and technicians is important for the quality control PV sector in general, but should not act as a barrier of entry for new startups. A key regulatory barrier mentioned in the interviews were related to land tenure. A significant amount of agriculture land is not formally owned and thus farmers cannot access loans and in continuous risk of land being confiscated. This limits their capacity to take risk. However, land reform in this sector is unlikely to change, and clean tech needs are not expected to catalyze these reforms.

When evaluating how to engage with players who are not traditionally involved in the entrepreneurship or clean tech sector, it is important to evaluate not only their potential role, but also the level of interest /willingness to engage in clean tech related initiatives. The following diagram looks at various market players and their level of influence at the farm compared to their interest in clean tech. It is important to note that while the figure for example indicate that's most Cooperatives have limited interest in cleantech, there are varying degrees of interest. For instance, it is not necessary to convince all cooperatives to engage, but rather finding one or two cooperatives in a relevant geographical location to carry out a demonstration project, share information, or engage at another level would be impactful. Accordingly, the following figure aims to map out the likelihood of key stakeholder actively or passively engaging with clean tech startup market objectives.

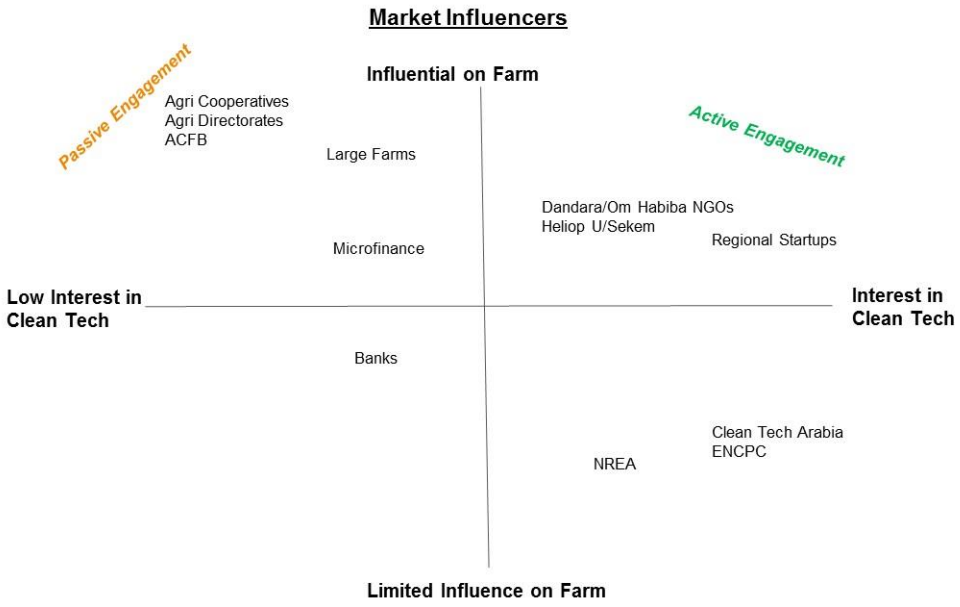


Figure 46 Stakeholders influence versus interest in PV farming market

7.6.1. Engaging customer gatekeepers with limited interest in cleantech

Agriculture directorates can play an important role in increasing awareness on the farm, providing startups with access to niche customer segments. Agriculture directorates play an important role in communicating to and increasing the awareness of farmers. Agriculture directorates are supposed to provide farmers with knowledge and information related to the farming process. Their offices are spread across the country and they are already in strong contact with and interaction with farmers. They interact the most with small farmers to inform them with types of crops that are recommended for farming and also details of purchases organized by the government if any. The directorate can play a key role of main streaming of PV technology by providing information related to PV applications and its benefits to farmers. Furthermore, the directorates often own equipment that are rented out and shared by farmers. Few demo cases of shared pumping systems for instances would help further increase the farmer's awareness and familiarity with the technology. However, as indicated in the table above, actively engaging with them will be challenging.

Microfinance institutions, NGOs, and Agriculture Cooperatives in enabling finance and providing market access. Both entities serve groups of small and small to medium farmers to increase their profits and competitiveness. They are a key market enabler, given the various roles they can play and their proximity to customers as well as the customers trust in them. These entities can play an important role in finance of PV applications. In many cases both entities provide finance and act as an intermediary between bank and the farmers. They particularly excel in facilitating loans for small farmers and ones that are not credit worthy and many cases are not bankable. In this case, they serve as the intermediary to manage credit provided to them by banks. They are capable of managing risk, that banks would not be willing to, due to their knowledge of the farmer and physical proximity to them. In addition, both entities can help in main streaming awareness of PV systems. NGOs, and Coops typically also provide training and capacity

building on certain technologies or methods and crops. Integrating basic awareness about PV systems will heavily contribute to the mainstreaming of PV awareness with various farmers. In many cases Cooperatives and NGOs also, own equipment for rental and sharing among farmers.

Agriculture Credit and Development Bank (ACDB) provides finance to farmers without following typical bank due diligence or loan requirement and credit assessment. It does so for agriculture equipment and raw material including fertilizers for instance. The bank has a social mission to support the agriculture welfare particularly for small farmers. Intervention from could help to start including PV applications among the high priority financed products. The bank is commonly used to finance limited set of traditional products, mainstreaming of PV applications will require coordinating policy intervention as well as training to staff in the ACDB. The key difference of the ACDB and other banks is that it is by mandate willing to accept high risks of lending small farmers and it does not operate at commercial lending rates. It is also generally open to rescheduling payments and providing soft default plans that does not include seizure of assets or more aggressive measures.

7.6.2. Engaging in mutually beneficial market partnerships

Connecting Fintech startups to market enablers can increase access to farmers. Some fintech startups, such as PayMob are already seeking partnerships with microfinance institutions, as they see an opportunity to provide their services to reduce the transaction costs associated with the microfinance institutions managing a multitude small loans and over several payment periods. Fintech can help reduce the transaction costs involved but also provide data which will help the microfinance institution better manage its operations. However, the opportunity should not end there, clean tech and fintech connections are important to further develop the foundation which these transactions are built.

The role of Cleantech as a Fintech 'killer app'. An important element of the M-Kopa model was that for customers who did not pay for their service, the lender (in this case M-Kopa) used machine-to-machine technology to shut down the functionality of the PV panel. Perhaps more importantly, once the PV panel was fully payed off by the customer, M-Kopa began to provide financing using the same model for other products (i.e. radios, mobile phones, TVs). M-Kopa was able to do so, because the customer built a credit history, but also the machine-to-machine technology enabled M-Kopa to suspend PV service for customers who did not pay on time. Fostering these cleantech and fintech partnerships is an important element of stimulating new business models and the necessary innovations to grow the market and penetrate niche market segments.

8. Sector Review & Recommendations

As demonstrated in the previous chapters, the market opportunity for replace diesel with solar PV applications is significant, and remains largely untapped. For the market to continue to grow and scale rapidly, the following recommendations need to be considered. The recommendations are diverse and address various gaps in the market. They can be taken on for implementation by various entities but ultimately, they all contribute unlocking the solar PV market in the agriculture sector.

The following is a SWOT analysis of the sector from the perspective of the startups. In this table, strengths represent the achievements of solar startups today, the weaknesses, is what their business models should aim to address. The opportunities, is what should be the startups should focus on in the long-term. Threats, is what firms should advocate for and policy makers should strive to address.

Table 5.

Table 5: Sector SWOT

Strengths • Agile fast-growing firms that are able to bring new business models • Rapid financial growth that attracts investors interest • Strong and diverse customer base • Evolving technical know how • Strong access to international market • Diverse business models and geographical reach • Healthy market structure in terms of strong base of middle size firms • Success cases in local manufacturing • Reasonable level of collaboration	**Weakness** • Absence of strategic planning for growth • Organizational structure reactive and relies heavily on founders • Weak interaction along the value chain with key type of startups that are complimentary • The work environment – whether due to mobility issues or cultural barriers – women entrepreneurs find it difficult to work on site • Limited formal quality control and assurance
Opportunities • Emerging market that has proven itself for investors and customers • High IRR Perception – due to forecasted increase of fuel and electricity prices. • Addressing a national high priority at the intersection of energy sustainability and food security • Market Demand, especially in off-grid locations is increasing due to increase in desert farming • Large available market size • Rapid removal of subsidies which the market has understood and reacting to • Continuous decrease in PV pricing and increase in alternatives • Capacity to meet various client's needs, for ease of operation, to energy security, sustainability and savings	**Threats** • Lack of certification system and accreditation of the off-grid PV market • Presence of low quality • Land ownership complications • Hesitation of financial sector • Low awareness of PV technology at few market players and customers • Reliance on important equipment which creates a FX risk • Penetration of mobile payment and fintech solutions, and related regulatory challenges preventing further innovation.

Business as usual will not transform this market, new innovative business models targeting the needs and challenges of the small and mediums size farmers are key to unlocking solar PV's potential in Egypt: The PV application in agriculture is a rapid evolving market with significant opportunities for growth and impact. The growth of this sector thus far has been championed by startups; young firms who have been operating for the past 2-6 years. Their agility and innovation has captured initial market opportunities, namely in the large farm market segment, opened by rapid removal of subsidies, volatility of energy suppliers and opening of the Egyptian energy market to the private sector following rapid governmental reforms. However, more resources are needed to support these innovative startups to enable them to develop business and financial models needed to mainstream PV solar applications in the small and medium size farming segment.

Designing programs focused on understanding customer needs and customer-oriented business case is key. Support programs need to take into account the geographical location of the farm and the key attributes of this customer segment. For instance, whether the farm is off-grid or on-grid, or the size and activity of the farm has a significant impact on the different business opportunities. The business offering to a thirty Feddan farm differs from that of half a Feddan in terms of centralization or decentralization of applications. In addition, the type of activity and economic profile of the farm has implications on the cash-flow alternatives for the farm owners according to season of harvest or even cattle market purchases. Ultimately, creating an open space and trust has given to startups in order to enable them to design customer centric business models capable of transforming markets.

Designing programs which leverage a cross sectoral, institution, and startup approach are needed to unlock market potential. It is important to take into consideration the value that can be created by exposing startups to other startups in related fields (i.e. fintech, big-data etc), exposing them to global business models which they can adapt, as well as exposing and linking startups to institutions (i.e. microfinance institutions, banks, cooperatives etc.). Cross-disciplinary approaches create opportunities for new business models and solutions to be developed leveraging strengths and skills to solve complex challenges. In addition, it is important to note that startups can also contribute to existing institutions such as microfinance providers and banks, by acting as sources of internal innovation. The value of convening and supporting these various groups, building a common vision, and level of trust amongst each other is an important design element of a future support program.

How can these opportunities be realized?

1. **Supporting business model innovation and adoption**

1.1. **Innovative and localized business models are needed to meet diverse client needs.** Startups need to develop business models that can meet the unique needs of their clients, this need is emphasized for small and medium off-grid farmers. For example, farmer needs can range from ease of utilization, avoiding distribution network cost, energy security, ease of payment, risk reduction, to financial saving. Accordingly, successful business models could involve innovative financial solutions but also rely on system sharing business models to address low utilization rates of small farmers. For these types of solutions to be developed is likely to require multi sectoral/disciplinary approaches (i.e. cleantech with fintech) and could require working with multiple startups towards a single objective.

Who? General startup support entities (incubators/accelerators) focused on fostering business model innovation.

How? Encouraging the ecosystem to link clean tech incubation and acceleration programs to existing fintech, smart-agri, or other programs. This can be achieved by supporting jointly designed programs, joint cohorts, rotational programs where respective startups can have access to respective training opportunities and resources provided in the ecosystem. Another approach could encourage incubators / accelerators to adjust support models from directly supporting one startup, to instead support multiple startups together to achieve a market objective.

1.2. **Connecting startups to relevant PV applications, business models, and technologies through matchmaking programs.** PV applications can provide more than a source of energy, for instance many customer segments rely on PV for ease of utilization, not simply as an energy source. There are limited PV applications in the Egyptian market, mainly lighting, pumping, and general electricity use. Other applications in desalination, powering handheld devices, pesticide sprayers, pest control devices could have strong potential in Egypt. However, many startups are not aware of the other technologies or applications which exist, or they do not have easy access to them in Egypt. Exposing startups to global business models and technologies can increase the business opportunities for startups and increase PV adoption rates in agriculture communities.

Who? Local clean tech incubators/accelerators with global incubators/accelerators, networks, or platforms (north-south and south-south) to expose Egyptian startups to the available technologies and business model applications.

How? Filling the knowledge gaps in the ecosystem by linking to global networks. This can be done by leveraging the World Bank Group's Climate Technology Program, UNIDO's Clean Tech Innovation Program, Shell Foundation, and other global knowledge hubs and networks. By using matchmaking programs and widening the reach of the local ecosystem players, Egyptian startups will have better exposure and access to the latest technologies and business models to adapt and develop locally. In addition, by improving the linkages between ecosystem players and R&D in universities it could also serve as a channel to open opportunities for startups and help commercialize relevant research.

2. **Supporting innovative financial and payment solutions**

To expand market penetration to the small and medium size farmer market segments, improved access to finance and payment solutions are needed. Innovative financing models are needed to address the upfront capital expenditure for PV applications, while digital payment solutions are needed to address the multiple transactions and distributed nature of farms throughout Egypt. It is important to note, that there are many challenges faced in this segment are due to legacy issues such as lack of land tenure. It is not anticipated that titling issues would be addressed, rather they should be taken into consideration

as a barrier, and furthermore this exemplifies the need for developing innovative financial solutions.

2.1. **Fin-tech and mobile payments.** The inclusion of fintech startups or infrastructure as an intermediary either between the PV startup and farmers or between intermediaries and farmer would decrease transaction cost, allow for managing larger portfolio of clients, facilitate collection fees, enable sharing models, and provide alternative methods to measure credit risk based on digital data.
Who? Fintech startups and PV startups. Incubators/accelerators should support the development of the business models through co-supported programs. Fintech infrastructure providers such as Fawry, Masary, Aman, and the telecom companies would have a key role in sharing data, providing access to their technologies / platforms, and providing support to startup programs.
How? Design acceleration programs in coordination with financial infrastructure providers aimed at a specific market challenge or opportunity. The financial infrastructure providers would be encouraged to actively provide startups with support on how to use their platforms, share data (i.e. mobile penetration / usage in the market segment targeted), and provide seed financing for promising business models.

2.2. **Inclusion of intermediaries and leveraging existing finance systems.** The agriculture sector has various intermediaries that finance small farmers through banks. These include NGOs and Cooperatives. There is potential demand to include PV systems among standard products financed for farmers. Relevant ministries should raise awareness regarding PV applications with these intermediaries and identify barriers for extending financing.
Who? Ministry of agriculture, ACDB, ministry of irrigation and water resources, ENCPC, NREA.
How? Knowledge dissemination and engaging, with agencies and NGOs articulating the opportunity for PV systems in agriculture and how existing financing systems can be adapted to include PV systems.

2.3. **Policy interventions and credit guarantee schemes.** There are merits to review the lending limits placed on microfinance institutions with the objective of enhancing their ability to engage with farmers. In addition, government and donors should consider the possibility of developing innovative finance vehicles based on guarantees to address information asymmetries and perceptions of risk.
Who? MIIC, other ministries, central bank, international donors, and financial organizations.
How? Diagnostic assessment and stakeholder engagement to determine if, or how, lending limits or other factors, are impacting microfinance institutions ability to engage with farmers, and if policy or other interventions are required. Review of international experience in de-risking the financing of similar technologies and customers through credit guarantee schemes which provide lenders with third-party credit risk mitigation.

3. Data to achieve market impact

3.1. **Developing market data.** Availability of data such as market size, energy use, mobile penetration, at the geographic and customer segment levels would help startups identify opportunities and design better business models. As well, it would help angel investors, banks, and other financiers better understand, evaluate, and have confidence in the market opportunity.
Who? NREA, ENCPC, accelerators/incubators, ministries, governorates, think tanks, donors.
How? Intermediaries should engage with the startups they support to gather and aggregate startup market data requirements and other needs. Ministries and agencies should be

encouraged to engage with intermediaries, to understand startup needs, and provide access to market data and other resources to support them. Data can be disseminated in the form of detailed market intelligence reports, white papers, quarterly or annual data dashboards on agency websites etc.

3.2. **Accessing market data.** Information asymmetries prevent the sector from reaching its potential. For example, a key limitation to access to finance in the sector is perceived risk, sharing data and knowledge is key to managing this perception. This can be done by sharing widely government data on the sector, including diesel consumption data at a village, district or municipality level, sharing mobile usage and penetration data, developing project briefs with benchmark financials targeting banks, encouraging PV startups to share data regarding their projects, services, and findings.
Who? NREA, ENCPC, accelerators/incubators, ministries, governorates, international organizations and donor agencies.
How? Intermediaries should engage with the startups they support to gather and aggregate startup market data requirements and other needs. Ministries and agencies should be encouraged to engage with intermediaries, to understand startup needs, and provide access to market data and other resources to support them. Startups should be encouraged to share data through existing peer-to-peer networks and online platforms, such as the Solar Data Platform *https://solardataegypt.info/* developed by the American University in Cairo. Online platforms can be effective tools to allow entrepreneurs in Egypt's lagging regions to access data and engage with their peers and value chain players.

4. Addressing quality and customer perception risks

4.1. **PV startups need to address perceived and real quality risk by their customers.** Startups should be encouraged to build their business models around eliminating the perception/risk of low quality by their customers.
Who? Clean tech startup support entities (incubators/accelerators).
How? Startup support entities to include in their programs how to develop integrated models which include PV installation and maintenance support, emphasizing the risk which low quality products have had on market development through similar cases in Egypt. Intermediaries can also share with startups how business models in other countries have been developed to de-risk customer use of new technology (i.e. pay-as-you-go models).

4.2. **Addressing market risk of low quality PV installations.** The risk poor practices in design and installation and low-quality products have on the market as a whole is significant. When PV startups install low quality PV systems which fail to work, this has an impact on the perception of PV quality as word of mouth spreads quickly in communities. PV startups or a group of startups can self-regulate and establish agreed upon quality control and monitoring systems. This is important to ensure growth can a positive demonstration effect increasing customers confidence in the PV technologies rather than negatively affect it.
Who? NREA, Egyptian Organization for Standards & Quality(EOS), and other related agencies.
How? NREA, EOS, in close cooperation with PV startups and companies, should assess the merits of developing PV and inverter quality and installation guidelines, firm certification schemes similar to what has been done for the feed-in-tariff, and the phasing in of standards on PV systems as

needed. Note, firm certification schemes should not act as a barrier to firm entry, but rather help inform potential customers.

4.3. **Off-grid PV firm certification and certification of engineers and technicians.** Startups are operating in many remote areas to reach their customers and are highly dependent on outsourcing engineers and technicians to carry out installation and maintenance work. Developing training and certification program could reduce risk and resources needed to identify and employ capable technicians or engineers while improving quality of service provision in the market.
Who? Universities, vocational programs, private entities, NREA, and PV associations or training centers.
How? Initiate a review of the expected skills requirements of PV firms, as well as the anticipated geographical location of those needs, as it is anticipated the growth of this sector will largely be in rural regions, in particular in Upper Egypt. Existing programs need to be refined or redesigned to meet identified market needs. Leverage existing platforms to help connect job seekers with emerging job opportunities in the sector.

5. Value Chain Development

5.1. **Supporting startup integration in the value chain with incumbent companies and other rural based startups.** Startups can benefit significantly by linking to established companies in the value chain, such as logistics providers, leasing companies, and farming equipment providers. Creating these linkages is important to provide startups with market access. In addition, there is value to be unlocked by linking Cairo-based startups to their counterparts based in the rural areas and bring complementary skills and networks to each other. Cairo based startups tend to have the best access to the Cairo centric support ecosystem and technical knowledge, while rural based startups have strong access to the customer and local value chain networks.
Who? Startup support entities (incubators/accelerators) and NGOs operating in Cairo and rural areas, by working together linking respective startups and designing joint programs.
How? Joint programs or competitions between incumbent companies and incubators and accelerators targeting a specific value chain objective (i.e. linking startups to equipment logistics companies). The ecosystem has carried out previous joint programs with large corporates, however the emphasis in this case would be to achieve a value chain objective and bringing in a relevant incumbent company (not necessarily a large corporate). In addition, encouraging Cairo based support programs to engage with rural based NGOs with similar objectives or target markets could provide significant value to both Cairo based and rural based startups.

5.2. **Localization of solar systems, components, and product design.** There is an opportunity for Egyptian startups to develop local components which require less-sophisticated technical know-how. These components and accessories could include: the aluminum framing of the panels, the mounting system on which the modules are installed and connected, the cabling – both A.C. and D.C.; and possibly inverters. Encouraging local manufacturing of some components is important as it create the know-how needed to enable future equipment modifications needed to meet business model design/objectives (i.e. shared/mobile PV pumps).
Who? Clean Tech startup support entities (incubators / accelerators).
How? Linking startups to relevant workshops and maker-spaces. Upgrading of maker-space and workshop equipment (i.e. laser cutters, 3D scanning and printers) and improving accessibility

to startups outside of Cairo.

6. Creating markets by strengthening the ecosystem

6.1. **Strengthening linkages in the Ecosystem using market objectives and a shared vision.** Government entities and intermediaries can play an important role showcasing the market opportunities and challenges faces in order to convene like-minded and capable ecosystem players to design comprehensive programs to unlock markets. Market information and data should be shared to give the various entities with a joint understanding and joint vision on the needed path forward to unlock markets and support startup growth. Resources are needed to support stronger collaboration and coordination to improve overall effectiveness as well as to extend support outside Cairo.

Who? Government, Donors, incubators, accelerators, industry association, universities, corporates.

How? Market data and intelligence reports need to be developed in order the support program design and bring together relevant players of the ecosystem to provide support. By having a clear market objective and road map, ecosystem players are more effectively able to commit and provide relevant support. As well, market intelligence reports will reduce information asymmetries and improve investors ability to make funding decisions. Through this process, gaps in the ecosystem can also be identified, which need to be addressed, or can be filled by linking to global networks.

6.2. **Strengthening sector specific startup support programs (i.e. cleantech, fintech, smart-agri, digital).** For incubators and accelerators to better serve startups, strengthening sector specific support programs are recommended. By being sector specific it allows incubators and accelerators to focus and provide more relevant services to their startups, tie into applicable networks, and be more accountable for their service offering. For instance, mentorship selection becomes more rigorous and avoids the use of general mentors, as well programs can provide better support to startups by developing connections with technical support entities, industry associations, and investors interested in the sector.

Who? Government, Donors, incubators, accelerators.

How? Creating an enabling environment conducive for global sector specific incubators and accelerators, impact investors, and venture capital to setup operations in Egypt. Linking local support entities to global networks to help improve the capacity, knowledge, and network gaps of existing sector specific incubators and accelerators.

6.3. **Strengthening quality, range of support, inclusion, and geographical reach of existing and future incubators and accelerators.** For startups to grow, their success is impacted by the quality and range of services provided by the ecosystem. Resources should be allocated with the objective of improving the robustness of service provision by the ecosystem, the number of startups the ecosystem can support, and the geographical reach of the ecosystem (in particular outside main cities). In addition, programs should be designed to take into account challenges faced by female entrepreneurs accessing support services.

Who? Government, donors, incubators, accelerators

How? Providing additional resources to incubators and accelerators, in particular those which aim to support female participation and geographical diversity. Creating an enabling environment conducive for top tier global incubators and accelerators, impact investors, and venture capital to setup operations in Egypt. Linking local support entities to global networks and partners to help fill ecosystem gaps in the short term, and improve the capacity of the local ecosystem in the medium term.

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Annex I: Insights on Gender Balance in Employment

Box 1: Female Insight on Working in the Solar Application in Agriculture

Anonymous Female Insight on Working in the Solar Application in Agriculture– 28 yrs.

As someone who has worked with a solar energy company and part of my job was to be present on-site on monthly basis, I see the relevance. Having to take the public transportation [Cairo to Bahariya Oasis] of which the main passengers are Agri male workers who visit the capital for basic services and family acquaintances. You are extremely aware that you are among the very few females riding on the bus. You are subject to probing about your whereabouts and why and where you are going. You are a stranger. Might as well be the random tourist who occasionally rides the public bus to see the White Desert; but for work purposes this is considered out of the norm. Then when you arrive at the destination after a 7 hours' drive. You have to either contact your on-site colleagues to transport you on site, or stop a passing car. Taxis or micro buses are not available. The other option is usually not preferred but due to bad phone signals that remains the only option to do so. Since you are the only female minority, you have to compromise on the expected standards of daily interactions. Another example, is the access to clean and hygienic bathrooms.

On site, the dynamics are no different. Male - construction - workers are suspicious of your presence. Unconsciously, you become the center of attention until you go back to the office headquarters.

The on-site office is a special case. A thin line separates the 'work' activities, and the 'domestic' activities. If you are not in full agreement with the team members, it becomes delicate to handle. Site engineers stay on site for a period ranging from two weeks to a month; treat the on-site office space as their second home. As a female on a short visit, you are considered as an intruder. Washing activities, cooking… etc.; the shared space does not become as convenient as it were before you were present.

I guess the situation as it is, is not in favor of females. Those of us who accept this type of jobs, are aware that we they are challenging the status quo.

Sample answers to the questions regarding barriers to female employment are shown below in Table

Table 6: Sample Answers by Interviewees on Challenges Perceived by Women Employed in the Sector

Code	Gender	Position	Estimated Age	Answers to the Question: What challenges hinder women employment in the sector.
2-SF-C	Female	Business Development	28 Years	• To have your own startup means that you'll be working 24 hours per day… all what you have. For example, the founders one of them travelled and got married. For a while, she worked remotely, but then she's on board but not on-board any more. Early phases of the company it is fine, but at later stages the responsibility gets bigger.
3-SF-C	Male	Founder / Manager	28 years old	• Not much barriers, even farmers encourage females to work in the field. We aim to promote a financing model – shared economy – and it would help house-wives with their day to day activities.
4-SF-C	Female	Founder Manager	30 years old	• Dealing with customers, with experts. But it is getting better, in Cairo especially. Still, there are challenges.
5-SF-C	Male	Founder / Manager	40 years old	• Hard working conditions, sun, tough conditions.
6-SF-C	Male	Project Manager	29 years old	• Women on site is an issue, being also the minority. We've had a case of one woman engineer on site, and the male staff went against her because she would get access to a separate WC and Prayer area and they are much more in number. The culture norms in Egypt – especially in the construction sector - is very difficult.
7-SF-C	Male	Project Manager	30 years old	• Only one woman engineer, remote years, harsh working conditions, among technicians who are with a different working conditions.
8-SF-C	Male	Founder Manger	40 years old	• Difficult working conditions. • They are not involved in either the direct sales or installation. Mostly office jobs.

Annex II: Business Opportunities factsheets

Business Opportunity Factsheet 1: PV Pumping for irrigation	
Market	
Final Products	Solar energy operated pump
Required Inputs	Electric components and equipment
Competing Products	Diesel pumps
Process	
Type of Process	Moderate – Electrical Design, Wiring, and insolation
Technology	Moderate – design, wiring, and installation
Equipment & Material	Electrical Tools, PV panels, Electric Pumps, Electric Inverters
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems to farm owners
CAPEX	Low - working capital
OPEX	Moderate - Salaries, Maintenance
Considerations	
Key Challenge	Cost of transportation and speed of procurement
Advantages	Payback on PV pumping is constantly decreasing due to the increase of diesel prices – provides more reliability for systems
Impact	
Environmental	CO2 emission reduction
Social	Sustainable and more reliable energy for better farming

Business Opportunity Factsheet 2: PV powered lighting/ ventilation systems for poultry farms	
Market	
Final Products	PV powered lighting system
Required Inputs	Electric components and equipment
Competing Products	Electric grid lighting
Process	
Type of Process	Moderate – design, wiring, and installation
Technology	System integration
Equipment & Material	Electrical Tools, PV panels, electric Inverters, LED lighting, batteries, (fans for ventilation)
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems to poultry farm owners
CAPEX	Low - working capital
OPEX	Moderate - Salaries, Maintenance
Considerations	
Key Challenge	Cost of transportation and speed of procurement
Advantages	Payback on system is constantly decreasing due to the increase of electricity prices
Impact	
Environmental	CO2 emission reduction
Social	Sustainable energy increases sustainability of farming

Business Opportunity Factsheet 3: Solar thermal heating powered ventilation system for poultry farms/ greenhouse	
Market	
Final Products	Solar thermal ventilation system
Required Inputs	Material and equipment
Competing Products	Electric grid ventilation
Process	
Type of Process	Moderate – mechanical design and machining
Technology	Design, manufacturing and assembly
Equipment & Material	Collector, pipes, tanks, fans
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems to poultry farm owners
CAPEX:	Low - working capital
OPEX:	Moderate - salaries, maintenance
Considerations	
Key Challenge	High initial cost of system for consumer
Advantages	Payback is constantly decreasing due to the increase of electricity prices
Impact	
Environmental	CO2 emission reduction
Social	More affordable and sustainable source of energy

Business Opportunity Factsheet 4: Low cost solar thermal heaters for Livestock production	
Market	
Final Products	Solar thermal heating system
Required Inputs	Material and components
Competing Products	Butane tank heating
Process	
Type of Process	Moderate - mechanical design and machining
Technology	Design, manufacturing and assembly
Equipment & Material	Collector, pipes
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems
CAPEX	Low - working capital
OPEX	Moderate - Salaries, Maintenance
Considerations	
Key Challenge	High initial cost of system for breeders
Advantages	Payback is constantly decreasing due to the increase of butane tanks prices
Impact	
Environmental	CO2 emission reduction
Social	Cheaper and more reliable energy for better poultry farming

Business Opportunity Factsheet 5: Low cost solar thermal heaters for farms	
Market	
Final Products	Solar thermal heaters
Required Inputs	Material and equipment
Competing Products	Electric heaters and gas heaters
Process	
Type of Process	Moderate - mechanical design and machining
Technology	Design, manufacturing and assembly
Equipment & Material	Collector, pipes, tanks
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems o farms
CAPEX	Low - working capital
OPEX	Moderate - salaries, maintenance
Considerations	
Key Challenge	High initial cost of system for consumer
Advantages	Payback is constantly decreasing due to the increase of butane tanks prices
Impact	
Environmental	CO2 emission reduction
Social	More affordable and sustainable source of energy

Business Opportunity Factsheet 6: Off-Grid PV systems for farms	
Market	
Final Products	PV systems
Required Inputs	Equipment and components
Competing Products	Diesel generators
Process	
Type of Process	Moderate - design and installation
Technology	Design and system integration
Equipment & Material	PV panels, cables, inverters and batteries
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems to farm owners in rural areas
CAPEX	Low - starting working capital
OPEX	Moderate - salaries, maintenance
Considerations	
Key Challenge	High initial cost of system for farmers
Advantages	Payback is constantly decreasing due to the increase of butane tanks prices
Impact	
Environmental	CO2 emission reduction
Social	Cheaper and more reliable energy for rural agriculture

Business Opportunity Factsheet 7: PV powered pest control for agriculture	
Market	
Final Products	PV powered pest control system
Required Inputs	Electric components and equipment
Competing Products	Various pest control alternatives
Process	
Type of Process	Moderate - system integration
Technology	PV panels and ultra violet lamps
Equipment & Material	Electrical Tools, PV panels, Electric Inverters, ultra violet lamps
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems to farmers
CAPEX:	Low - working capital
OPEX:	Moderate - salaries, maintenance
Considerations	
Key Challenge	Convincing customers with a relatively new product
Advantages	Payback is constantly decreasing due to the increase of diesel prices
Impact	
Environmental	CO2 emission reduction and substitute of chemical pest control
Social	Cheaper and more pest control

Business Opportunity Factsheet 8: Solar dryers for agriculture	
Market	
Final Products	Drying machines
Required Inputs	Material and components
Competing Products	Sun drying
Process	
Type of Process	Moderate - mechanical design and machining
Technology	Design, manufacturing and assembly
Equipment & Material	Collector, pipes, tanks, racks
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems to farmers
CAPEX	Low - working capital
OPEX	Moderate - Salaries, Maintenance
Considerations	
Key Challenge	Upscaling production
Advantages	Product in high demand
Impact	
Environmental	CO2 emission reduction and decrease of produce waste
Social	Provides a tool for farmers to increase revenue streams

Business Opportunity Factsheet 9: Small scale solar thermal well-water desalination	
Market	
Final Products	Solar well-water desalination
Required Inputs	Pumps, storage tanks and collectors
Competing Products	
Process	
Type of Process	Moderate - mechanical design and machining
Technology	Solar desalination equipment
Equipment & Material	Battery Voltage Regulator (BVR), high pressure pump, Reverse Osmosis unit, water tank
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems to farmers
CAPEX	Low - working capital
OPEX	Moderate - Salaries, Maintenance
Considerations	
Key Challenge	Upscaling production
Advantages	Product in high demand
Impact	
Environmental	CO2 emission reduction and decrease of produce waste
Social	Provides a tool for farmers to increase revenue streams

Business Opportunity Factsheet 10: PV RO desalination System	
Market	
Final Products	Solar desalination system
Required Inputs	PV Panels, Pumps, Inverters, Membrane (RO), pressure vessel and Electric components
Competing Products	Fossil fuel RO desalination system
Process	
Type of Process	Moderate - mechanical design and machining
Technology	PV powered Reverse Osmosis AC mode seawater and brackish water desalination
Equipment & Material	PV panels, Battery Voltage Regulator (BVR), DC/AC, high pressure pump, Reverse Osmosis unit, water tank
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems to farmers
CAPEX	High - Membrane and PV panels
OPEX	High – Replacing membrane, Salaries and Maintenance
Considerations	
Key Challenge	Upscaling production, Technology is locally limited, disposal of brine
Advantages	Product in high demand (water deficits due to population and economic growth)
Impact	
Environmental	CO2 emission reduction
Social	Provides a tool for farmers to increase revenue streams

Business Opportunity Factsheet 11: PV powered heating system for poultry farms/ greenhouse (solar thermal)	
Market	
Final Products	Solar thermal heating system
Required Inputs	Material and components
Competing Products	Butane tank heating
Process	
Type of Process	Moderate - mechanical design and machining
Technology	Design, manufacturing and assembly
Equipment & Material	Collector, pipes
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems
CAPEX	Low - working capital
OPEX	Moderate - Salaries, Maintenance
Considerations	
Key Challenge	High initial cost of system for farmers
Advantages	Payback is constantly decreasing due to the increase of butane tanks prices
Impact	
Environmental	CO2 emission reduction
Social	Cheaper and more reliable energy for better poultry farming

Business Opportunity Factsheet 12: PV powered fences for cattle control	
Market	
Final Products	Solar powered fences
Required Inputs	Electric components and equipment
Competing Products	Electric powered fences
Process	
Type of Process	Moderate – Electrical Design, Wiring, and insolation
Technology	Moderate – design, wiring, and installation
Equipment & Material	Electrical Tools, PV panels, 12V battery
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of fences to farms
CAPEX	Low - working capital
OPEX	Moderate - salaries, maintenance
Considerations	
Key Challenge	High initial cost of system for consumer
Advantages	Payback is constantly decreasing due to the increase of butane tanks/ diesel/ gas prices
Impact	
Environmental	CO2 emission reduction
Social	More affordable and sustainable source of energy

Business Opportunity Factsheet 13: Solar PV inspection system (soil/ plant) sensors	
Market	
Final Products	Solar powered fences
Required Inputs	Electric components and equipment
Competing Products	Electric powered fences
Process	
Type of Process	Moderate – Electrical Design, Wiring, and insolation
Technology	Moderate – design, wiring, and installation
Equipment & Material	Electrical Tools, PV panels, monitoring system, sensors, battery, wireless controls
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of inspection systems to farms
CAPEX	Low - working capital
OPEX	Moderate - salaries, maintenance
Considerations	
Key Challenge	High initial cost of system for consumer
Advantages	Reduce drawbacks of lack of data and increasing shortage of labor
Impact	
Environmental	CO2 emission reduction
Social	More affordable and sustainable source of energy

Business Opportunity Factsheet 14: PV powered pesticide/ fertilizer car for vine yards	
Market	
Final Products	Solar pesticide/ fertilizer car
Required Inputs	Electric components and equipment
Competing Products	Diesel powered cars
Process	
Type of Process	Moderate – Electrical Design, Wiring, and insolation
Technology	Moderate – design, wiring, and installation
Equipment & Material	Electrical Tools, PV panels, Electric Pumps, Electric Inverters
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems to farm owners
CAPEX	Low - working capital
OPEX	Moderate - Salaries, Maintenance
Considerations	
Key Challenge	Cost of transportation and speed of procurement
Advantages	Payback on PV pumping is constantly decreasing due to the increase of diesel prices – provides more reliability for systems
Impact	
Environmental	CO2 emission reduction
Social	Provides a tool for farmers to increase revenue streams

Business Opportunity Factsheet 15: Solar thermal egg incubator	
Market	
Final Products	Solar thermal egg incubators
Required Inputs	Material and equipment
Competing Products	Electric and gas heaters
Process	
Type of Process	Moderate - mechanical design and machining
Technology	Design, manufacturing and assembly
Equipment & Material	Heat storage unit, saturated salt solution, 3 V battery
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems to farms
CAPEX	Low - working capital
OPEX	Moderate - salaries, maintenance
Considerations	
Key Challenge	High initial cost of system for consumer
Advantages	Payback is constantly decreasing due to the increase of butane tanks/ diesel/ gas prices
Impact	
Environmental	CO2 emission reduction
Social	More affordable and sustainable source of energy

Business Opportunity Factsheet 16: PV water pump for cattle watering	
Market	
Final Products	Solar energy operated pump for cattle
Required Inputs	Electric components and equipment
Competing Products	Diesel pumps
Process	
Type of Process	Moderate – Electrical Design, Wiring, and insolation
Technology	Moderate – design, wiring, and installation
Equipment & Material	Electrical Tools, PV panels, Electric Pumps, Electric Inverters
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems to farm owners
CAPEX	Low - working capital
OPEX	Moderate - Salaries, Maintenance
Considerations	
Key Challenge	Cost of transportation and speed of procurement
Advantages	Payback on PV pumping is constantly decreasing due to the increase of diesel prices – provides more reliability for systems
Impact	
Environmental	CO2 emission reduction
Social	Sustainable and more reliable energy for better farming

Business Opportunity Factsheet 17: PV powered Cooling for fruit and milk preservation	
Market	
Final Products	Solar powered refrigerators for fruit and milk
Required Inputs	Electric components and equipment
Competing Products	Electric powered refrigerators
Process	
Type of Process	Moderate – Electrical Design, Wiring, and insolation
Technology	Moderate – design, wiring, and installation
Equipment & Material	Electrical Tools, PV panels, DC/AC, Electric Inverters
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of refrigerators to farms
CAPEX	Low - working capital
OPEX	Moderate - salaries, maintenance
Considerations	
Key Challenge	High initial cost of system for consumer
Advantages	Payback is constantly decreasing due to the increase of butane tanks/ diesel/ gas prices
Impact	
Environmental	CO2 emission reduction
Social	More affordable and sustainable source of energy

Business Opportunity Factsheet 18: Thermal powered Cooling for fruit and milk preservation	
Market	
Final Products	Solar thermal refrigerators
Required Inputs	Material and equipment
Competing Products	Electric powered refrigerators
Process	
Type of Process	Moderate - mechanical design and machining
Technology	Design, manufacturing and assembly
Equipment & Material	Heat storage unit, saturated salt solution, battery
Human resources	Manual labor, technical labor, engineers
Economic Features	
Revenue Stream	Sales and maintenance of systems to farms
CAPEX	Low - working capital
OPEX	Moderate - salaries, maintenance
Considerations	
Key Challenge	High initial cost of system for consumer
Advantages	Payback is constantly decreasing due to the increase of butane tanks/ diesel/ gas prices
Impact	
Environmental	CO2 emission reduction
Social	More affordable and sustainable source of energy

Annex III: Workshop Insights

Table 7: Attendees Insights on current barriers and recommendations to support Solar (and Agri-Waste) Businesses - 19 Oct 2017 (10-12 PM) – Access to Finance Session

Attendee/Entity	Description	Comment
CIB	Financing schemes	Creating virtual credit cards doesn't require a bank account
Al-Hamad, Agri Company	Agri-waste market prime movers	Market availability and size are the prime movers to the market Access to capital is easy and not a problem Studies must be carried out and should focus on each: o Region o Market size o Type of waste and its quantities o Uses for each type of waste
CIB	Analysis of agri-waste market, data accuracy issue	Value chain and feasibility analysis should be carried out for each region and type of waste (in agreement with the comment above) Inaccurate data about types waste and their prices are a threat to feasibility studies
Sanabil (Fintech), Omar Bahy	Availability of data	Data and information are present but not easily accessible even to experts A database for information and equipment suppliers is required An entity should be responsible for collecting and publishing of data. This entity could be any one as long as it is reputable and creditable
Aya Zein Eldin	Banks financing PV systems	Banks do not consider PV panels to be an asset that can guarantee a loan (low awareness and lack of technical knowledge) Informal sector and problems of land ownership are a major threat to securing loans for PV projects
CIB	Reputable sources of information and studies	Reputable sources of information and studies include: Ministry of agriculture and RCREE

Aman, RAYA	How to motivate the market, and where to focus	• There must be a need for agri-waste or PV technologies to stir the market • Financing should not be the main focus or the main problem • The market should be well supervised and regulated • Who should be responsible for providing the studies and data?
R&D Tech, Wael Abdel Moez	Innovative projects are risky	• Had a previous experience with World Bank for producing solar driers • Innovative projects and products are risky, the require generous funding to cover the iterations of design and production • Customers mostly are not willing to take the risk • Contrary to PV systems, solar driers can be 100% locally manufactured
Bio Energy	Technical awareness and studies	• Startups can't afford the cost of a feasibility study required by a bank to grant a fund • Banks should have technical teams for better assessment of submitted studies and projects

Al-Hamad, Agri Company	Possible solutions to the problem of access to finance, problems faced during collecting agri-waste from farmers	- In the agricultural sector, for each crop the regions of cultivation, number of labor, wages are already mapped by the ministry of agriculture. This data can be the starting point for studies on the agri-waste sector which should be mapped in a similar fashion
		- Access to finance for solar energy projects especially off-grid ones can be problematic as most of these projects are in deserted areas where legal issues of land ownership are prevalent (banks cannot guarantee the ownership of the land to provide the loan)
		- Neutral entities that are creditable to the banks should be responsible for:
		  - Carrying out feasibility studies for PV and agri-waste technologies
		  - Provide these studies to banks and startups to help securing loans
		  - These studies should clarify the profit of each entity in the value chain. (Personal profit is the prime mover of any investment, service, etc.… That is the human nature)
		- Farmers tend to overprice their waste in a way that could non-profitable for the buyer (“They would rather burn it even though they know it causes problems to their crops, or throw it into the Nile or canals”, Mohamed Khalaf)
		- The role of government should be limited to monitoring and regulation of the value chain
		- In the agri-waste sector individuals and small enterprises are better than large enterprises in collecting the waste from farmers

Ahmed Ghandour, Sunway Egypt	Lack of available data	- Creditable companies should provide studies and data as a service for fees

Table 15: Attendees Insights on current barriers and recommendations to support Solar Sector- 19 Oct 2017 (2-4 PM) – Solar Application in Agriculture Value Chain Session

Attendee/Entity	Description	Comment
Ahmed Abbas, Suncity	Integration between different enterprises in the PV market	An integration between him (suncity) and Andrew as an example between a Large Supplier and a smaller enterprise
Aya Zein Eldin	Informality of PV market	PV is mostly informal; Therefore, the quality of end product cannot be guaranteed
Ahmed Abbas, Suncity	Cooperation between companies	Cooperation between different companies in the PV market is mostly informal Successful formal cooperation between companies requires lots of procedures and regulations
Ahmed Ghandour, Sunway Egypt	Competition among companies	Small companies tend to apply for large projects without the access to finance and technical experience Large companies tend to apply for small projects, which, according to him, should be done by small, local companies There should be a way to regulate the distribution of projects among different sized companies
Ayman Elkhlewy	Local companies require a better paying scheme to large suppliers	Local companies take the risk of a farmer not being able to repay the full value or a PV pump or system, therefore large suppliers should provide better payment plans On the other hand, larger companies and suppliers should cooperate with local companies as they have better knowledge of water wells and the people of the village
		Startups have a problem identifying the suppliers
	PV market quality control	Bad quality of service and product is a threat to the whole industry Bad quality is a result of the informality of the market PV market should be regulated
		NREA provides certifications only for large (500 kW and above) on-grid systems Companies specializing in PV pumps are not required by to have any certifications

Ayman Elkhlewy		▯ The PV market does not need any sort of regulation
Aya Zein Eldin		▯ The market should be monitored to guarantee the quality of components and quality of service
Ahmed Ghandour, Sunway Egypt		▯ A consulting center should be responsible for publishing quarterly testing reports for the different system components
Andrew		▯ A source for conflict of interests
(Fintech representative)	PV market quality control	▯ A block-chain should be formed for the PV market ▯ The block chain should be responsible for: ○ Evaluating different system components ○ Evaluating and rating every transaction (Project) in the market ○ Maintaining a ledger for the above evaluations
		▯ Lake of awareness of the end-user. ▯ The end-user can pay large amounts of money for fake products. These products don't last long and can ruin the end market acceptance to PV technologies ▯ This is harmful to each entity in the PV market
Noha Elbalky		▯ Increase the awareness of end-user ▯ Each region should have a number of certified suppliers and installers ▯ The quality of components in the markets need a regulating mechanism
Aya Zanaty		▯ Local manufacturing of PV panels in Egypt is in fact only assembly work ▯ Due to customs and taxes on components importing the whole panel is a cheaper alternative
Ali Abo Sena		▯ Key factors to the customer are: ○ Payback time ○ Quality of product/Service ▯ Why don't we manufacture for other markets (other than the local market) since we have a competitive advantage? ▯ Banks are not supporting the PV market
	Who is responsible for the quality	▯ GOEIC and EOS are responsible for ensuring the quality of components

	control of the market?	- Cooperation of suppliers is a must to ensure quality of components, but a block chain is susceptible to conflict of interest
		- The regulating entity must be independent and should have enough technical knowledge
Dynergy	Possible business models for PV plug and play devices	- Usually the customer is not even aware of the presence of PV plug and play devices - They require large efforts for marketing - Usually these devices have low revenue as their sole purpose is, quoting, “to spread the idea of using solar energy” - Cash-and-Carry is the only business model - There is a large possible market for these devices
FEI	Role of NGO	- NGOs can help easing the access to finance to small and medium farmers
Aya Zanaty	De-risking solar applications	- Large companies often certify local distributors in villages and rural areas to decrease the risk of supplying individual informal companies or individuals directly
Sun of Oasis, Ayman Elkhlewy	Micro-financing schemes	- As a local person, knowing the cropping seasons in his region, he sometimes collected a portion of late payments from farmers in the form of crops, livestock, etc.… and using a network of relatives and friend who trade in this sort of goods he could earn his money back

Annex IV: Mapping of PV Supporting Entities

Table 7: Major players in the clean-tech entrepreneurship ecosystem (excluding investors and financial institutions)

#	Organization or Individual	Type	Sector Focus	Sub-sector Focus	Start range for support	End range for support	Geographical Scope
1	Cleantech Arabia	Firm operating on non-profit basis	Cleantech	Waste management, Renewable energy, sustainable agriculture and food production	idea	Growth	Nationwide
1	Nahdet El-Mahrousa	Foundation	General	Waste, Renewable Energy	Seed and development	Seed and development	Focused on Greater Cairo Area (GCA) - Recently Expanded to Suez
2	Dandara	Foundation	General	Agriculture, Waste, Renewable Energy	Seed and development	Startup	Upper Egypt
3	Alashanekya Baladi (AYB) Ibtaker Project	Foundation	General	Waste Management	Seed and development	Seed and development	Country wide
4	Aga Khan (through Om Habiba Foundation)	Foundation	General	Agriculture, Waste, Renewable Energy	Seed and development	Startup	Aswan
5	INJAZ	Foundation	General	NA	Seed and development	Startup	Focused on GCA
6	Drosos	Foundation	General	NA			Country wide
7	Misr El Kheir Foundation (GESR Initiative)	Foundation	Clean tech	Agriculture, Water, & Renewable Energy	Seed and development	Seed and development	Focused on GCA

8	Cairo University - YouthinkGreen	Research & Development Institution/Education	Clean tech	Water, Waste, Renewable Energy	Seed and development	Seed and development	Country wide
9	Heliopolis University	Research & Development Institution/Education	Clean tech	Agriculture, Renewable Energy, Water & Energy Efficiency	Seed and development	Startup	Focused on GCA and Sharqia
10	Venture Lab at AUC	Research & Development Institution/Education	General	NA	Seed and development	Startup	Focused on GCA
11	Sustaincubator	Incubator/Accelerator	Clean tech	Renewable Energy, Food, Waste and Water	Seed and development	Startup	Focused on GCA
12	Innoventures	Incubator/Accelerator	General	NA	Seed and development	Startup	Focused on GCA
13	GIZ	DFI/Bilateral Donor	Clean tech	Agriculture & Renewable Energy	Seed and development	Growth	Country wide
14	UNIDO	Multilateral Donor	Clean tech	Agriculture, Renewable Energy, & Waste	Seed and development	Startup	Country wide
15	UNDP	DFI/Bilateral Donor	General	Agriculture, Renewable Energy, & Waste	Seed and development	Startup	Country wide
16	AFDB	Multilateral Donor	General	Waste, Waste to Energy	Seed and development	Seed and development	Country wide
17	British Embassy	DFI/Bilateral Donor	General	Agriculture, Waste & Renewable Energy	Seed and development	Seed and development	Country wide
18	German Embassy	DFI/Bilateral Donor	General	Agriculture, Waste & Renewable Energy	Seed and development	Seed and development	Country wide
19	ILO	DFI/Bilateral Donor	General	Waste, Waste to Energy	Seed and development	Seed and development	Country wide

28	Riseup Summit	Network/Association	General	NA	Seed and development	Startup	Focused on GCA
29	MIT Enterprise Forum	Network/Association	General	NA	Seed and development	Startup	Country wide
30	Hult Prize	Network/Association	General	NA	Seed and development	Startup	Country wide
31	Cleantech Arabia	Network/Association	Clean tech	Agriculture, Renewable Energy, Water, Transportation n & Energy Efficiency	Seed and development	Growth	Country wide
32	ENCPC	Government	Clean tech	Agriculture, Renewable Energy, Water & Energy Efficiency	Seed and development	Startup	Country wide