People in Need

Constraints Analysis within the Solar Energy Market System of Northern Syria

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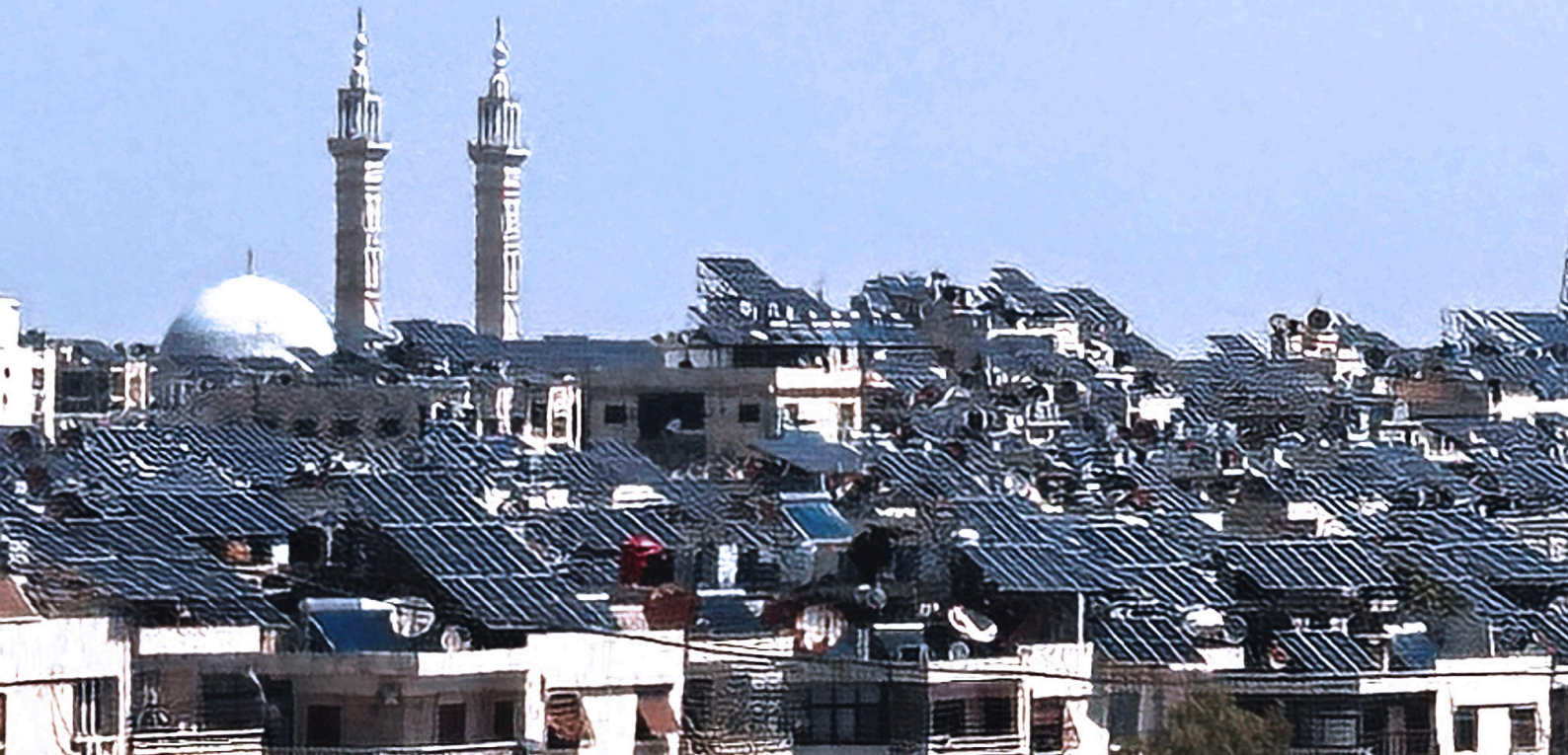


TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report presents the findings of People in Need's Market Systems Development (MSD) Feasibility Project for the Solar Energy Market System (SEMS) in northern Syria. The assessment was conducted during April-May 2026 across Aleppo, Idlib, and Raqqa governorates to understand market structure, actor incentives, constraints, and feasible MSD-oriented programming pathways. Although the evidence base covers three governorates, the recommended proof of concept focuses on Aleppo because of the concentration of solar small and medium enterprises (SMEs), supplier linkages, training-provider access, and PIN's ability to facilitate and monitor actor collaboration during a limited learning intervention.

47 interviews and consultations across 8 actor types

3 governorates assessed (Aleppo, Idlib, Raqqa)

4 further pathways flagged for future support: finance, certification, advisory, battery recycling

1 proof-of-concept pathway recommended: hybrid VTC-SME-supplier skills model

At a glance: this assessment in numbers

The assessment used a qualitative, purposive methodology and included 47 interviews and consultations with wholesalers/importers, solar retailers and SMEs, existing and potential household customers, industrial and business customers, vocational training centers (VTCs)/training providers, battery recycling companies, and one representative of the energy ministry. The findings should be read as market-pattern evidence rather than statistically representative measurement. The assessment did not include direct interviews with banks, MFIs, chambers of commerce, certification bodies, or multiple regulatory actors; findings related to finance, certification, subsidies, and formal standards therefore require further validation.[1]

The findings confirm that solar energy is commercially active and increasingly necessary. Unreliable public electricity, high fuel and generator costs, weak grid provision, and the need for decentralised power have created demand among households, farms, businesses, NGOs, and industrial users. Indicative field estimates suggest a meaningful private-sector base, including approximately 500 solar shops/SMEs in Aleppo, 250 in Idlib, and 100 in Raqqa. These are unverified, observation-based estimates from the assessment team, not a sector census or secondary-source figure — no ministry, chamber, or other registry data was available to cross-check them.[2]

The enabling environment is mixed. Public policy already supports renewable energy in several ways, including under Electricity Law No. 32 of 2010, which has been amended to allow private-sector investment in solar and wind energy, customs-duty reductions on solar equipment have been applied, memoranda of understanding and power purchase agreements have been signed with investors, and longer-term energy planning is underway. Implementation remains constrained by damaged infrastructure, weak financing, sanctions and import difficulties, limited grid readiness, lack of smart meters, absence of widespread net metering, and an unstable investment environment.

Despite strong demand, the market does not yet work inclusively or reliably enough for low-income households, smaller enterprises, or new labour-market entrants. Customers face high upfront costs and lack formal finance. They also struggle to verify product quality, compare offers, understand warranty conditions, and access consistent maintenance. Installation quality and advisory services vary across providers, while local certification and labelling remain weak. These constraints affect trust and limit adoption even where demand is clear.

The skills function is one of the most immediate and testable constraints. Solar SMEs mostly recruit through personal networks and train workers informally on the job. VTCs are not currently providing strong solar-

[1] *A category-level breakdown of these 47 interviews is at Section 1.3; a full respondent list, added in response to internal review, is at new Annex 3.*
[2] *See the evidence-confidence note in Section 1.4.*

energy-related training, despite some previous experience. Constraints include outdated curricula, lack of equipment and materials, limited funding and space, no systematic labour market assessment, no graduate tracking, weak apprenticeship pathways, and limited women's inclusion. The Ministry of Energy interview also confirmed shortages of qualified engineers and technicians and the need for practical renewable-energy training and stronger cooperation between government institutions and VTCs.

The recommended immediate pathway is a limited, learning-oriented proof of concept testing a hybrid VTC–SME–supplier model in Aleppo. VTCs would provide structured training, SMEs would co-design content and host apprenticeships or work exposure, and suppliers would provide product-specific sessions on panels, batteries, inverters, warranties, safe installation, maintenance, and common faults. This pathway is prioritised not because skills are the only or deepest constraint, but because it is urgent, actor-led, feasible, and testable without waiting for regulatory reform, grid investment, or a mature solar finance market.

Finance, standards and certification, information and advisory services, maintenance models, safer battery recycling, and public-private coordination remain important future pathways. They should not be dropped. They should be sequenced for future validation because they require actors and conditions not yet sufficiently assessed through this feasibility study.

ACRONYMS

CSR	Corporate Social Responsibility
DCED	Donor Committee for Enterprise Development
GESI	Gender Equality and Social Inclusion
IEC	International Electrotechnical Commission
LMA	Labour Market Assessment
MFI	Microfinance Institution
MSD	Market Systems Development
NGO	Non-Governmental Organisation
PIN	People in Need
PPE	Personal Protective Equipment
SEMS	Solar Energy Market System
SME	Small and Medium Enterprise
ToC	Theory of Change
TVET	Technical and Vocational Education and Training
VTC	Vocational Training Centre
WDWP	Who Does / Who Pays

1. INTRODUCTION

1.1 Overview of the Market Systems Development Feasibility Project

This report presents the findings of the Market Systems Development Feasibility Project of the Solar Energy Market System in Northern Syria: Aleppo, Idlib, and Raqqa Governorates. The assessment was conducted by People in Need (PIN) during April–May 2026 as an internal learning exercise to examine the structure, performance, constraints, and intervention potential of the Solar Energy Market System (SEMS) in the target governorates.

The original concept note focused mainly on Aleppo and Idlib. Raqqa was included during the assessment because access to relevant actors was feasible and because VTCs, solar adoption, and battery recycling in Raqqa provided useful evidence for testing whether key SEMS constraints were visible across a wider northern Syria market geography.

The project is grounded in a Market Systems Development (MSD) approach, which focuses on understanding how market actors interact, what incentives shape their behaviour, and how supporting functions and rules influence market performance. Rather than treating solar energy only as a technical or infrastructure sector, the assessment examines solar energy as a market system composed of retailers, wholesalers, importers, electricians, blacksmiths, installers, customers, maintenance providers, battery recycling businesses, training providers, financial actors, public institutions, informal networks, and other supporting service providers.

The original project concept note frames the initiative as a learning-oriented intervention designed to strengthen the evidence base and strategic readiness for inclusive green energy programming in Syria. It defines the core transaction of the solar energy market as the relationship between solar SMEs on the supply side and end customers, including households, commercial enterprises, farms, NGOs, and industrial facilities, on the demand side. It also identifies a potential labour-market sub-system in which solar SMEs demand skilled workers, while trained labourers, including youth and women, represent the potential supply of labour.

The assessment therefore examines two connected layers of the market system. The first is the core solar energy transaction, where solar systems and related services are sold, installed, maintained, and repaired for rural households, enterprises, farms, NGOs, and industrial users. The second is the skills and supporting services sub-system, where technical training, apprenticeships, installation capacity, maintenance, after-sales services, customer advisory services, transport, marketing, financial services, and battery recycling influence the quality, affordability, reliability, and sustainability of solar energy adoption.

Solar energy was selected because of its growing relevance in Syria's recovery context. Long electricity outages, high diesel costs, weak public electricity provision, and the increasing need for decentralised energy solutions have pushed households, farmers, businesses, and industrial users toward solar systems. The Ministry of Energy representative confirmed that the wider energy sector faces structural challenges, including damaged electricity infrastructure, fuel and gas shortages, high grid losses, weak investment capacity, sanctions, import difficulties, and ageing control and communication systems. These constraints strengthen the relevance of decentralised solar energy solutions.

The assessment also confirms that the enabling environment is not entirely absent. Public-sector policy directions exist to support renewable energy, including private-sector investment in solar and wind energy under Electricity Law No. 32 of 2010, which has been amended to allow such investments, customs-duty reductions on solar equipment have been applied, and memoranda of understanding and power purchase agreements have been signed with investors. The Ministry of Energy is also working on longer-term energy planning, including an energy mix study until 2040 and a renewable energy master plan. However, implementation remains constrained by weak financing, damaged infrastructure, import difficulties, sanctions, lack of grid readiness, absence of widespread net metering, and an unstable investment environment.

The assessment includes battery recycling as a connected supporting market. Batteries are central to household and enterprise solar systems, especially where users need storage capacity because public electricity supply is unreliable. Battery repair, component recovery, and safe recycling therefore affect both the economic and environmental performance of the solar market. However, recycling is not treated

as the main core transaction of the SEMS. It is analysed as an interconnected supporting market linked to maintenance, battery replacement, component recovery, waste management, and environmental safety.

The project does not assume that a full-scale market intervention is ready for implementation. Instead, it uses the assessment to identify systemic constraints, compare possible intervention pathways, and prioritise one feasible proof-of-concept hypothesis. Several systemic constraints emerged from the findings, including weak affordability, limited access to finance, absence of clear standards and certification, customer confusion around product quality, inconsistent after-sales services, weak information channels, unclear warranty rules, environmental and health risks in battery recycling, and limited structured training pathways. However, the report gives specific attention to the Vocational Training Centre (VTC) and skills pathway as the most urgent and immediately testable hypothesis.

This prioritisation does not mean that finance, standards, information, public incentives, or recycling are unimportant. Rather, these are treated as wider systemic needs and medium- to longer-term intervention pathways. The VTC/skills pathway is prioritised because it is more immediately feasible to test, because solar SMEs already show willingness to cooperate with practical training and apprenticeships, because VTCs have identifiable capacity gaps, and because the public-sector energy actor confirmed the need for practical renewable-energy training and stronger links between VTCs, recognised certification, and labour market needs.

Although the original concept note treated the VTC pathway as a tentative hypothesis, the assessment findings confirm that skills development is one of the most feasible immediate entry points. This does not mean that skills are the only or deepest constraint. Rather, the VTC/skills pathway is prioritised because it is testable within a limited proof of concept, has identifiable private-sector incentives, and can generate learning for future interventions on finance, standards, advisory services, maintenance, and certification.

1.2 Purpose of the Market Systems Assessment

The purpose of this market systems assessment is to generate a practical and evidence-based understanding of the solar energy market system in Aleppo, Idlib, and Raqqa and to identify feasible entry points for future MSD-oriented programming.

More specifically, the assessment aims to:

1. Analyse the structure of the solar energy market system, including the core transaction, key actors, supporting functions, connected markets, and formal and informal rules.
2. Understand the incentives, capacities, constraints, and relationships of solar market actors, including wholesalers/importers, retailers, solar SMEs, customers, maintenance providers, VTCs/training providers, battery recycling companies, and the public-sector energy actor.
3. Identify the main symptoms and root causes of market underperformance affecting solar energy adoption, especially among low-income households, rural households, and enterprises.
4. Assess the relevance and feasibility of solar energy as a market system for inclusive economic recovery, green jobs, and youth and women's participation.
5. Examine possible systemic intervention pathways, including finance, standards and certification, information and advisory services, maintenance, battery recycling, public incentives, and skills development.
6. Prioritise the most urgent and feasible hypothesis for a proof-of-concept intervention, with particular attention to the VTC/skills pathway.
7. Inform future programme design, donor engagement, internal learning, and the potential scale-up of MSD-oriented green energy programming.

The assessment is not intended to provide a statistically representative measurement of the entire solar energy sector. It is a feasibility-orientated market systems analysis designed to support decision-making. Its value lies in identifying patterns, constraints, incentives, and practical leverage points that can be tested through future facilitative interventions.

1.3 Research Methodology

The assessment used a qualitative, purposive research design to capture perspectives from key market actors across the core solar energy transaction, selected supporting functions, one connected supporting market, and the enabling environment. Data collection was conducted by PIN staff through face-to-face interviews during April–May 2026 in Aleppo, Idlib, and Raqqa governorates.

The sample was purposively selected to include actors directly involved in solar energy supply, demand, installation, maintenance, training, battery recycling, and public-sector energy policy. This approach was appropriate for an MSD feasibility assessment because the objective was not to produce representative statistical estimates but to understand how different actors participate in the system, what constraints they face, what incentives shape their behaviour, and where there may be opportunities for systemic change.

The analysis covered the market-system overview and actor map; the core transaction between solar-system suppliers and customers; products, services, prices, supply chains, imports, and customer demand; installation, maintenance, warranties, transport, market information, finance, technical training, and battery recycling as supporting functions; and the formal and informal rules affecting quality, certification, work safety, subsidies, loans, and market behaviour. It also examined employment and skills, gender and inclusion, actor incentives and capacities, the root causes of identified constraints, the feasibility of alternative intervention pathways, and the proof-of-concept result chain, sustainability, and potential for scale.

A total of 47 interviews and consultations were conducted with market actors, supporting-function actors, and one public-sector energy actor across the solar energy market system.

Actor type	Number interviewed
Wholesalers/importers	3
Retailers / solar SMEs	11
Existing household customers	11
Potential household customers	11
Industrial/business customers	3
VTCs / training providers	4
Battery recycling companies	3
Ministry of energy representative	1
Total	47

A full list of consulted actors by category and location, in response to an internal review request, is provided at Annex 3; it does not identify individual respondents or businesses by name.

The tools explored business models, products and services, customer profiles, price ranges, supply chains, import dependency, quality concerns, warranties, after-sales services, installation and maintenance practices, finance, employment and skills, gender inclusion, market information, competition, recycling practices, formal and informal rules, public policy directions, grid readiness, and future business or sector plans.

The assessment also drew on project design documents, a draft result chain, and an internally developed WDWP matrix. These tools helped structure the analysis of current and future roles for retail, installation, wholesale, import, maintenance, advisory services, financial services, technical training, warranties, certification, work safety, and potential subsidies or loans. The result chain and WDWP should be treated as analytical tools and intervention-design inputs rather than validated sector-wide commitments.

1.4 Methodological Limitations

Key limitations were considered. First, female respondent representation was limited, and the assessment does not provide a deep gendered analysis of women's technical, commercial, or household decision-making roles. Second, respondent willingness to share sensitive business information varied. Third, the assessment included one Ministry of Energy interview but did not include wider consultation with local authorities, chambers of commerce, banks, MFIs, certification bodies, or multiple regulatory actors. Fourth, consolidated respondent distribution by governorate and gender was not available in the reviewed version of the report and should be added if it can be reconstructed from raw interview records. Fifth, the assessment did not conduct a full scored comparison of SEMS against three alternative market systems, although the original concept note anticipated such validation. SEMS was retained as the assessment focus based on project scope, strong demand, visible private-sector participation, climate and recovery relevance, and operational feasibility.

These limitations do not invalidate the findings. They clarify the level of evidence. Findings on market demand, private-sector activity, skills gaps, service quality, and customer constraints are reasonably well supported by the sample of actors interviewed. Findings on finance products, formal certification, public subsidies, and regulatory implementation require further validation before being converted into intervention design.

No separate market-actor validation workshop was conducted following the initial assessment. Instead, validation will continue through pathway-specific individual data collection and a participatory labour market assessment undertaken jointly with the selected VTCs. This process will both test the assumptions underlying the selected skills pathway and strengthen the capacity of VTCs to collect, analyse, and respond to labour-market information.

The counts of solar shops/SMEs by governorate (approximately 500 in Aleppo, 250 in Idlib, 100 in Raqqa) and the price ranges reported in Section 2.1 are the assessment team's own field estimates, based on observation and respondent statements during the April–May 2026 interviews. No secondary source was available to cross-check them. This does not mean the figures are unreliable. They are sufficient in providing a reasonable basis for describing the market's approximate scale and cost structure, but they should be treated as directional planning inputs, not verified statistics, and should not be cited externally (for example, to donors) without this caveat attached.

2. SOLAR ENERGY SECTOR

2.1 Overview of the Sector

The solar energy sector in Syria has expanded in response to the deterioration of the wider electricity system, high fuel and energy costs, and the need for decentralised energy solutions among households, farms, enterprises, NGOs, and industrial users. In the target governorates of Aleppo, Idlib, and Raqqa, solar energy has moved from being a specialised product to becoming an increasingly necessary coping and investment option for different customer segments.

The Ministry of Energy representative confirmed that the national energy system is facing deep structural constraints. These include damaged electricity generation, transmission, and distribution infrastructure; shortages of fuel and gas required for power generation; high technical and non-technical losses across the electricity grid; weak financial capacity for infrastructure investment and maintenance; sanctions and restrictions affecting the import of equipment and spare parts; and ageing control and communication systems. These constraints affect the reliability of public electricity supply and create strong demand for decentralised energy options, including household solar systems, agricultural solar pumping, solar systems for enterprises, and other off-grid or semi-grid solutions.

Within this context, solar energy is not only an environmental alternative. The sector is intricately connected to the broader energy system, agricultural practices, household resilience, industrial production, small business sustainability, and the development of green livelihoods, all of which are under strain due to unreliable grid electricity, high diesel generator operating costs, diminished household purchasing power, and a lack of sufficient public or private financing options.

It is a practical response to energy insecurity. Interviewed customers repeatedly linked their interest in solar systems to electricity outages, high generator or electricity costs, and the need to operate essential appliances, production equipment, irrigation systems, refrigeration, lighting, and household devices. Industrial and business users also identified solar energy as a way to reduce operating costs and support production continuity, although larger investments remain constrained by liquidity and uncertainty around business revenues.

The solar energy market system in the target areas includes several connected business activities: importing, wholesaling, retailing, installation, transport, maintenance, repair, customer advisory services, battery replacement, and battery recycling. The core commercial transaction is between solar system retailers/SMEs and rural households and enterprises that purchase, install, and use solar systems. Wholesalers and importers play a critical upstream role by supplying panels, batteries, inverters, cables, and other components. Retailers and solar SMEs translate these inputs into customer-facing products and services, often offering advice, delivery, installation, warranties, and in some cases maintenance or repair.

The sector remains highly import-dependent. Solar products and components are mainly sourced from international manufacturers and supply chains, with products reaching target markets through supplier connections in Aleppo, Idlib, Sarmada, Damascus, and other trading hubs. Respondents referred to imports from China, Türkiye, India, and other external markets. Local production is limited, with most local economic activity concentrated in trade, installation, minor assembly, repair, battery services, recycling, and maintenance. This import dependency exposes the sector to exchange-rate volatility, customs and import rules, international money-transfer barriers, shipping costs, border access constraints, global supply disruptions, and quality variation.

The internally developed WDWP matrix confirms that wholesale and import are important but constrained supporting functions. Wholesale currently depends heavily on United States dollar pricing, faces fluctuating prices, risks of monopoly or concentration among major suppliers, and limited formal contracting. Imports are affected by international money-transfer difficulties and wider restrictions on supply-chain access. These factors contribute to unstable prices and weaken the ability of retailers and customers to plan investment decisions.

The assessment suggests that the market has grown significantly since 2020, although growth is uneven across actors and locations. Some wholesalers reported continued growth, while some retailers reported declining or fluctuating sales due to rising prices, exchange-rate instability, stronger competition, weakened purchasing power, and market saturation. This indicates that demand exists, but purchasing capacity remains a binding constraint. The sector is therefore not expanding in a simple linear way; it is growing as a necessity-driven market while also facing affordability, quality, information, skills, and trust constraints.

In terms of geographical coverage, the assessment identified Aleppo and Idlib as major commercial and supplier connection points, while Raqqa was included as a target governorate with relevance for VTCs, solar adoption, and battery recycling. Based on field estimates, there are approximately 500 solar shops/SMEs in Aleppo, 250 in Idlib, and 100 in Raqqa. These figures should be treated as indicative estimates rather than verified census data, but they suggest that the sector has reached meaningful scale and that a broad base of private actors is already active.

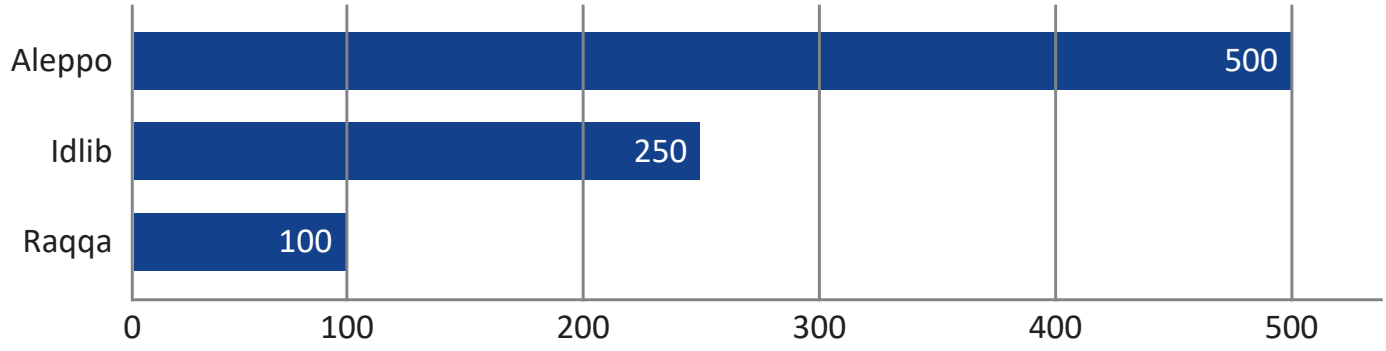


Figure 1. Estimated solar shops/SMEs by governorate (PIN field assessment, April–May 2026 — team estimates).

The solar market serves multiple customer segments. Household customers purchase systems mainly to cover essential domestic electricity needs, such as lighting, refrigeration, washing machines, fans, air conditioning, and basic appliances. Enterprises and small businesses use solar systems to reduce operating costs and maintain business continuity. Industrial customers use solar power to operate machinery, refrigeration compressors, motors, pumps, workshops, and production-related equipment. Farmers and rural enterprises use solar energy for irrigation and water pumping. NGOs and institutions may also purchase solar systems to support service delivery and reduce operating costs. This means that the solar sector is interconnected with the household energy market, agricultural production, industrial recovery, small enterprise development, public service continuity, and green jobs.

Current price ranges confirm that affordability is a key constraint. Based on assessment inputs, a small household system costs approximately USD 300–700, a medium household system USD 700–3,500, a large household system USD 3,500–6,000, and an industrial system USD 10,000–50,000. Installation services generally range between USD 100 and USD 500, while a maintenance visit may cost around USD 200. These prices are significant in relation to household income and business liquidity, particularly for low-income rural households and small enterprises.

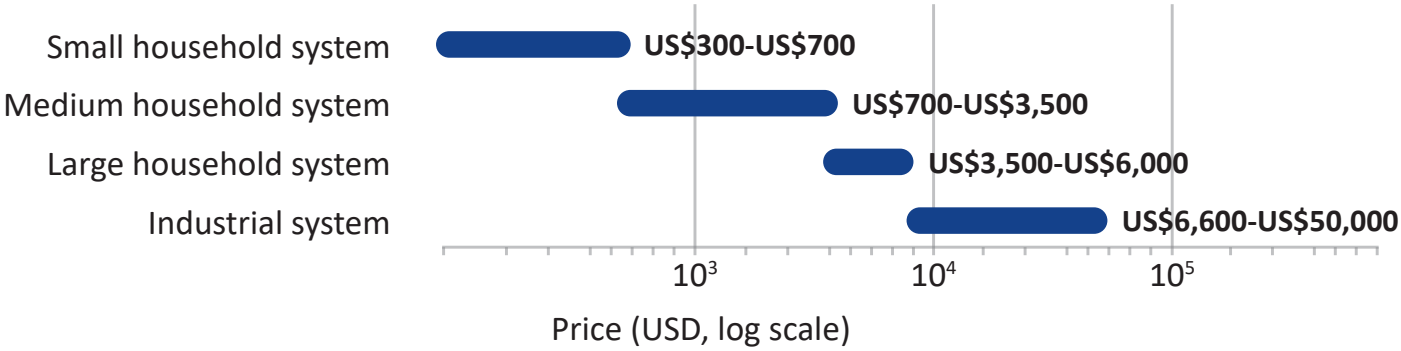


Figure 2. Typical solar system price ranges reported to the assessment team (team estimates; log scale).

The public-sector energy actor also confirmed that grid-connected household solar systems and resale of electricity are not currently a realistic short-term pathway at scale. Barriers include weak distribution infrastructure, lack of protection and metering readiness, absence of smart meters, lack of widespread net metering, grid stability and power-quality concerns, and the need for major investments and regulatory upgrades. This confirms that, in the short term, solar systems should mainly be understood as decentralised self-consumption solutions rather than as a market for selling surplus electricity to the grid.

Battery recycling and component recovery are connected to the solar energy sector but should not be treated as the main market system. Batteries are central to household and enterprise systems, especially where users require storage to manage unreliable electricity access. The assessment included three formal battery recycling companies in Aleppo and Raqqa. These companies buy damaged or used batteries from customers, companies, suppliers, and factories and engage in battery repair, component recovery, resale, and recycling. This connected market is relevant for environmental sustainability, battery replacement, safe disposal, and circular economy opportunities. However, it remains a supporting or interconnected market, not the main core transaction.

Overall, the solar energy sector in Aleppo, Idlib, and Raqqa has clear market relevance and growth potential. It is active, demand-driven, and supported by some public policy direction toward renewable energy. However, it is constrained by affordability, weak financing, product quality uncertainty, limited certification, weak customer information, inconsistent maintenance, informal training, import dependency, unclear warranty rules, limited grid readiness, and weak structured links between solar SMEs and training providers.

2.2 Relevance, Impact Potential, Feasibility

2.2.1 Relevance to Target Groups

The solar energy sector is highly relevant to the target groups because it responds to a real and persistent energy need while also creating potential employment and service opportunities. For households and enterprises, solar energy is a response to unreliable electricity access, high operating costs, and the need to maintain daily life, production, refrigeration, irrigation, communications, and basic services. For youth and women, the sector offers potential labour-market entry points linked to installation support, maintenance support, sales, customer service, administration, marketing, technical advisory work, and, over time, more specialised technical roles.

For low-income and rural households, solar energy is relevant but not yet fully accessible. Many potential customers expressed interest in purchasing solar systems but identified high upfront cost, weak purchasing power, lack of loans, and reliance on savings or informal borrowing as major barriers. This suggests that the sector has strong demand-side relevance, but current market arrangements do not adequately serve lower-income customers.

For enterprises and industrial users, solar energy is relevant because it can reduce dependence on diesel generators or expensive electricity sources and can improve continuity of production. Industrial users interviewed under the assessment reported interest in solar energy to reduce production costs and power machinery, but investment decisions are constrained by the size of the initial investment, unstable revenues, limited roof or installation space, and uncertainty about market recovery.

For rural areas, the public-sector energy actor identified several suitable green energy solutions, including household solar systems, agricultural solar systems, solar-powered water pumping, mini-grids, energy efficiency measures, and accessible financing for households and farmers. This supports the relevance of solar energy not only for household electricity access, but also for agriculture, water access, and rural economic recovery.

For youth, the sector is relevant because solar energy is labour-intensive at the service level. Retailers and wholesalers need workers for sales, transport, installation, maintenance, customer communication, stock handling, and technical troubleshooting. However, recruitment is currently informal and based heavily on trust, referrals, prior practical experience, and on-the-job learning rather than structured training, certification, or clear career pathways.

For women, the sector is relevant but currently restrictive. Women appear as customers and, in some cases, in administrative and marketing roles. However, they are rarely present in technical work, installation, battery handling, field maintenance, or recycling. This reflects social norms, safety concerns, mobility restrictions, perceptions about physical work, and the absence of women-friendly training and employment pathways. The relevance of the sector for women therefore depends on intentionally identifying realistic entry points, such as customer service, sales, administration, marketing, advisory services, digital promotion, quality documentation, warranty tracking, and selected technical assistant roles where appropriate.

2.2.2 Impact Potential

The sector has impact potential at several levels.

First, improved access to solar energy can reduce household vulnerability by increasing access to lighting, refrigeration, cooling, communication, and basic domestic electricity. This can contribute to improved household resilience, especially in areas where public electricity supply is unreliable or costly.

Second, solar energy can reduce operating costs for businesses, farms, and industrial users. For enterprises, energy cost reduction can support business continuity, productivity, and recovery. For farms, solar-powered irrigation can reduce reliance on diesel and improve production reliability. For small businesses, solar energy can help maintain operations during outages.

Third, the sector can create and improve jobs. Installation, maintenance, repair, transport, sales, customer service, advisory services, and battery-related services all require labour. However, the quality and inclusiveness of these jobs depend on whether the market can improve training pathways, practical skills, safety practices, and links between training providers and employers.

Fourth, the sector has environmental and climate relevance. Solar energy can reduce dependence on diesel generators and contribute to more climate-resilient energy access. At the same time, battery disposal, recycling, and component recovery must be managed safely to ensure that the environmental impact is not automatically positive. The connected battery recycling market therefore matters for the longer-term sustainability of the solar system. The WDWP matrix flags environmental problems and health risks related to battery production and recycling, which should be addressed through safety standards, technical training, and specialised referral pathways.

Fifth, the sector can support systemic change if market actors begin to perform functions that are currently weak or sponsor-dependent. For example, solar SMEs and suppliers could contribute to practical training; VTCs could update curricula and track graduates; retailers could improve customer advisory services; wholesalers could support product-specific training and warranty-linked standards; public actors could support certification and recognition; and financial actors could eventually develop instalment or loan products for solar adoption.

2.2.3 Feasibility of an MSD Intervention

The solar energy market is feasible for an MSD-oriented intervention because there is already active private-sector participation, visible customer demand, existing commercial incentives, and a clear set of constraints that affect market performance. This makes it more appropriate for facilitation than for direct delivery alone.

The strongest feasibility factor is that the market already exists. Solar retailers, wholesalers, installers, customers, and recycling actors are active. The sector does not require the project to create demand from zero. Instead, the project can work with existing actors to improve how the market functions, especially around skills, information, service quality, coordination, and eventually finance and standards.

A second feasibility factor is the existence of public-sector policy direction toward renewable energy. The public-sector energy actor confirmed that private-sector investment in solar and wind energy is legally possible under Electricity Law No. 32 of 2010 and its amendments, and that memoranda of understanding, and power purchase agreements have been signed with investors. There have also been previous customs-duty reductions for solar equipment. These measures do not remove all constraints, but they show that renewable energy is not outside the public policy agenda.

A third feasibility factor is that humanitarian organisations can play a facilitative role without replacing market actors. The public-sector energy actor identified possible contributions from humanitarian organisations, including support for VTC upgrading, equipment, capacity building, technical studies, rural renewable energy solutions, microfinance, and employment linkages. This aligns with the MSD approach, provided that support is conditional, time-bound, and designed to strengthen local actor functions rather than substitute for them.

A fourth feasibility factor is the willingness of some solar SMEs and wholesalers to cooperate with practical training and apprenticeships. Interview data indicates that businesses value practical experience more than theoretical training. Some actors stated that formal training could be useful if it is practical and linked to real business needs. This creates a realistic entry point for testing a VTC–SME–supplier skills model.

A fifth feasibility factor is that VTCs exist and have previous or potential relevance to the sector, even though they are currently constrained. Four VTCs were consulted in Aleppo and Raqqa. Some had provided solar-related training in the past, particularly around 2020, but are not currently doing so due to constraints related to space, equipment, funding, materials, and institutional capacity. The public-sector energy actor also confirmed that cooperation between government institutions and VTCs exists but remains limited and requires further development, especially around recognised certification and curriculum updates based on labour market needs.

2.3 Defining the Target Group

For the proof of concept, the assessment distinguishes between final beneficiaries, direct market partners, and wider system actors.

Final beneficiaries are youth and women with potential to enter solar-related work, especially in technical assistance, installation support, maintenance support, sales, customer service, marketing, administration, advisory services, stock and warranty documentation, and selected technical assistant roles. Low-income households and enterprises are indirect end-market beneficiaries because they would benefit from better installation, advice, maintenance, and service quality.

Direct market partners are VTCs, solar SMEs, retailers, wholesalers/importers, electricians, technicians, blacksmiths, and selected battery recycling actors. These actors shape whether the skills function becomes more responsive to market demand and whether youth and women can access realistic pathways into the sector.

Wider system actors include relevant public or sector bodies, chambers, banks/MFIs, local authorities, NGOs/donors, media platforms, and community networks. These actors are important for future pathways related to finance, certification, standards, advisory services, public incentives, and customer information.

The main symptoms of market underperformance affecting these groups are concentrated around affordability, trust, service quality, and skills. Customers want solar systems but cannot afford the upfront cost; formal finance is largely absent; product quality is difficult to verify; advisory services are often sales-driven; installation quality varies; warranties have no fixed rules; maintenance is inconsistent or missing; and training remains informal, short, or disconnected from labour-market demand.

Women remain largely excluded from technical roles and are more visible as customers or in administrative and marketing functions. Future programming should therefore map realistic roles before enrolment and avoid assuming that all technical positions are immediately accessible without changes to safety, mobility, timing, workplace arrangements, and employer acceptance.

Taken together, these symptoms show that the market is not underperforming because of lack of demand alone. The deeper constraints are linked to affordability, trust, information, standards, warranties, skills, maintenance, and weak coordination between actors. For this feasibility project, the most practical entry point is the skills and VTC pathway, while the other constraints remain part of the wider systemic agenda.

2.4 Cross-Cutting Issues (climate change, gender issues, conflict sensitivity)

Gender equality and social inclusion

Women are present as customers and occasionally as employees in administrative or marketing roles, but they are rarely involved in installation, maintenance, technical advisory roles, or recycling. Retailers and wholesalers generally did not reject women's participation outright, but technical roles are still perceived as male-dominated due to physical work, field mobility, roof installation, safety risks, customer norms, and the nature of electrical work. Women's inclusion should therefore be based on role mapping before recruitment, not after training delivery.

Youth employment

Youth are an important potential labour pool for the sector. Solar SMEs often employ young men, and some businesses reported that practical skills can be developed through experience. However, the current market does not provide a structured pathway from training to employment. Youth without personal networks, prior experience, or informal access to employers may struggle to enter the sector.

Climate and environment

Solar energy can reduce reliance on diesel generators and provide decentralised renewable energy in areas with weak public electricity supply. It also aligns with public-sector interest in renewable energy, rural energy solutions, energy efficiency, and longer-term energy planning. However, battery use, replacement, damaged components, and unsafe disposal require careful environmental and occupational safety management. Solar training curricula should include safe battery handling, environmental risks, disposal practices, PPE, and referral to specialised recycling actors.

Conflict sensitivity

SEMS operates in a fragile and politically complex environment. Import routes, customs, taxes, border access, money transfers, supply chains, and local governance arrangements can all be affected by political and security dynamics. An MSD intervention must avoid market distortion by subsidising individual businesses in ways that undermine competition. Support should be facilitative, conditional, time-bound, and linked to behavioural change.

Safety and occupational risk

Solar installation and maintenance involve electrical hazards, work at heights, roof installation, manual handling, and exposure to batteries and electrical components. Safety must be a core component of the VTC/skills pathway, including electrical safety, working at heights, battery handling, PPE, basic first aid, and customer safety.

3. MARKET SYSTEM STRUCTURE AND CONSTRAINTS

The Solar Energy Market System in Aleppo, Idlib, and Raqqa is structured around a core transaction between solar system retailers/SMEs on the supply side and rural households and enterprises on the demand side. Retailers and SMEs sell solar systems, provide or arrange installation, offer customer advice, issue warranties, and in some cases provide maintenance or repair services. Customers purchase solar systems to meet household electricity needs, operate enterprises, reduce production costs, power irrigation or agricultural equipment, and maintain industrial activity.

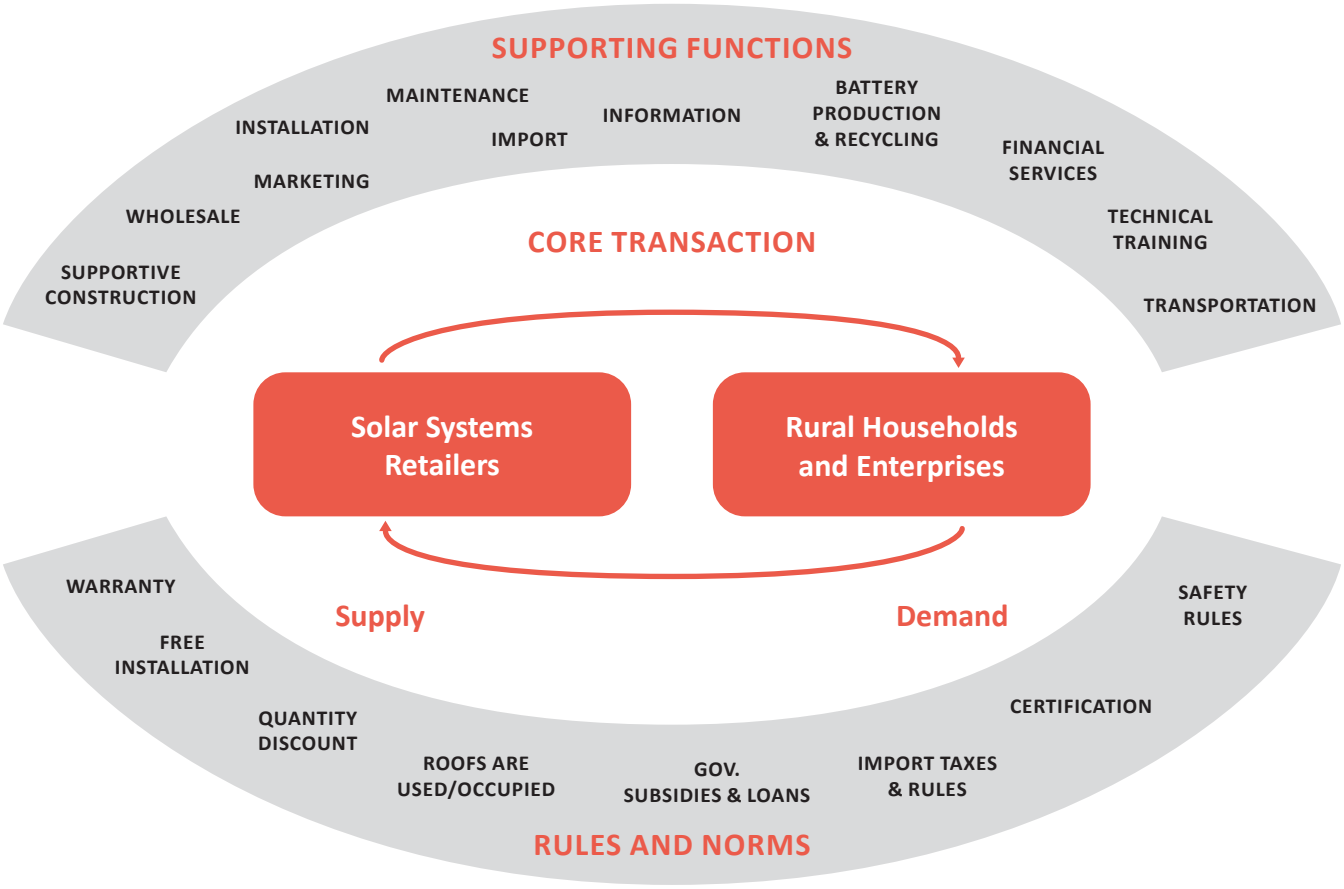


Figure 3. Market system overview: the core transaction, supporting functions, and rules and norms (original assessment diagram).

The following summary reflects the current market-system structure.

Market system layer	Key actors and functions
Core supply	Solar system retailers, solar SMEs, electricians, blacksmiths, installers, wholesalers/ importers, battery suppliers
Core demand	Rural households, urban households, small businesses, farms, NGOs, enterprises, industrial users
Supporting functions	Wholesale, import, installation, maintenance, awareness and advisory, feasibility study/design, technical training, financial services, transport, warranties, battery production and recycling, second-hand equipment supply
Rules and norms	Import taxes and rules, product certification, work safety rules, government subsidies or loans, quantity discounts, roof use/occupation, free or bundled installation, informal trust, reputation, warranty norms
Influential actors	Public-sector energy actors, local authorities, chambers, banks/MFIs, NGOs/donors, media platforms, community networks, suppliers, VTCs/TVET institutions

The concept note also frames the assessment around this type of market-system structure, with a core solar transaction and a potential skills sub-system where solar SMEs demand trained labour and youth/women represent potential labour supply.

3.1 Core Transaction

The core transaction in the solar energy market system is the sale, installation, and servicing of solar energy systems by solar retailers/SMEs to households, enterprises, farms, NGOs, and industrial users.

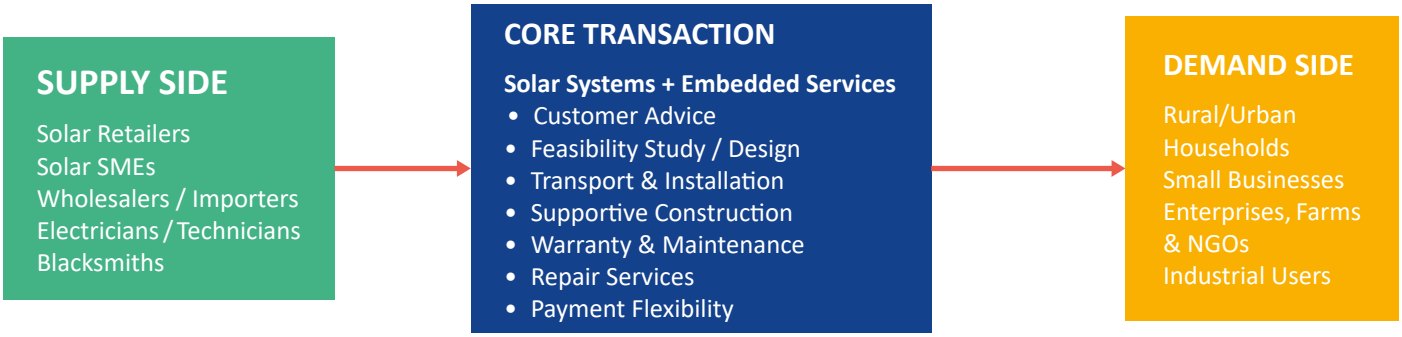


Figure 4. The core transaction between solar retailers and household and enterprise customers.

On the supply side, solar retailers and SMEs source panels, batteries, inverters, cables, accessories, and related components from wholesalers, importers, or local suppliers. Some businesses import directly, while others purchase from local supplier hubs. Retailers then package these products into solar systems according to customer needs, available budget, roof space, intended use, and available components.

On the demand side, customers purchase solar systems primarily because of unreliable electricity, high energy costs, and the need to operate essential equipment. Household customers use solar systems for lighting, refrigeration, washing machines, fans, air conditioning, ovens, and basic appliances. Enterprise and industrial customers use systems for machinery, refrigeration compressors, motors, pumps, workshops, and production-related equipment. Farms and rural enterprises use solar systems for water pumping and irrigation. NGOs and public service institutions may use solar systems to support essential service delivery.

The transaction is not only a product sale. It usually includes a bundle of embedded or associated services.

Embedded or associated service	Current practice
Customer advice	Often provided informally and free of charge by retailers, electricians, or technicians, usually linked to sales
Feasibility study/design	Often provided by electricians or technicians, but may include misleading information or poor system sizing
Transport	Provided by retailers, importers, or local transporters; sometimes included in the system price

Installation	Provided by retailers, electricians, blacksmiths, or subcontracted technicians; usually paid by the customer
Supportive construction	Blacksmiths may be involved in roof structures and mounting systems
Warranty	Provided by retailers and importers, but with no fixed market rules
Maintenance	Provided by some wholesalers, retailers, specialists, or customers themselves, but mostly missing as a structured service
Repair	Available through some retailers, technicians, or specialised actors
Payment flexibility	Limited; some informal arrangements through retailers or hawala, but no formalised finance products at scale

The core transaction is functioning, but it is not yet transparent or consistently quality-assured. Customers rely heavily on trust, reputation, referrals, and shop visibility when selecting providers. Retailers also rely on trust-based relationships with suppliers and customers. This trust-based system enables transactions in a fragile market, but it leaves customers exposed to information asymmetry, counterfeit products, unclear warranties, misleading design advice, and inconsistent maintenance. This confirms that the market relies heavily on trust and social proof rather than formal certification, independent advice, or transparent quality labelling

The main transaction constraints are high upfront cost, counterfeit or low-quality products, variable installation quality, unclear warranty rules, inconsistent maintenance, informal skills development, and exposure to import and currency risks. These constraints reduce adoption, weaken customer trust, and limit the ability of low-income customers and new labour-market entrants to benefit from the market.

3.2 Supporting Functions

Supporting functions are the services, systems, relationships, and information flows that allow the core transaction to operate. In SEMS, they are partially present but unevenly developed. Retail and installation are commercially active, while maintenance, technical training, independent advisory services, formal finance, certification, and warranty rules remain weak or fragmented.

Supporting function	Current assessment
Wholesale and import	Commercially active but affected by USD pricing, price volatility, money-transfer barriers, customs, sanctions, and supply disruptions.
Installation	Central to system performance and safety, but quality varies across retailers, electricians, technicians, and blacksmiths.
Maintenance and after-sales service	Mostly missing as a structured market function; weakens system efficiency, equipment life, and customer trust.
Awareness and advisory services	Often provided by sellers and technicians; limited independent information increases risk of poor system selection.
Feasibility study and system design	Poor sizing or misleading advice can lead to underperformance, overpayment, and reduced trust.
Battery repair and recycling	Relevant for component recovery and environmental sustainability, but occupational and environmental risks need further assessment.
Financial services	One of the weakest functions; customers rely on savings, borrowing, hawala, or informal arrangements.
Technical training	The priority proof-of-concept pathway; current training is informal, short, and weakly linked to employer demand.
Warranties	Important trust mechanism but no fixed market rules; practices vary by product, supplier, and retailer.
Transport and second-hand supply	Relevant but lower priority; linked to product damage, warranty, affordability, and quality risks.

Technical training receives specific attention because it is urgent and testable. Four VTCs were consulted in Aleppo and Raqqa. They are not currently providing strong solar-energy-related training, although some had done so around 2020. Their constraints include outdated curricula, limited practical equipment, lack of materials, funding and space, no systematic labour market assessment, no graduate tracking, limited apprenticeship pathways, and weak women's inclusion. Solar SMEs currently rely heavily on personal networks and on-the-job learning. This creates a practical opening for testing whether a VTC–SME–supplier model can improve market responsiveness, technician readiness, safety, and service quality.

3.3 Rules and Norms

Rules and norms shape how the solar market functions. Some are formal, such as import rules and product certification. Others are informal, such as trust, reputation, bundled installation, and customer reliance on referrals.

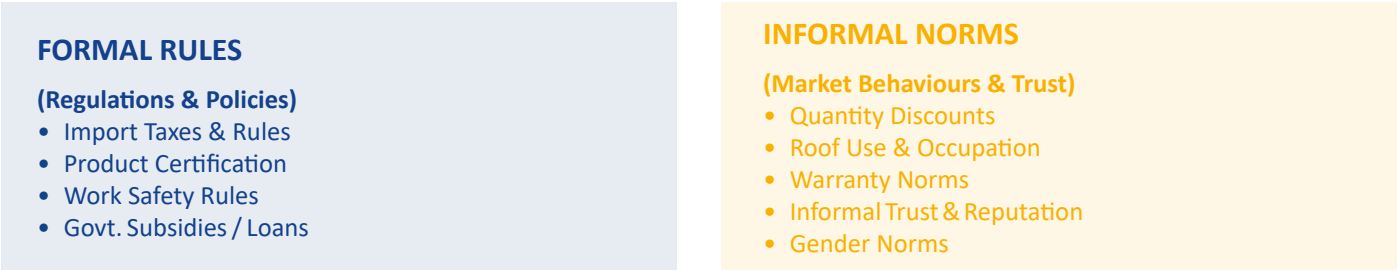


Figure 5. Formal and informal rules and norms shaping the solar energy market.

Rule / Norm	Current Problem
Import taxes and rules	Unclear rules and high costs; customs duties and import constraints affect pricing and product availability
Product certification	No consistent local certification; only international certificates used for import; counterfeit risks and customer confusion
Work safety rules	Weak or absent enforcement; electrical, roof-work, battery, and recycling risks are managed informally and inconsistently
Government subsidies or loans	Current support is mainly donor and NGO-led; weak public financing capacity; no structured solar loan or subsidy mechanism at scale
Quantity discounts	Informal commercial practice that benefits larger buyers; low-income households rarely benefit from volume pricing
Roof use and occupation	Some customers want to expand systems but lack suitable, available, or structurally adequate roof space; roofs may be shared, occupied, or too small
Warranty norms	No fixed market rules; coverage varies by product, supplier, customer relationship, and business policy; customer protection depends on reputation rather than enforceable standards
Informal trust and reputation	Enables transactions in a low-trust environment but limits transparency, excludes new entrants without networks, and makes it difficult for customers to make informed decisions
Gender norms	Technical roles perceived as male-dominated; women mainly participate as customers or in administrative and marketing roles; barriers include physical work, field mobility, roof installation, safety risks, toxic materials, and social expectations

Product certification is weak. The WDWP analysis indicates that international certificates may be used for import, while local certification or recognition is missing or inconsistent. This contributes to counterfeit products, quality variation, and customer confusion. Work safety rules are also weak or unevenly enforced, which matters because installation involves electrical hazards, roof work, and battery exposure. Government subsidies or soft loans are not operating at sufficient scale, although the public-sector energy actor identified possible incentives such as customs and tax incentives, soft loans, net metering, local manufacturing support, and awareness campaigns.

The enabling environment should therefore be described as mixed. Renewable energy is recognised in public policy direction, but implementation is constrained by financing, infrastructure, sanctions, import difficulties, grid limitations, lack of smart meters, absence of widespread net metering, and limited public investment capacity. For the proof of concept, the most realistic public-sector link is not grid reform or finance policy. It is dialogue around recognised training, curriculum relevance, certificate credibility, and eventual links between training, standards, and safer working practices.

3.4 Market Actors

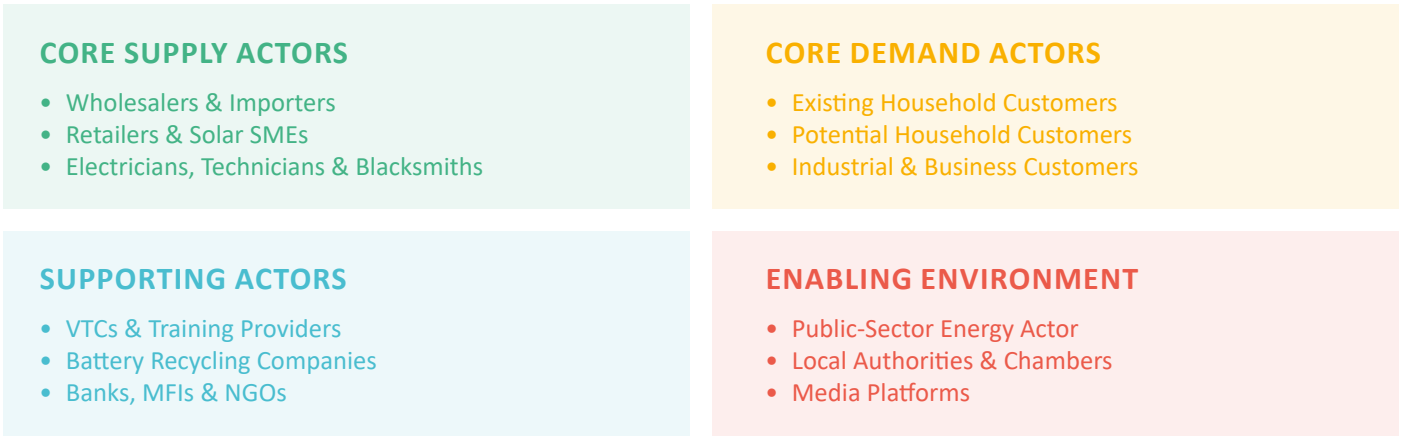


Figure 6. Key market actors and their roles in the solar energy market system.

The table below profiles the main actors operating in the solar energy market system, together with their incentives and their relevance to strengthening the sector.

Actor	Incentives	Relevance
Wholesalers/importers	Expand sales, protect reputation, reduce warranty misuse, strengthen retailer relationships	Potential role in product-specific training, warranty explanation, and technical demonstrations
Solar SMEs/retailers	Increase customer trust, reduce complaints, recruit better workers, differentiate from lower-quality competitors	Core partners for curriculum co-design, apprenticeships, employer feedback, and recruitment pathways
Electricians/technicians/ blacksmiths	Paid work, reputation, repeat clients, stronger retailer links	Practical trainers, mentors, apprenticeship hosts, or upskilling participants
Existing and potential customers	Reliable electricity, reduced energy costs, better household/business functionality	Indirect beneficiaries; provide feedback on service quality, advice, warranty, and maintenance
VTCs/training providers	Attract trainees, improve graduate outcomes, reconnect with labour market demand	Primary institutional partners, but require capacity support and market linkages
Battery recyclers	Recover value, expand battery services, access used batteries	Secondary input on safe battery handling and referral pathways
Ministry of Energy Representative	Renewable-energy planning, skills, certification, public coordination	Dialogue on certificate recognition, standards, and public learning
Banks/MFIs/chambers/ certification bodies	Potential role in finance, standards, and formal recognition	Future validation partners; not directly consulted in this assessment

3.5 Interconnected Market Systems

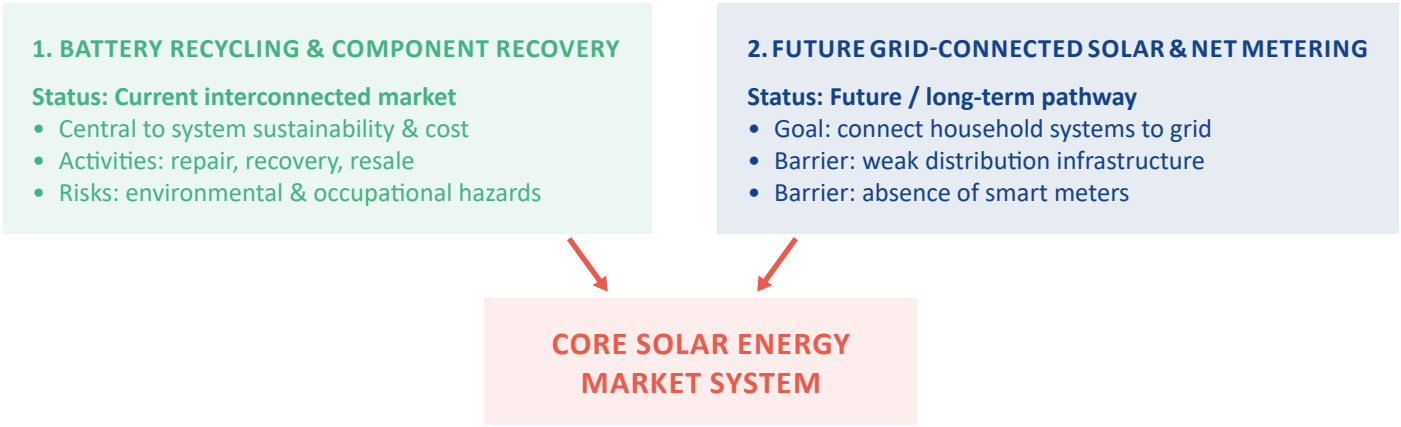


Figure 7. How the solar energy market system interconnects with related market systems.

Battery recycling and component recovery are the most relevant interconnected systems identified during the assessment. Battery recycling is not the main solar energy core transaction, but it is closely connected to system sustainability, customer satisfaction, maintenance costs, and environmental management. The assessment included three formal battery recycling companies in Aleppo and Raqqa. These actors buy damaged or used batteries from individuals, suppliers, companies, and factories, and engage in repair, component recovery, resale, and recycling.

Battery recycling matters because batteries are expensive and central to solar system performance; repair and recycling can reduce replacement costs and recover value; and unsafe disposal can create environmental and occupational risks. The proof of concept should not focus on recycling as the main pathway, but solar training should include basic modules on battery handling, environmental safety, and referral to specialised recyclers.

A second interconnected system is future grid-connected decentralised solar energy. The Ministry interview confirmed interest in mechanisms that allow household systems to connect to the public grid, but this is not feasible at scale in the short term. Barriers include weak distribution infrastructure, lack of protection and metering readiness, absence of smart meters, limited net metering, power-quality concerns, regulatory challenges, and major investment needs.

3.6 Summary of Identified Constraints

The table below summarises the main constraints identified across the Solar Energy Market System.

Core Market: constraints, root causes, and impact.

Symptom / constraint	Underlying (root) cause(s)	Impact on market system
High upfront cost of solar systems	Low household income, high import costs, exchange-rate volatility, absence of finance products	Limits adoption among low-income households and small enterprises despite strong demand
Counterfeit and low-quality products	Weak local certification, limited labelling, competition on price, customer information gaps	Weakens customer trust and makes purchasing decisions risky
Variable installation quality	Informal skills, weak certification, reliance on retailers/electricians/ blacksmiths, limited safety standards	Reduces system performance and customer satisfaction
Unclear warranty rules	No fixed market rules, supplier-dependent practices, weak standards	Reduces customer protection and increases reliance on trust
Inconsistent or missing maintenance	Maintenance not standardised, weak service models, limited trained technicians	Reduces efficiency, system life, and customer confidence

Supporting Functions: constraints, root causes, and impact.

Symptom / constraint	Underlying (root) cause(s)	Impact on market system
Import dependency	Limited local production, reliance on external manufacturers and local import hubs	Exposes prices and availability to customs, border access, exchange rates, and global disruptions
International money-transfer barriers	Sanctions, weak banking channels, reliance on informal channels	Disrupts import and supplier payments
Price volatility and weak contracts	USD pricing, fluctuating exchange rates, monopoly risks, no contracts	Creates uncertainty for retailers and customers
Lack of formal finance products	Weak banking/MFI engagement, trust issues, high fees, no structured solar loan products	Prevents low-income customers from purchasing systems and limits business expansion
Weak independent advisory services	Customers rely on traders, friends, referrals, and social media	Increases information asymmetry and risk of inappropriate system selection
Misleading or weak technical advice	Informal design practices, limited standards, sales-driven advice	Leads to poor system sizing and lower customer satisfaction
Informal worker training	SMEs train on the job, weak VTC-SME links, limited practical curricula	Limits quality, safety, standardisation, and entry pathways for youth and women
Weak training-provider capacity	Outdated curricula, lack of equipment, funding, materials, space, LMA, graduate tracking, apprenticeships	Prevents VTCs from functioning as effective market-responsive skills providers

Rules and Regulations: constraints, root causes, and impact.

Symptom / constraint	Underlying (root) cause(s)	Impact on market system
Weak product certification	Local certification missing; only international certificates used for import	Allows quality variation and weakens trust
Weak work safety rules	Missing or weak enforcement, informal safety practices	Creates risks for workers, customers, installers, and recyclers
Limited government subsidies or loans	Current support mainly donor/NGO-led, weak public financing capacity	Limits sustainable affordability mechanisms
Gender norms restrict women's participation	Social norms, safety concerns, physical work, mobility constraints, toxic-material concerns in recycling	Women remain largely excluded from technical and higher-value opportunities
Informal recruitment and trust-based market behaviour	Reliance on personal networks, referrals, and reputation	Excludes new entrants and reduces transparency
Environmental and health risks in battery recycling	Toxic materials, uneven waste handling, limited evidence on safe disposal	May undermine environmental sustainability of solar adoption
Weak grid readiness for decentralised generation	Damaged distribution infrastructure, lack of smart meters, limited protection systems, absence of widespread net metering	Limits grid-connected solar and resale of electricity
Limited public-private coordination	Partial public direction but constrained implementation; weak engagement with chambers, banks, MFIs, and certification actors	Finance, certification, net metering, and subsidies remain longer-term pathways

The assessment identifies several important constraints, but not all are equally feasible for immediate action. Finance and standards are highly important, but they require higher-level engagement with banks, MFIs, public authorities, chambers, and certification actors. Net metering and grid-connected solar are also important but require infrastructure investment, smart meters, regulatory upgrades, and grid readiness. Information and advisory services are important, but may require broader communication platforms and trusted independent actors.

The most urgent and feasible constraint to test through the proof of concept is the skills and VTC pathway. This conclusion is supported by three evidence sources:

1. Solar SMEs and retailers report reliance on informal worker training and practical on-the-job learning.
2. VTCs report lack of equipment, funding, space, updated curricula, labour market assessment, graduate tracking, and apprenticeship pathways.
3. The public-sector energy actor confirms difficulty attracting qualified engineers and technicians and confirms the need for practical renewable-energy training and stronger VTC-government cooperation around recognised certification and labour-market-relevant curricula.

The priority hypothesis is therefore that a hybrid VTC–SME–supplier model can improve the market responsiveness of training, strengthen technician readiness, reduce recruitment costs for SMEs, improve installation and maintenance quality, strengthen customer trust, and indirectly contribute to increased adoption of solar energy systems among low-income households and enterprises.

4. VISION AND SYSTEMIC INTERVENTION

4.1 Vision for Sustainability

The long-term vision is for the solar energy market system in Aleppo, Idlib, and Raqqa to become more accessible, reliable, transparent, service-orientated, skills-responsive, and environmentally safer, particularly for low-income rural households and enterprises. In this future system, customers would be able to access better information, identify reliable products and service providers, receive quality installation and maintenance, benefit from clearer warranty arrangements, and eventually use suitable financing mechanisms to reduce the barrier of high upfront costs.

The assessment identified several systemic needs across the market, including finance, standards, information, maintenance, skills, safer recycling, and public-sector incentives. However, not all of these are equally feasible for immediate intervention. Finance, certification, subsidies, and net metering require engagement with public authorities, banks, MFIs, chambers, certification bodies, and regulatory actors. Information and advisory services require trusted technical content and credible communication channels. Battery recycling has environmental relevance but remains a connected supporting market rather than the main transaction.

For the immediate proof of concept, the most feasible and urgent pathway is the VTC/skills pathway. The sustainability vision is therefore that VTCs, solar SMEs, wholesalers/suppliers, electricians, blacksmiths, and apprentices gradually move from fragmented, informal, and supply-driven training practices toward a more market-responsive skills system.

Function	Current weakness	Future role	Relevance to proof of concept
Retail and installation	Quality varies; customers struggle to compare providers	Retailers/SMEs, electricians, technicians, blacksmiths provide better-quality installation	Training and employer engagement improve service quality and trust
Maintenance and after-sales	Mostly missing or inconsistent	Retailers and specialised technicians offer clearer paid or warranty-linked maintenance	Curriculum includes fault diagnosis, maintenance, and customer communication
Advisory and system design	Sales-driven advice and possible poor sizing	Trained advisors/technicians provide clearer sizing and customer guidance	Training includes system design, roof assessment, battery sizing, and honest trade-offs

Technical training	Informal, short, weakly linked to demand	VTCs, SMEs, suppliers, and technicians jointly deliver market-responsive training	Core proof-of-concept pathway
Certification and warranties	Weak local certification; unclear warranty rules	Sector/public actors explore recognition and clearer warranty-linked standards	Certificate recognition treated as a learning question
Finance	Formal solar finance absent or weak	Banks/MFIs/government/ retailers may develop future products	Future validation pathway, not immediate proof-of-concept focus
Battery recycling	Environmental and occupational risks under-assessed	Licensed recyclers linked to SMEs and customers through safe referral pathways	Training includes basic battery safety and referral

Sustainability in MSD terms means that market actors continue performing improved functions after project support ends because it is in their commercial interest to do so. The VTC/skills PoC is sustainable when VTCs charge market-rate fees to trainees or employers, suppliers fund their own product training sessions because doing so reduces warranty claims, and SMEs recruit from VTCs as a standard practice because trained graduates reduce recruitment risk and improve service quality. That is the exit condition, and the PoC design should be evaluated against it from the start.

The complementary systemic pathways - finance, certification, information, maintenance, safer recycling, and public-private coordination - are important but less immediately feasible. They are positioned as future phases, with the PoC generating learning that informs their sequencing and design.

In this improved system:

- VTCs regularly assess labour market demand and adapt solar-related training accordingly.
- Solar SMEs contribute to curriculum design, practical training, apprenticeship placements, and graduate feedback.
- Wholesalers and suppliers provide product-specific training linked to warranties, quality standards, safe installation, battery handling, and maintenance.
- Electricians, blacksmiths, and technicians improve their practical skills, safety practices, and service quality.
- Youth and women access realistic entry points into the solar labour market.
- Customers receive better installation, advice, maintenance, and after-sales services.
- Improved service quality increases customer trust and contributes to wider adoption of solar energy systems among low-income households and enterprises.
- Public or sector actors may gradually support recognition of training certificates, technical standards, and safer working practices.

4.2 Intended Systemic Change

The intended systemic change is to strengthen the capacity and incentives of market actors to provide more relevant, practical, and employment-linked solar energy skills. The immediate focus is not to solve all solar market constraints. It is to test whether a better-performing skills function can contribute to improved service quality, customer trust, and, eventually, wider adoption of solar energy systems.

The assessment identified several possible systemic pathways:

Pathway	Systemic need	Importance	Immediate feasibility	Sequencing
Finance	Customers cannot afford high upfront costs; formal solar finance is weak or absent	High	Low to medium	Future validation

Standards/ certification	Customers struggle to identify quality products and reliable providers	High	Low to medium	Future validation
Information/ advisory	Customers lack trusted independent information and may receive weak design advice	Medium to high	Medium	Medium-term
Maintenance/ service	After-sales service is inconsistent or missing	Medium to high	Medium	Integrate into skills pathway
VTC/skills	Training is informal, short, and poorly linked to market demand	Medium to high	High	Immediate proof of concept
Battery recycling	Battery repair/recycling affects environmental safety and component recovery	Medium	Medium	Secondary/ future
Grid/net metering	Household systems cannot realistically connect to the grid at scale	High long-term	Low short-term	Long-term enabling environment

The prioritised proof-of-concept hypothesis is: If VTCs co-design solar training with solar SMEs and integrate practical apprenticeships, then graduates will be more employable and solar SMEs will have stronger incentives to engage with training providers, because training will reduce recruitment costs, improve technician readiness, strengthen service quality, and contribute to increased customer trust and adoption of solar energy systems among low-income households and enterprises.

The recommended intervention model is a hybrid VTC–SME–supplier model in Aleppo. PIN's role should be facilitative: convening actors, supporting tools, reducing initial transaction costs, applying smart and conditional support, documenting learning, and monitoring behavioural change. PIN should not become a retailer, installer, direct training provider, or permanent funder of market functions.

Actor	Proposed role
VTCs / TVET institutions	Provide structured technical training, basic theory, practical sessions where equipment is available, safety training, trainee management, and graduate tracking
Solar SMEs / retailers	Co-design practical content, host apprenticeships, provide real work exposure, give feedback on trainee readiness, identify priority skill gaps
Wholesalers / suppliers	Provide product-specific sessions on panels, batteries, inverters, warranties, safe installation, common faults, and maintenance
Electricians, technicians, blacksmiths	Contribute practical experience; participate as trainers, mentors, apprenticeship hosts, or upskilling participants
Battery recyclers	Provide input on safe battery handling, component recovery, environmental risks, and referral pathways
Public-sector energy actor / relevant public or sector bodies	Explore recognition of training certificates, curriculum relevance, and possible links to future standards or safety rules
Trainees	Participate in structured training, practical sessions, apprenticeships, and feedback mechanisms
PIN	Facilitate coordination, support tools, reduce initial transaction costs, apply smart and conditional support, document learning, and monitor behavioural change
Customers	Benefit indirectly from improved installation, maintenance, advice, and service quality

The intervention should avoid a traditional supply-driven training model. Training should only be supported if SMEs and suppliers participate meaningfully. The proof of concept should measure whether market actors change behaviour, not only whether trainees complete a course.

The public-sector energy actor confirmed that cooperation between government institutions and VTCs exists but remains limited and requires development, particularly around recognition of certificates and curricula that respond to labour market needs. Therefore, certificate recognition should be included in the proof of concept as a learning question, not as a guaranteed output.

The proposed learning question: Can a locally credible VTC solar training certificate be developed or endorsed through cooperation between VTCs, solar SMEs, suppliers, and relevant public or sector actors, and would such recognition increase employer trust in graduates?

This should be explored carefully. The project should not promise formal government accreditation unless the responsible institutions confirm a realistic pathway. However, even a sector-recognised certificate endorsed by participating SMEs and suppliers could improve trust and graduate signalling in the short term.

4.3 Potential Private/Public Sector Partners

The assessment points to several categories of potential partners. Since business names will remain anonymised, partners will be described by function and capacity rather than by company name.

VTCs are the primary institutional partners, though they need further support to work effectively. Solar SMEs and retailers are central: they understand customer demand and the practical skills the market needs. Suppliers matter too, as they control the product knowledge, warranties, and technical specifications that underpin quality and reliability. Electricians, technicians, and blacksmiths should be treated as key market actors rather than informal labourers, given the expertise they bring. Battery recyclers are secondary partners, relevant mainly for building environmental safety content into the training. Public or sector actors have a role in the dialogue on certificate recognition and standards, which could help establish credibility for the training. Banks and microfinance institutions (MFIs) are potential future validation partners, though they have not yet been directly consulted.

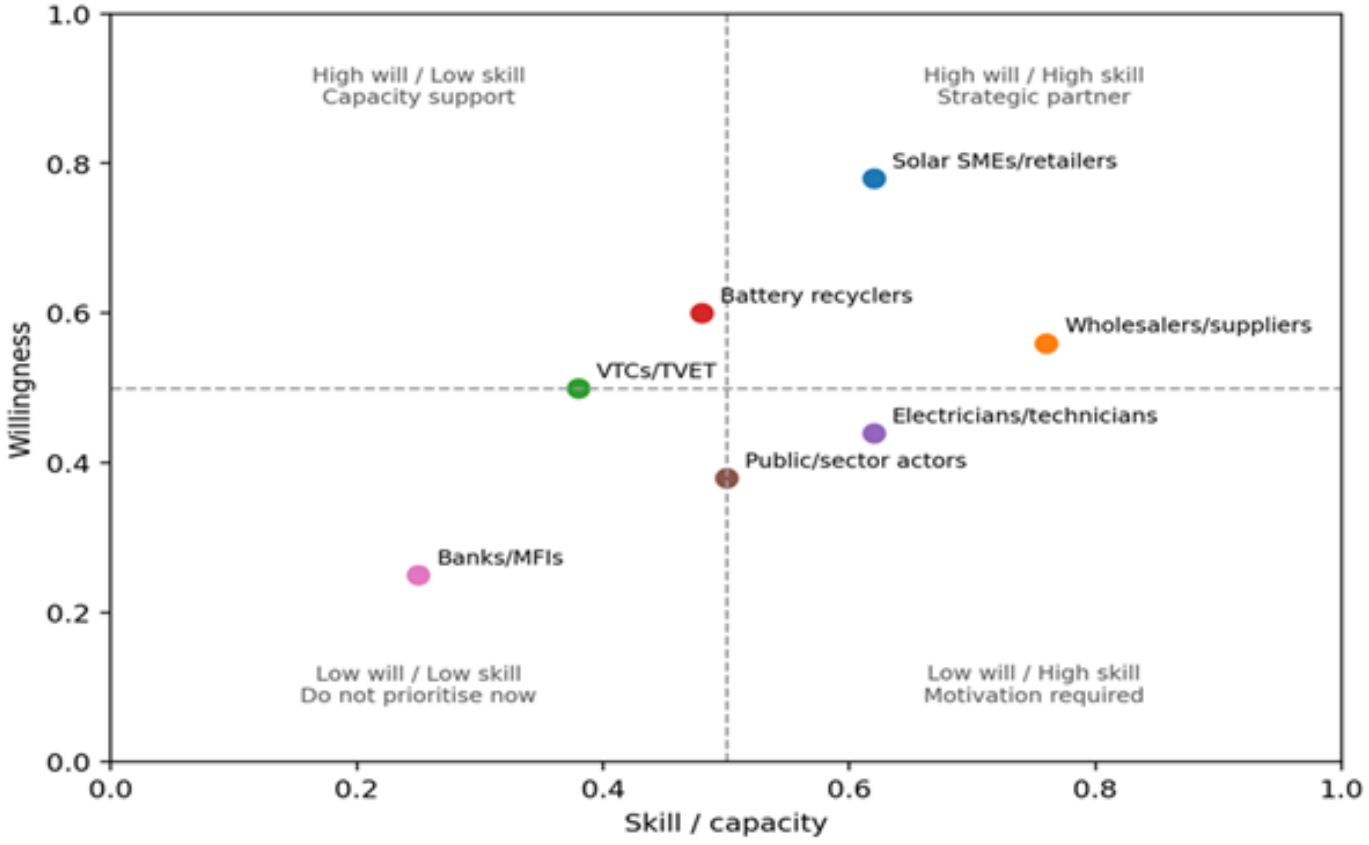


Figure 8. Will-skill matrix for potential implementation partners.

4.4 Theory of Change

The proposed Theory of Change should distinguish between the wider systemic vision and the immediate proof-of-concept pathway.

The result chain below presents the broader systemic vision for how the solar energy market system could become more inclusive, transparent, and service-orientated over time. It reflects multiple potential pathways identified through the assessment, including finance, standards and certification, information, advisory and maintenance services, and skills development. While the full result chain captures the wider market-system logic, the immediate proof of concept recommended by this report focuses only on the VTC–SME–supplier skills pathway as the most feasible entry point for testing.

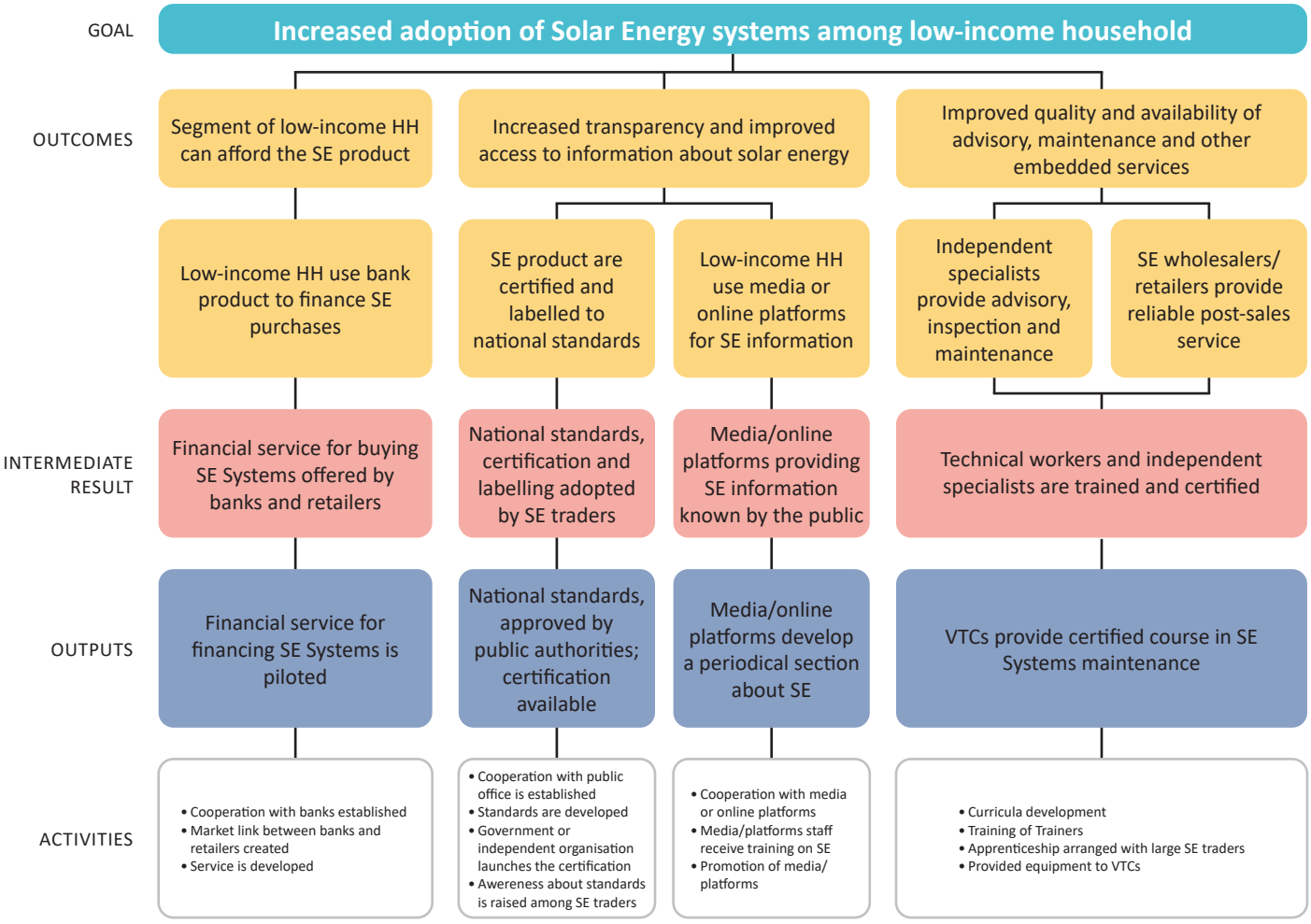


Figure 9. Theory of change: from the immediate proof-of-concept pathway to the wider systemic vision.

The wider vision is that low-income households and enterprises increase adoption of solar energy systems because the market becomes more affordable, transparent, service-oriented, quality-assured, environmentally safer, and supported by stronger technical skills. The immediate proof of concept tests only one priority pathway: whether a hybrid VTC-SME-supplier model can improve the skills function and generate commercially meaningful behaviour change among training providers, SMEs, suppliers, and technicians.

If PIN facilitates a hybrid partnership between VTCs, solar SMEs, suppliers, electricians, technicians, and relevant public or sector actors, then VTCs will be better able to design and deliver practical, market-relevant solar training. If solar SMEs and suppliers contribute to curriculum design, product-specific training, and apprenticeships, then trainees will gain more relevant technical and service skills. If electricians, technicians, and blacksmiths contribute practical experience, then training will better reflect the real conditions of installation, roof structures, maintenance, safety, and customer interaction. If trainees gain practical skills and workplace exposure, then solar SMEs will be more willing to recruit, host, or collaborate with trained graduates because the cost and risk of recruitment will decrease. If SMEs have access to better-prepared technicians and service staff, then installation, maintenance, customer advice, system design, and after-sales services will improve. If customers receive better-quality installation, clearer advice, more reliable maintenance, and

clearer warranty information, then customer trust in solar systems will improve. If customer trust improves, and if affordability and information barriers are addressed through future complementary pathways, Then adoption of solar energy systems among low-income households and enterprises is more likely to increase, contributing to improved energy access, enterprise resilience, and green livelihood opportunities.

4.4.1 Theory of Change Table

Level	Result statement	Key assumptions
Goal	Increased adoption of solar energy systems among low-income households and enterprises	Systems remain relevant to customer needs; affordability barriers are gradually addressed
System-level outcome	Customers have greater trust in solar systems due to better service quality, advice, installation, maintenance, and warranty clarity	Customers value quality and after-sales service; SMEs maintain service improvements
Intermediate outcome	Solar SMEs improve installation, maintenance, system design, advisory services, and customer support	SMEs see commercial value in better-trained workers
Behaviour change	SMEs, suppliers, technicians, and public/sector actors actively engage with VTCs	Actors are willing to invest time; suppliers see reputation and warranty benefits
Supporting function change	VTCs deliver practical, market-responsive solar training and track graduates	VTCs have minimum equipment, space, trainers, and management commitment
Recognition change	VTC certificates or training completion documents gain some employer or sector credibility	Employers value the certificate; public/sector actors are willing to discuss recognition
Intervention outputs	Training modules updated; apprenticeships established; supplier sessions delivered; trainees complete practical learning	PIN facilitation reduces coordination barriers
Activities	VTC capacity assessment, LMA, curriculum co-design, ToT, equipment/material support, SME apprenticeship agreements, supplier sessions, graduate tracking	Actors remain accessible and willing to cooperate

4.4.2 Key Indicators

The proof of concept should measure behavioural and systemic indicators, not only activity outputs.

Result area	Suggested indicator
SME engagement	Number of SMEs contributing to curriculum design, practical sessions, or apprenticeships
Supplier engagement	Number of suppliers providing product-specific training or warranty-related sessions
Technician engagement	Number of electricians, technicians, or blacksmiths involved in training, mentoring, or upskilling
VTC responsiveness	Number of VTCs updating curricula based on SME/supplier input
Practical training	Number of trainees completing practical solar training
Apprenticeship pathway	Number of trainees placed in apprenticeships or work exposure
Graduate tracking	Number/percentage of graduates tracked after training
Employment linkage	Number/percentage of graduates employed, self-employed, apprenticed, or retained in sector-related roles

Women's inclusion	Number/percentage of women enrolled, completing, and accessing relevant roles
Service quality	SME/customer feedback on trainee readiness and service quality
Certificate credibility	Number of SMEs/suppliers recognising or using the training certificate in recruitment decisions
Customer trust	Customer satisfaction with advice, installation, and maintenance from participating SMEs
Sustainability	Number of VTC–SME–supplier cooperation mechanisms continuing after project support

4.4.1 Theory of Change Table

Risk/assumption	Likelihood	Implication	Mitigation
SMEs may agree to participate but not invest meaningful time	High	Training remains supply-driven	Require clear commitments before support
VTCs may lack equipment, space, trainers, or management commitment	Medium	Training quality remains weak	Provide targeted, conditional, time-bound support
Women face structural barriers limiting participation beyond enrolment	Medium-High	Inclusion outcomes remain weak	Design realistic role pathways, safe transport, suitable timing, women-friendly cohorts where needed
Suppliers may treat training as marketing only	Medium	Product sessions become promotional rather than technical	Set technical content standards and include multiple suppliers where possible
Certificate recognition may not be formally possible	Medium	Certificate pathway may remain informal	Treat recognition as a learning question and begin with employer/sector recognition
Graduates may not find jobs due to weak demand	Medium	Employment outcomes limited	Link training to real SME demand and apprenticeships before enrolment
Better skills may not overcome affordability barriers	Low-Medium	Adoption impact remains indirect	Treat finance and information as complementary future pathways
Safety risks during practical training	Medium	Harm to trainees/ workers	Include mandatory occupational safety modules and PPE
Market distortion through subsidies	Low-Medium	SMEs/VTCs become donor-dependent	Use smart, conditional, time-bound support focused on behaviour change

4.5 Prioritised Intervention Package for Proof of Concept

Intervention title: Testing a Market-Responsive Solar Skills Model through VTC–SME–Supplier Collaboration

Intervention objective: To test whether VTCs can become a more effective supporting function in the solar energy market by co-designing and delivering practical solar training with SMEs and suppliers, linked to apprenticeships, service quality, certificate credibility, and employment pathways for youth and women.

Core components. The table below sets out the core components of the pilot, what each one involves, and how they fit together to test the intervention model.

Component	Description
VTC capacity assessment	Assess VTC readiness, equipment, trainers, space, curricula, inclusion capacity, and management commitment
Labour market assessment	Facilitate VTCs to collect basic labour market information from solar SMEs and suppliers
Curriculum co-design	SMEs and suppliers define practical skills, common faults, customer service needs, and safety requirements
Training of trainers	Strengthen VTC trainers in solar installation, maintenance, safety, customer advice, and market-responsive teaching
Equipment/material support	Provide limited, conditional support to enable practical training
Supplier technical sessions	Wholesalers/suppliers provide product-specific modules on batteries, inverters, panels, warranties, and faults
SME apprenticeships	Selected SMEs host trainees for practical exposure
Women's inclusion measures	Identify realistic roles and remove participation barriers through timing, transport, safe spaces, and role mapping
Graduate tracking	VTCs track trainee outcomes and share feedback with SMEs
Learning documentation	PIN documents whether the model changes actor behaviour and should be scaled, adapted, or discontinued

Expected learning questions

1. Can VTCs adapt training content based on direct SME, supplier, technician, and public/sector input?
2. Are solar SMEs willing to host apprentices or provide practical exposure?
3. Do suppliers see value in contributing to technical training?
4. Can electricians, technicians, and blacksmiths help make training more practical and safer?
5. Do trainees become more employable after practical training and work exposure?
6. Which roles are realistic for women in the solar energy market?
7. Can training completion documents or certificates become credible to employers?
8. Does improved training contribute to better service quality and customer trust?
9. What level of subsidy or facilitation is needed, and what can market actors sustain themselves?

4.6 Positioning of Other Intervention Pathways

The pathways below are not rejected; they are sequenced for future validation because they require actors and conditions not yet sufficiently assessed through this feasibility study.

Finance pathway. Finance is one of the strongest constraints. Customers want solar systems but cannot afford the upfront cost, and formal solar loans, leasing, insurance, or instalment products are mostly absent. However, banks and MFIs were not directly interviewed. Finance should therefore be treated as a priority pathway for future validation rather than a fully designed intervention option.

Standards and certification pathway. Quality uncertainty and counterfeit products affect trust. Certification, product labelling, technician standards, installation standards, and clearer warranty rules could improve the market. This pathway requires consultation with chambers, certification bodies, public authorities, suppliers, and SMEs. In the immediate proof of concept, the project can only begin to explore certificate recognition and sector endorsement for training.

Information and advisory pathway. Customers need better information to compare products, understand system sizing, assess payback periods, avoid low-quality products, and understand warranties. Advisory services currently come mainly from retailers, technicians, friends, referrals, and social media. This is a medium-term pathway and could later be linked to the skills model through trained customer advisors.

Maintenance and after-sales pathway. Maintenance is commercially relevant and linked to customer trust. It can be partially integrated into the VTC proof of concept through modules on fault diagnosis, safe maintenance, customer communication, warranty conditions, and after-sales service.

Battery recycling pathway. Battery recycling is relevant for environmental sustainability and component recovery. In the immediate proof of concept, it should be included through awareness modules on battery handling, environmental risks, safety, and referral to specialised recyclers. A dedicated recycling intervention would require further environmental and occupational-safety assessment.

Public incentives, net metering, and grid-connected solar. Customs and tax incentives, soft loans, net metering, support to local manufacturing, and awareness campaigns may be relevant longer-term options. However, household grid connection and electricity resale are constrained by weak infrastructure, lack of smart meters, limited net metering, power-quality concerns, and major investment needs. This is a long-term enabling-environment pathway, not an immediate proof-of-concept focus.

5. SUMMARY AND CONCLUSION

The assessment confirms that the Solar Energy Market System in Aleppo, Idlib, and Raqqa is commercially active, demand-driven, and highly relevant to household resilience, enterprise recovery, agricultural production, and emerging green livelihoods. Solar energy has become a practical response to unreliable electricity, high fuel and energy costs, weak public electricity provision, and the need for decentralised power among households, farms, businesses, NGOs, and industrial users.

The wider energy context reinforces this relevance. The public-sector energy actor confirmed major structural constraints in the energy sector, including damaged infrastructure, fuel and gas shortages, high grid losses, weak investment capacity, sanctions and import difficulties, and ageing control and communication systems. At the same time, public policy directions supporting renewable energy exist, including private-sector investment in solar and wind energy, previous customs-duty reductions, and longer-term energy planning. Implementation remains constrained by financing, infrastructure, regulatory, and import barriers.

The market has an existing base of private actors. Retailers, wholesalers, importers, electricians, blacksmiths, installers, maintenance actors, and battery recycling companies are already operating. Indicative field estimates suggest around 500 solar shops/SMEs in Aleppo, 250 in Idlib, and 100 in Raqqa. Therefore, the market does not need to be created from zero; the priority is to improve performance, inclusion, service quality, affordability, and trust.

Strong demand exists, but the system does not yet work well for low-income households, smaller enterprises, or new labour-market entrants. Customers face high upfront costs and lack formal finance. They also struggle to verify product quality, compare offers, understand warranties, and access consistent maintenance. Installation quality and advisory services vary across providers, while local certification and labelling remain weak.

The skills function is one of the weakest and most immediate constraints. Solar SMEs rely heavily on informal recruitment, personal networks, and on-the-job learning. VTCs are not currently functioning as strong supporting actors in the solar market and face constraints related to curricula, equipment, funding, space, labour market assessment, graduate tracking, apprenticeships, and women's inclusion. The public-sector energy interview further validated the need for practical renewable-energy training and stronger cooperation between VTCs, employers, and relevant public or sector actors.

Women's participation remains limited and should be approached through realistic role pathways. Battery recycling is relevant as a connected supporting market because batteries are central to solar system performance and environmental sustainability, but recycling should not be treated as the main market system. Environmental and occupational risks around batteries should be integrated into training and future safety work.

The Solar Energy Market System in Aleppo, Idlib, and Raqqa is relevant, commercially active, and strategically important for recovery, resilience, and green livelihoods. Demand exists across households, enterprises, farms, NGOs, and industrial users, and the market already includes a meaningful base of private actors.

The system does not yet work inclusively or reliably enough for low-income customers or new labour-market entrants. Affordability, weak finance, quality uncertainty, limited information, inconsistent installation, missing maintenance, unclear warranties, weak certification, informal skills development, and limited

women's participation all constrain market performance.

The recommended strategic direction is to proceed with a limited, learning-oriented VTC proof of concept. PIN should facilitate cooperation between VTCs, solar SMEs, suppliers, electricians, technicians, blacksmiths, and relevant public or sector actors to test whether training providers can become more responsive to market demand, whether SMEs and suppliers will invest time in practical training and apprenticeships, whether certificates can gain employer credibility, and whether better skills can improve service quality and customer trust.

If the proof of concept is successful, it can provide the evidence needed to expand into complementary pathways, including customer finance, certification, information services, maintenance models, safer battery recycling, and longer-term public-private coordination around renewable energy.

5.1 Constraints, Root Causes, and Prioritized Interventions

Priority 1: Immediate

Addressed directly by the VTC–SME–supplier proof of concept

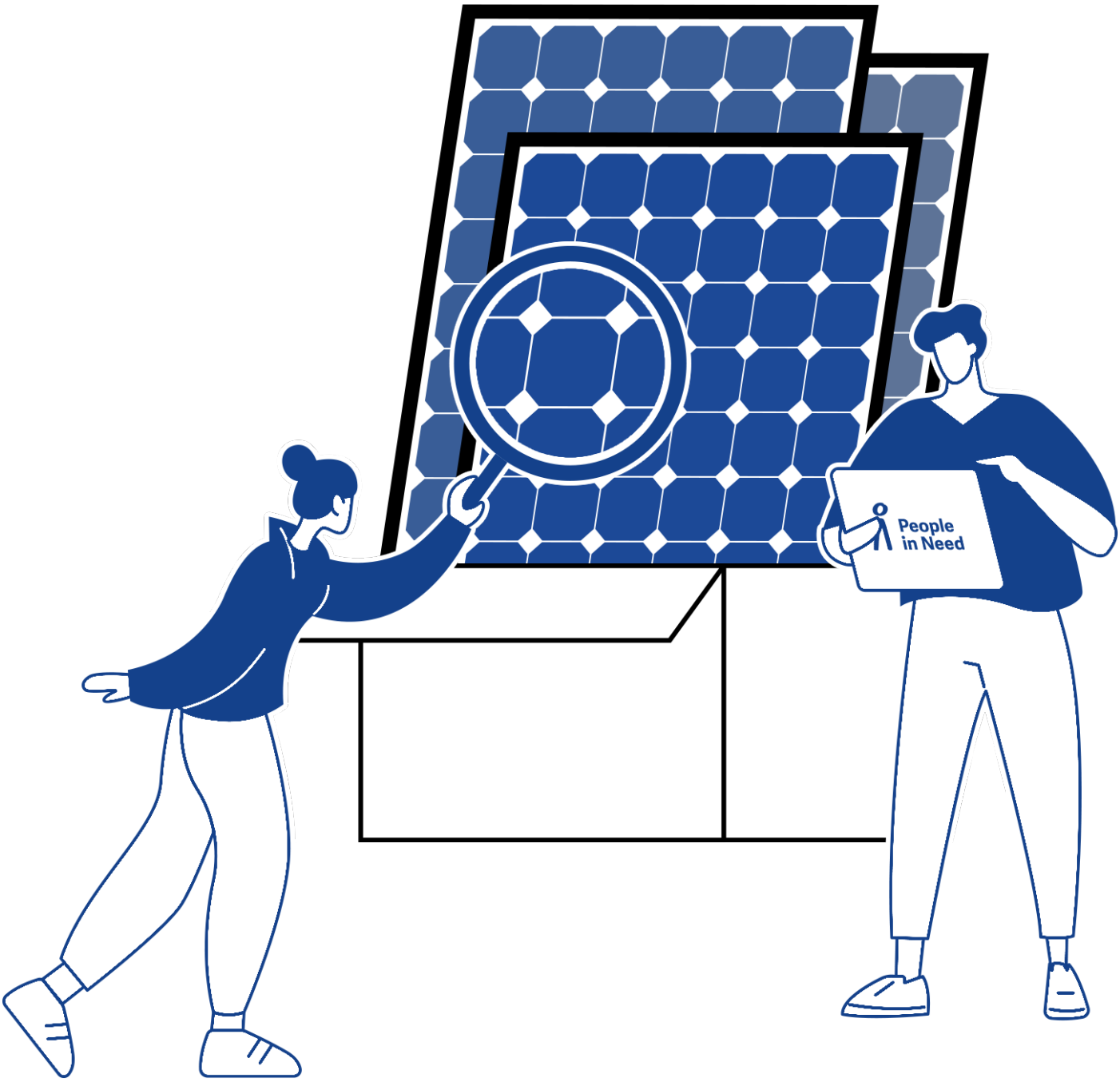
Constraint	Root Cause	Intervention Response
Informal worker training	SMEs train on the job; weak VTC–SME links; limited practical curricula	Facilitate VTC–SME–supplier curriculum co-design and apprenticeship placements
Weak training-provider capacity	Outdated curricula, lack of equipment/funding/space, no labour market assessment or graduate tracking	VTC capacity assessment, training of trainers, conditional equipment/material support
Variable installation quality	Informal skills, weak certification, reliance on informal technicians, limited safety standards	Practical training modules on installation technique and electrical/roof-work safety
Misleading or weak technical advice	Informal, sales-driven design practices; limited standards	Curriculum module on honest system design, sizing, and roof/battery assessment
Inconsistent or missing maintenance	Maintenance not standardised; limited trained technicians	Training module on fault diagnosis, safe maintenance, and customer communication
Gender norms restrict women's participation	Social norms, safety concerns, physical work, mobility constraints	Role mapping before recruitment; women's inclusion measures (timing, transport, safe spaces) built into PoC design

Priority 2: Medium-term

Sequenced pathways requiring further actor consultation; partial elements can be layered onto the PoC now

Constraint	Root Cause	Intervention Response
High upfront cost of solar systems	Low household income, high import costs, exchange-rate volatility, absence of finance products	Finance pathway: engage banks/MFIs to explore solar loan, leasing, or instalment products (future validation)
Lack of formal finance products	Weak banking/MFI engagement, trust issues, high fees	Same finance pathway; treat as a distinct future validation stream, not a PoC component
Counterfeit and low-quality products	Weak local certification, limited labelling, price-based competition	Standards/certification pathway: explore local certification and product labelling mechanisms
Weak product certification	Local certification missing; only international (e.g. IEC) certificates used at import	Standards/certification pathway: consult certification bodies and public authorities

Unclear warranty rules	No fixed market rules; supplier-dependent practices	Certification/standards pathway, paired with a warranty-awareness module inside the PoC curriculum now
Weak independent advisory services	Customers rely on traders, friends, referrals, social media	Information/advisory pathway: trusted independent information channel; can later link to VTC-trained advisors
Environmental and health risks in battery recycling	Toxic materials, uneven waste handling, limited safe-disposal evidence	Integrate basic battery-safety and referral module into PoC now; dedicated environmental/occupational assessment later



5.2 Recommendations

- PIN should test the proposed market-responsive solar skills model in Aleppo before considering wider geographical expansion. The intervention should require VTCs, solar SMEs, suppliers and relevant technicians to jointly identify skills needs, co-design practical training and provide workplace exposure or apprenticeships. PIN should remain a facilitator and not a permanent training provider or subsidising functions that viable market actors could eventually perform themselves.
- Equipment, training-of-trainers and material support to participating VTCs should only be provided where there is demonstrated management commitment and specific contributions from SMEs and suppliers. Participating businesses should commit to activities such as curriculum design, practical instruction, apprenticeships, recruitment feedback or supplier-led technical sessions before PIN resources are committed. This will reduce the risk of recreating a supply-driven vocational training programme disconnected from actual labour demand.
- The proof of concept should establish a simple mechanism through which VTCs periodically collect information from solar SMEs, suppliers and technicians on vacancies, emerging technologies, common installation faults and changing skills requirements. Graduate tracking and employer feedback should become part of the VTC operating model so that training continues to adapt after project support ends. The sustainability test should be whether these relationships continue because VTCs and businesses see sufficient value in maintaining them.
- Curricula should cover system sizing and design, installation, diagnostics, preventive maintenance, customer advice, warranty interpretation, battery handling, working at height, electrical safety and after-sales service. Supplier sessions should be technical rather than promotional and, where possible, involve more than one supplier. This responds directly to weaknesses identified in installation quality, maintenance, customer advice and warranty practices while reducing the occupational risks associated with solar and battery systems.
- PIN should facilitate dialogue between VTCs, SMEs, suppliers and relevant public or sector actors to determine whether completion certificates can become credible signals of technician competence. Formal government accreditation should not be promised at the proof-of-concept stage. A more realistic initial test is whether participating employers recognise the certificate when recruiting, selecting apprentices or subcontracting technicians; formal accreditation can subsequently be pursued if a viable institutional pathway emerges.
- Before recruitment begins, PIN and participating employers should identify realistic entry points for women and young people across installation support, maintenance, sales, system advisory services, customer service, marketing, administration, warranty management and other relevant functions. Barriers relating to transport, working hours, workplace safety, mobility and employer acceptance should be addressed during intervention design. Success should be measured by transition into employment, apprenticeships or viable self-employment—not simply training attendance.
- The assessment identifies affordability and finance as major constraints, but banks and MFIs were not directly consulted; similarly, certification bodies and chambers were outside the current evidence base. PIN should therefore undertake targeted consultations with these actors to determine the feasibility of future solar finance, product and installer standards, warranty mechanisms and trusted advisory services. Only after this validation should options such as instalment finance, leasing, group purchasing or other affordability mechanisms be considered for testing.
- Expansion to Idlib, Raqqa or additional systemic pathways should depend on evidence of sustained actor behaviour change rather than the number of people trained. Key decision criteria should include continued SME participation, supplier co-investment, apprenticeship uptake, employer use of VTC graduates, improved trainee employment outcomes, certificate credibility, service-quality improvements and continuation of VTC–SME–supplier relationships without significant PIN subsidy. If these conditions are demonstrated, the model can be adapted and scaled while progressively testing complementary pathways in finance, certification, advisory services, maintenance and safer battery recycling.

ANNEXES

Annex 1. Condensed WDWP Matrix

This annex presents a condensed WDWP matrix. The purpose is to show which functions should remain market-led, which actors have incentives to perform them, and where PIN can facilitate improvement without substituting for market actors.

	Current picture			Future vision		
Function	Current: Who does?	Current: Who pays?	Current issues	Future vision: Who should do?	Future vision: Who should pay?	Key incentive
Core functions						
Retail of solar systems	Solar retailers and solar SMEs	Customers	Counterfeit and low-quality products; weak customer ability to compare quality	Retailers and solar SMEs with clearer quality information and stronger reputation incentives	Customers	Sales, reputation, customer trust
Installation	Retailers, electricians, blacksmiths, technicians	Customers, often embedded in system price	Variable quality; weak integration between sale, design, installation, and safety	Certified or trained retailers, electricians, blacksmiths, and technicians	Customers	Reputation, customer satisfaction, reduced complaints
Supporting functions						
Wholesale	Wholesalers/ importers	Retailers and large customers	USD pricing, fluctuating prices, monopoly/ concentration risks, limited contracts	Wholesalers with clearer supplier relationships, better product information, and possible training role	Retailers/ customers through product price	Profit, market expansion, reputation
Import	International manufacturers and importers	Importers, retailers, customers through final price	International money-transfer difficulties, sanctions, import costs, customs, supply disruptions	Importers and suppliers operating through more predictable channels where possible	Importers/ customers through final price	Supply continuity, profit
Maintenance	Some wholesalers, retailers, specialists, customers themselves	Customers, or indirectly through warranty	Mostly missing as a structured market function	Wholesalers, retailers, and specialised technicians provide clear maintenance services	Customers; warranty-covered services paid through product/ service price	Customer trust, repeat business, efficiency
Awareness and advisory	Retailers, electricians, technicians, social media, friends/referrals	Usually free or embedded in sales	Limited and inadequate advice; no labelling; advice linked to promotion	Certified specialists, online platforms, media, trained advisors, VTC-linked information channels	Customers, advertisers, retailers, or mixed models	Trust, sales, customer protection

Feasibility study and system design	Electricians, technicians, retailers	Customers	Misleading information; poor sizing; sales-driven advice	Trained technicians, certified advisors, SMEs with improved design capacity	Customers	Better performance, reduced complaints
Battery production and recycling	Local recyclers and battery businesses	Retailers/ customers	Environmental problems and health risks	Licensed recyclers linked to SMEs and customers through safer referral channels	Recycling businesses, customers, retailers where relevant	Recovered value, safety, environmental protection
Financial services	Hawala, informal retailer credit, self-financing	Customers	High fees, trust issues, limited access, no formal solar finance products	Banks, MFIs, government, retailers, possible donor de-risking	Customers; finance providers recover cost through fees/ interest	Profit, expanded access, environmental and social benefit
Technical training	Retailers informally, NGOs occasionally, workers through experience	Retailers, jobseekers, donors	Missing or too short; lack of expertise; weak practical training	VTCs/TVET institutions, SMEs, suppliers, electricians, technicians	Mixed: trainees, employers, VTCs, government, initial donor smart support	Employment, reputation, service quality, reduced recruitment cost
Transportation	Local transporters, importers, retailers	Retailers/ customers	Risk of product damage during transport	Transporters and retailers using safer handling practices	Retailers/ customers	Reduced damage, customer satisfaction
Warranties	Retailers and importers	Retailers/ customers	No fixed rules; product- and supplier-dependent	Retailers/ importers with clearer warranty terms linked to standards and product information	Customers through product price; suppliers through warranty commitments	Trust, reputation, reduced disputes
Second-hand equipment supply	Retailers/ importers	Customers	Prohibited import; quality and safety risks	Only where legally allowed and quality-tested	Customers	Affordability, circular economy, risk reduction
Rules and norms						
Import taxes and rules	Government sets and enforces; importers and retailers comply	Retailer and Importers	Rules may be unclear; high tolls and costs affect prices	Clearer and more predictable rules; targeted incentives for quality renewable-energy products	Government, customs authorities, importers	Market growth, investment, energy access
Product certification	International certificates may be used for imports; local certification is weak or missing	Importer	No consistent local certification; customer confusion and counterfeit risks	Local certification or recognition mechanisms for products and possibly installers/ training	Government, Chamber of Industry, technical bodies, importers	Safety, quality, reputation

Work safety rules	Weak or missing enforcement; practices vary by actor	practices vary by actor	Electrical, roof-work, battery, and recycling risks	Government enforces; retailers, importers, technicians, blacksmiths, recyclers comply	Government, SMEs, specialists, recyclers, VTCs	Worker protection, service quality
Government subsidies or loans	Current support mostly donor/ NGO-led or absent at scale	NGOs, Donors	Weak sustainability; limited affordability support	Government-supported or regulated finance, soft loans, incentives, or targeted subsidies	Government, banks, MFIs, donors as facilitators	Grid pressure reduction, clean energy adoption
Quantity discounts	Informal commercial practice	Importer	Larger buyers benefit more than low-income households	Could support group purchasing or aggregated demand if well designed	Retailers, wholesalers, community groups, NGOs	Sales volume, affordability
Informal trust and reputation	Customers rely on referrals, friends, previous users, and shop reputation	practices vary by actor	Enables transactions but limits transparency and excludes new entrants	Trust supported by clearer information, standards, warranties, and trained service providers	Retailers, SMEs, suppliers, media, VTCs, chambers	Market credibility
Gender norms	Women mainly participate as customers or in admin/ marketing roles	practices vary by actor	Technical roles remain male-dominated	Realistic women-friendly roles identified and tested	VTCs, SMEs, NGOs, families, communities	Inclusion, expanded labour pool

Annex 2. Proof-of-Concept Implementation Checks

Before launching the Aleppo proof of concept, PIN should confirm the following minimum conditions:

- At least one VTC has minimum management commitment, trainer availability, space, and willingness to track graduates.
- Participating SMEs confirm specific roles in curriculum design, practical sessions, apprenticeships, work exposure, or employer feedback.
- At least one or more suppliers agree to provide technical, non-promotional product sessions on panels, batteries, inverters, warranties, faults, and safe installation.
- Training roles for women and youth are mapped before enrolment, including non-installation roles where relevant.
- Occupational safety requirements, PPE, supervision, and practical training risk controls are agreed before field exposure.
- Certificate recognition is framed as a learning question; formal accreditation is not promised unless a responsible authority confirms the pathway.
- PIN support is conditional, time-bound, and linked to behaviour change rather than routine operating costs.
- Monitoring tools capture actor behaviour change, not only trainee attendance or completion.
- Finance, certification, and advisory-service pathways are documented as future validation priorities, not ignored constraints.

Annex 3: List of Participants

Code	Actor group / consultation type	Governorate / level	Consultation month
WHI-01	Wholesaler/importer KII	Aleppo	April 2026
WHI-02	Wholesaler/importer KII	Aleppo	April 2026
WHI-03	Wholesaler/importer KII	Idleb	May 2026
RET-01	Retailer/solar SME KII	Raqqa	April 2026
RET-02	Retailer/solar SME KII	Raqqa	April 2026
RET-03	Retailer/solar SME KII	Raqqa	April 2026
RET-04	Retailer/solar SME KII	Raqqa	April 2026
RET-05	Retailer/solar SME KII	Aleppo	April 2026
RET-06	Retailer/solar SME KII	Aleppo	April 2026
RET-07	Retailer/solar SME KII	Aleppo	April 2026
RET-08	Retailer/solar SME KII	Aleppo	April 2026
RET-09	Retailer/solar SME KII	Idlib	April 2026
RET-10	Retailer/solar SME KII	Idlib	April 2026
RET-11	Retailer/solar SME KII	Idlib	April 2026
EXC-01	Existing-customer interview	Raqqa	April 2026
EXC-02	Existing-customer interview	Raqqa	April 2026
EXC-03	Existing-customer interview	Raqqa	April 2026
EXC-04	Existing-customer interview	Raqqa	April 2026
EXC-05	Existing-customer interview	Aleppo	April 2026
EXC-06	Existing-customer interview	Aleppo	April 2026
EXC-07	Existing-customer interview	Aleppo	April 2026
EXC-08	Existing-customer interview	Aleppo	April 2026
EXC-09	Existing-customer interview	Idlib	April 2026
EXC-10	Existing-customer interview	Idlib	April 2026
EXC-11	Existing-customer interview	Idlib	April 2026
POT-01	Potential-customer interview	Raqqa	April 2026
POT-02	Potential-customer interview	Raqqa	April 2026
POT-03	Potential-customer interview	Raqqa	April 2026
POT-04	Potential-customer interview	Raqqa	April 2026
POT-05	Potential-customer interview	Aleppo	April 2026
POT-06	Potential-customer interview	Aleppo	April 2026
POT-07	Potential-customer interview	Aleppo	April 2026
POT-08	Potential-customer interview	Aleppo	April 2026
POT-09	Potential-customer interview	Idlib	April 2026
POT-10	Potential-customer interview	Idlib	April 2026
POT-11	Potential-customer interview	Idlib	April 2026
IND-01	Industrial/business KII	Aleppo	April 2026
IND-02	Industrial/business KII	Aleppo	April 2026
IND-03	Industrial/business KII	Aleppo	April 2026
VTC-01	VTC/training-provider KII	Aleppo	May 2026
VTC-02	VTC/training-provider KII	Aleppo	May 2026
VTC-03	VTC/training-provider KII	Raqqa	May 2026
VTC-04	VTC/training-provider KII	Raqqa	May 2026

BAT-01	Battery-recycler KII	Aleppo	May 2026
BAT-02	Battery-recycler KII	Aleppo	May 2026
BAT-03	Battery-recycler KII	Raqqa	May 2026
MOE-01	Public-sector energy KII	National level	May 2026