Opportunities for Inclusivity in the Solar Value Chain:

GEDSI Practice Across the Solar Value Chain in the Global South

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Acknowledgements

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Table of Contents

Executive summary

This paper is a companion to the *Barriers to Inclusivity in the Solar Value Chain* (Paper 1). Where that paper mapped out the structural barriers affecting inclusion across the global solar sector, this paper examines current practices and examples of how more inclusive approaches are being implemented across the solar value chain. It explores how these approaches are being implemented: how does this work, can it be replicated, what enabling conditions such as policy, finance and institutional support can help, and crucially what can we learn?

The case studies presented here span the solar value chain; from upstream market research and product design, through distribution, installation and repair, to community governance and end-of-product life. They include both delivery-level examples, where projects and enterprises work directly with communities and markets, and system-level enablers, organisations that influence programme design conditions, technical approaches and financing pathways to support the integration of inclusive practices at scale.

Together, they suggest that inclusion is most effective when it is embedded into energy access from the outset, rather than treated as an add-on. It is a design choice and one that requires deliberate attention at every stage of the value chain.

For detailed implementation guidance and real-world examples, readers are encouraged to consult the full-length case studies in the appendices.

Delivery-level

The report draws on five focused case studies collected through the TEA@SUNRISE network. The cases span pre-market innovation, distribution and retail, installation and repair and community governance. Together they show how inclusion mechanisms operate differently at different stages of the value chain, and what enabling conditions make each possible.

System-level

Alongside delivery-focused case studies, we include a second category of examples that operate as **system level support.** These enabling support functions are not yet consistently integrated across programmes, but they can provide critical resources, technical expertise, and enabling mechanisms to embed inclusivity from the outset and strengthen programme design, delivery, and impact.

Organisations such as Value for Women and the Global Disability Innovation Hub function as 'platform-level enablers' within the Transforming Energy Access ecosystem, shaping how inclusion is defined, resourced, and embedded across programmes. Within this ecosystem, Value for Women (VfW)[i] provides specialised gender advisory and programme design support that strengthens the performance and inclusivity of energy initiatives by embedding gender responsive market insights, inclusive delivery approaches and practical implementation tools that help partners and investors translate inclusion commitments into operational practice. Ashden[ii] (a UK-based charity that supports transformative climate solutions) supports Transforming Humanitarian Energy Access (THEA)[1] by enabling inclusive financing and partnerships that integrate refugee-led energy enterprises into sustainable energy delivery models. Through mechanisms such as THEA, Ashden influence financing models, evidence generation, and technical support and can create the enabling environment for more inclusive solar value chains, rather than implementing projects directly.

These cases together demonstrate that inclusion is not only delivered through projects, but designed through wider system conditions that influence how programmes are designed, resourced and implemented.

[1] TEA supports early-stage innovation, investment readiness, and scale-up of clean energy enterprises -within that Transforming Humanitarian Energy Access (THEA) window focuses on energy innovation in humanitarian and displacement settings.

The paper is intended as a strategic resource for FCDO, TEA@SUNRISE partners, and development practitioners. While significant barriers and structural challenges remain across the solar value chain, the report highlights opportunities, practical examples, and emerging approaches that show where more inclusive outcomes may be possible.

Scope note: This paper focuses on mid- to downstream value chain stages. Upstream extraction and global manufacturing are not directly addressed. Evidence from the Sheffield Hallam forced labour reports (Murphy et al., 2022, 2023) makes clear that those stages present structural challenges that individual project-level interventions cannot resolve. That analysis belongs to a different register of policy engagement, and to Paper 1.

1. Introduction: A different question

As of 2024, approximately 730 million people worldwide lack access to electricity, with Sub-Saharan Africa home to the majority[2] (IEA, 2025). While the scale of global energy poverty is well documented, headline access figures obscure persistent inequalities and how structural exclusion within the solar value chain determines who can access, influence, sustain, and benefit from emerging technologies.

Solar photovoltaic technology is widely promoted as the primary solution to this gap (due in main to its perceived suitability for off-grid and decentralised deployment in underserved areas, declining costs, scalability, and its relative independence from centralised grid infrastructure). But access to electricity is not the same as participation in the economy that

[2] IEA (2025), *Access to electricity stagnates, leaving globally 730 million in the dark*, IEA, Paris https://www.iea.org/commentaries/access-to-electricity-stagnates-leaving-globally-730-million-in-the-dark, Licence: CC BY 4.0

produces it. Who designs the systems? Who installs them? Who maintains them, owns them, and captures the value they generate? These questions are what this paper aims to address.

Our previous paper established that the solar value chain (SVC), understood as a spatial and political geography of power, tends to replicate rather than disrupt existing inequalities. Three interconnected systemic barriers emerged from that analysis: 1) gender as a system of power, shaped by colonial and patriarchal structures; 2) colonial spatial patterns and epistemic injustice, embedded in the geography of manufacturing and knowledge production; and 3) structural financial and procedural exclusion, operating through financing systems, land ownership, and consultation processes.

This companion paper does not revisit those findings. It takes them as a foundation and moves forward, asking: under what conditions, and through which mechanisms, can GEDSI-informed practice deliver genuinely inclusive outcomes at specific stages of the solar value chain?

To answer it, we draw on five case studies from the TEA@SUNRISE network: projects operating across Kenya, Indonesia, Malaysia, and India and provide through them a shared analytical framework. The cases were selected not to represent the full breadth of the SVC, but to illustrate variation in inclusion mechanism and context. Together they demonstrate that inclusion, when designed in from the outset, is achievable. What it requires, why it works, and what it cannot do on its own are the substance of the analysis that follows.

To ground the discussion, the following vignette (an illustrative scenario) shows how breakdowns across the solar value chain often unfold in practice when inclusion and long-term system design are not embedded from the outset.

Vignette: A system under strain

In a fictional lower-income country…

Several rural districts received donor-funded solar home systems and mini-grids over a five-year period to expand energy access. The installations initially improved lighting, mobile charging, and small business activity, and were widely cited as a success.

Five years on, many systems across the region now sit idle or partially functioning. Batteries have degraded, inverters have failed, and spare parts are difficult to source locally. Local technicians, where trained, have often moved on, leaving limited capacity for maintenance and repair. In many cases, those responsible for operating the systems received only brief training, insufficient for managing faults, balancing loads, or carrying out preventative maintenance.

The systems themselves were designed to meet procurement requirements, prioritising cost-efficiency and connection targets. Service levels were sufficient at installation but poorly aligned with how demand evolved. As households acquired appliances and usage increased, systems became strained, leading to declining performance and eventual failure.

Warranty processes frequently require contacting suppliers overseas, making repairs slow and costly. As reliability declines, households revert to kerosene and diesel, while infrastructure remains physically intact but unusable.

The situation reflects a breakdown across the wider solar value chain rather than a single technical fault. Early design focused on short-term access gains, with limited attention to maintenance, operator capacity, or long-term system viability — resulting in energy access that could not be sustained.

Based on an engineer's extensive field observations across development work in West Africa (see Appendix D).

2. Framework: Inclusion across the value chain

Social inclusion in solar energy transitions has typically been understood as a question of access. For example, who receives electricity, who can afford a solar home system, who benefits from electrification. This paper shifts the frame. It treats inclusion as a question of participation and agency across the value chain: who shapes technology design, who enters technical roles, who governs infrastructure, and who captures economic value.

2.1 An integrated model for inclusive change in the solar value chain

The solar value chain can be understood in four broad segments. Upstream stages, (raw material extraction and component manufacturing are dominated by global supply chains concentrated in China and a small number of other industrial economies) where, as Paper 1 established, the leverage points for individual interventions are limited. Midstream stages cover distribution, retail, and the import/logistics infrastructure through which systems reach markets. Downstream encompasses installation, technical services, repair, maintenance and end of productive product life. The ancillary or auxiliary segment includes financing, regulation, standards, training, and other enabling support functions.

Community-level actors and institutions interact with all of these segments to varying degrees. While their influence may be more direct in downstream deployment, governance, and productive use, communities also shape midstream demand, inform policy and regulatory design, and through consultation, ownership models, or local enterprise participation can influence upstream decision-making. Governance, ownership, and productive-use arrangements are therefore not confined to a single stage, but operate across the value chain, affecting how infrastructure is adopted, maintained, and sustained over time.

This paper focuses primarily on midstream, downstream, and ancillary level stages, not because upstream exclusions are unimportant, quite the contrary, but because these are the stages where we consider project-level intervention has the greatest demonstrated capacity to shift outcomes.

2.2 A conceptual model for advancing inclusion across the solar value chain

This paper combines two complementary components into a single conceptual model for advancing inclusion across the solar value chain.

2.2.1 A framework of inclusion

The **Framework of Inclusion** defines *where* inclusive change must occur. Inclusion operates at four interconnected levels, each building on the last:

Governance	Who decides: about siting, design, tariffs, benefit distribution, and system management
Workforce	Who participates: in technical, entrepreneurial, and leadership roles across the chain
Infrastructure	Who maintains: and who benefits from durable, locally serviced systems
Ownership	Who captures value: through asset ownership, revenue sharing, and economic agency

Together, these domains form a continuum from consultation to co-ownership and systemic change. They describe the structural terrain across which inclusion must deepen.

The case studies in Section 4 demonstrate interventions operating at different points along it, and the analysis in Section 5 returns to this continuum to ask what it takes to move from one level to the next.

The **GEDSI Feedback Loop** set out in 2.3 explains *how* movement along this continuum is achieved and sustained.

2.2.2 The GEDSI feedback loop

Underpinning the case analysis is a practical framework for embedding GEDSI as an iterative process rather than a 'one off' compliance requirement. The GEDSI feedback loop (Fig 1) supports the development and maintenance of the framework of inclusion and conceptualises inclusion through five stages:

1. **DIAGNOSE**: Identify structural barriers with stakeholders: gendered labour segmentation, financial exclusion, epistemic injustice, data gaps, procedural marginalisation
2. **DESIGN**: Embed inclusive principles in technology, policy, financing, and capacity development from the outset — not as afterthought
3. **OPERATIONALISE**: Deploy through local knowledge, trusted relationships, and context-appropriate mechanisms
4. **MEASURE**: Track meaningful social and equity outcomes, not just headcounts: participation quality, decision-making authority, benefit distribution
5. **ADAPT**: Refine based on learning; treat inclusion as an ongoing process, not a completed state

→ The feedback loop runs continuously. Each stage informs the next, and evidence from measurement feeds back into diagnosis.

The cases that follow are read through this framework. For each, we ask: where in this loop was inclusion embedded? What did it produce? And what enabling conditions such as policy, finance, relationships, institutional support and made it possible?

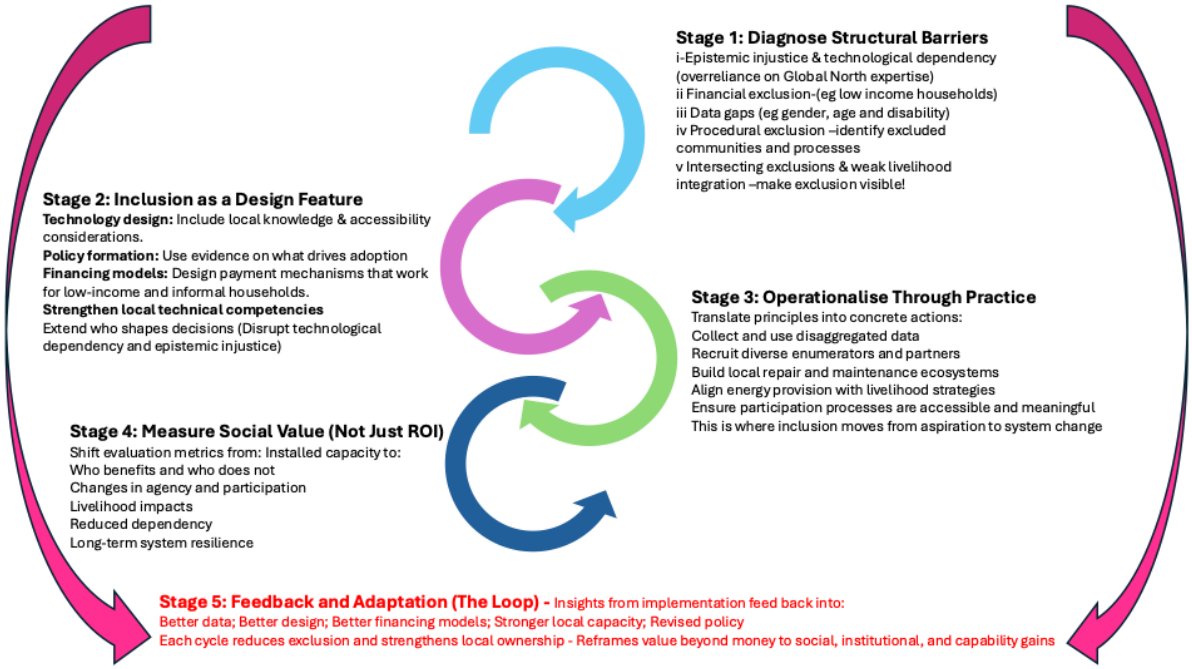

Figure 1 GEDSI Feedback loop

3. Case selection and methodology

The five cases presented here were collected through the TEA@SUNRISE network and selected based on theoretical purpose rather than any assumed level of representation. The aim was not to sample the full breadth of the solar value chain or to identify an average intervention. It was to illustrate variation in inclusion mechanism across different value chain stages and geographic contexts.

Each case was chosen because it demonstrates a specific inclusion mechanism operating at a specific point, or indeed multiple mechanisms at multiple points in the chain, and because it provides sufficient evidence to assess outcomes rather than intentions alone. Cases were not

selected because they show uniformly positive results; we have tried to include the tensions and limitations that each highlights.

The approach draws on analytic generalisation in the tradition of Yin's (2011; 2018) case study methodology: the aim is to identify transferable insights about mechanisms and enabling conditions, not to make claims that are (statistically) generalisable across all solar projects.

This paper adopts a qualitative case study approach where context-sensitive analysis of selected initiatives across the solar value chain was conducted. Case study methodology is designed to examine complex issues within their real-world settings, enabling a detailed understanding of how processes unfold and why particular outcomes emerge (Yin, 2018; Feagin et al., 2016).

3.1 Delivery-level cases

Case	Value Chain Stage	Inclusion Mechanism
Inclusive Market Research for Next-Generation Solar Adoption (India)	Upstream design & market development (technology adoption, product design, policy alignment)	Inclusion as process in market research/technology development--early and wide stakeholder inclusion
PREO–SUNSAFE (Kenya)	Midstream-Distribution, retail & installation	Technical democratisation via digital tool
Kijani Testing (Kenya)	Midstream-Installation, repair & maintenance	Repair ecosystems & informal technician certification

ENACT / Pos Titom (Malaysia)	Cross-cutting intervention across SVC- (community co-design), midstream (deployment governance), and downstream (productive use), with institutional embedding functioning as an ancillary, system-level enabler.	Co-creation through Village Energy Committees
POWERE (Indonesia) Institutional Co-Ownership in Indonesia's Remote Coastal Communities- (pre-deployment stage)	Cross-cutting intervention across SVC- (community co-design), midstream (deployment governance), and downstream (productive use), with institutional embedding functioning as an ancillary, system-level enabler.	Institutional co-ownership, women-led governance

3.2 System-level cases

Case	System-level stage	Inclusion Mechanism
Ashden	As ancillary system enablers, deliver tailored finance, enterprise support, and partnerships to enable refugee-led organisations to	Adapted financing models, enterprise development support, and partnership brokering for refugee-led organisations

	participate and scale within energy initiatives	
Global Disability Innovation (GDI) Hub	Upstream programme design infrastructures inform GEDSI guidance to improve inclusion outcomes and enable replication across energy projects	Provision of disability responsive market insights, frameworks and implementation guidance that improve inclusion performance and replicability across energy initiatives
Value 4 Women	Upstream programme design, evidence generation and partner capacity strengthening	Provision of gender responsive market insights, GEDSI frameworks and implementation guidance that improve inclusion performance and replicability across energy initiatives

4. The cases

Each case study is presented using a consistent analytical structure: the inclusion challenge addressed; where and how inclusion was embedded; the mechanism deployed; the outcomes observed; and the enabling conditions that made it possible. While the cases are diverse and not directly comparable, this structure allows us to identify common patterns in how inclusive approaches may be designed, operationalised, and sustained across the solar value chain. [Expanded, more detailed case studies from the case study authors are included in the appendix C for those seeking deeper insight the intent, process, and contextual factors shaping each intervention, and to support reflection on how elements may be adapted or replicated in other settings.]

Delivery-led cases

4.1 Inclusive market research for next-generation solar adoption

ORGANISATION/ LOCATION	VALUE CHAIN STAGE	INCLUSION MECHANISM
IIT Kanpur; Uttar Pradesh, India (urban and peri-urban)	Upstream design and market development (technology adoption, product design, policy alignment)	Discrete Choice Experiment (DCE) to simulate real-world decision-making (Pilot/Main Survey), widening stakeholder net

1. INCLUSION CHALLENGE

Conventional market research methods were failing to capture how low-income households in peri-urban Uttar Pradesh make decisions about solar adoption. Standard surveys elicit stated preferences rather than real trade-offs, creating systematic data gaps that lead to products and policies misaligned with the needs of underserved communities.

Perovskite-based solar panels are not yet commercially deployed in India, meaning market preferences are undeveloped. Without early engagement, technology and policy decisions risk being driven by expert assumptions rather than the household priorities that matter most, particularly low-income and non-technical users who are often overlooked in early-stage innovation.

2. WHERE AND HOW INCLUSION WAS EMBEDDED

Inclusion was embedded at the design stage, specifically within market research and technology development processes. Rather than treating low-income urban and peri-urban households as passive recipients of pre-designed products, the research actively engaged them in realistic decision-making scenarios before the technology entered the market.

This positioned inclusion upstream in the SVC, ensuring that user perspectives shaped product design, financing models, and policy development from the outset. A pilot survey took place in December 2025 across four residential areas of Kanpur Nagar, involving 90 respondents in face-to-face interviews spanning both urban and rural communities.

3. MECHANISM DEPLOYED

A Discrete Choice Experiment (DCE) was used to simulate real-world decision-making. Households were presented with structured scenarios requiring them to choose between solar options with varying attributes including, cost, lifespan, subsidy, bill reduction, social adoption, and efficiency, mirroring the genuine trade-offs they face rather than relying on idealised responses.

The DCE was administered in person by trained enumerators in easy to follow, standardised scripts in local languages enabling participation from households with lower literacy levels. Survey progress was monitored in real time, with the research team reviewing responses and enumerators in continuous contact throughout fieldwork.

For the main survey, four districts have been identified with 1,200 households to be surveyed in total. Locations within each district are selected using Probability Proportional to Size sampling, and 50 households will be interviewed at each site

4. OUTCOMES OBSERVED

The pilot produced three key findings:

1) Affordability is the primary adoption driver. Cost and subsidies consistently outweighed technical performance, revealing a fundamental gap between engineering priorities and user needs.
2) Lifespan is the only valued technical attribute. Households valued each additional year at ₹1,152.
3) Efficiency had no meaningful influence on decisions.

Social signalling does not substitute for affordability. Community adoption rates had negligible effect on choices and low uptake **should not** be attributed to community disinterest.

The DCE also highlighted real trade-offs that conventional surveys had missed. A mid-pilot adjustment replaced 'bill reduction' with 'emission reduction' following respondent-led interest in environmental impacts – itself a finding about how user priorities diverge from programme assumptions.

5. ENABLING CONDITIONS

- **Methodological innovation:** Willingness to move beyond conventional survey approaches and adopt DCE design.
- **In-person engagement:** Field-based data collection reaching households unlikely to respond to remote or self-administered instruments.
- **Trained enumerators:** Investment in enumerator capacity to administer scenarios accurately and accessibly across diverse literacy levels, with real-time monitoring and support.
- **Pre-deployment timing:** Engagement before the technology reached market ensured user voices shaped early design and policy, not deployment afterthought.

Feedback loop: Findings – including willingness-to-pay estimates – are structured to inform product design, subsidy frameworks, and future research, creating ongoing alignment between technology development and user priorities.

Methodological innovation: Willingness to move beyond conventional survey approaches and adopt DCE design.

Author: Dr Deepika Swami (IIT Kanpur)

4.2 Embedding gender equality and social inclusion across the SVC via PREO[iii]-SUNSAFE[iv]

A GEDSI-informed digital decision-support tool for solar system sizing

ORGANISATION/ LOCATION	VALUE CHAIN STAGE	INCLUSION MECHANISM

PREO-SUNSAFE, Strathmore University; Machakos and Makueni Counties, Kenya	Midstream/downstream: design; retail and distribution; installation; household decision-making	GEDSI-informed app design; women-only training; gender-disaggregated data; peer-led champions

1. INCLUSION CHALLENGE

In Kenya's rural off-grid markets, technical expertise for solar system design was concentrated among trained, predominantly male, technicians who frequently migrated to urban centres (post training). Women were active in retail and sales but lacked access to the technical knowledge that would give them genuine authority in the value chain. Women are not excluded because of lack of interest or ability but by structural and cultural barriers: e.g. limited training access, workplace power dynamics, childcare responsibilities, and social norms that define technical work as masculine. This gap between promise and performance is precisely where the SUNSAFE initiative was conceived.

2. WHERE AND HOW INCLUSION WAS EMBEDDED

Inclusion was embedded across four entry points from the project's inception: 1) inclusive system design and digital access; 2) women-led distribution and entrepreneurship; 3) installation and technical services; and 4) data generation for governance. A GESI lens was integrated throughout, not added at the end, addressing both social and technical outcomes simultaneously.

3. MECHANISM DEPLOYED

GESI-integrated Android application: automates solar system sizing calculations, making complex engineering decisions accessible to retailers and installers without formal technical training. By removing the technical knowledge bottleneck, the tool shifts the basis of authority in the value chain.

Adapted training model: women-only training spaces, with practical accommodation of caring responsibilities and flexible scheduling, consistently improved participation and learning outcomes. Participants reported greater confidence asking questions and admitting knowledge gaps, dynamics that mixed settings had suppressed.

4. OUTCOMES OBSERVED

Fieldwork in 2023 engaged 158 women household consumers, 22 solar retailers, and 33 solar installers. Women-only training settings demonstrably improved participation and learning. The app began to shift the basis of credibility in retail and installation from formal technical training (to which women had unequal access) to accessible, tool-supported decision-making. Visible women technicians were found to shift norms across the value chain beyond the individuals trained.

5. ENABLING CONDITIONS

- **Design that reflects real constraints:** tools built for users with limited time, mobility, and formal training – not necessarily for 'ideal' conditions.
- **GESI integration from inception:** embedding inclusion across all four entry points rather than treating it as a standalone component.
- **Recognising participation is not empowerment:** meaningful inclusion requires access to technical skills and decision-making authority, not just a presence in the value chain.
- **Gender-disaggregated data:** essential for accountability and adaptive policy, not only a reporting requirement.

Feedback loop: gender-disaggregated data from fieldwork informs tool refinement, training design, and policy recommendations thus creating an adaptive cycle between evidence, practice, and governance.

Authors: Maryvelma Nafula, Jovia Nampewo, Augusta Njogo, Anne Wacera Wambugu, Kirsten Erica Dass

4.3 Kijani Testing: Building repair ecosystems for inclusive solar futures

ORGANISATION / LOCATION	VALUE CHAIN STAGE	INCLUSION MECHANISM
Kijani Testing; Kenya	Downstream (installation, repair and maintenance); influencing design and market development	Living labs; tiered repair and capacity-building model across end users, technicians, and service centres

1. INCLUSION CHALLENGE

Hardware failure is a primary driver of exclusion from solar energy, not because systems are inherently unreliable, but because repair capacity is typically absent at the last mile. Kijani Testing's research shows that 60% of product failures are preventable through basic user training, reframing the problem as one of service and knowledge, not technology. People want to repair, not dispose of products. The barrier is the absence of accessible repair infrastructure.

2. WHERE AND HOW INCLUSION WAS EMBEDDED

Inclusion is embedded downstream in operational practice, aftersales support, repair, and maintenance, while evidence from practice feeds back upstream into product design and market development. The model intentionally strengthens local knowledge, technical capacity, and trusted repair networks, treating repair ecosystems as social inclusion infrastructure: the mechanism by which initial access to solar energy either translates into durable benefit, or is undone by breakdown and loss of trust.

3. MECHANISM DEPLOYED

Living labs bring end users, technicians, suppliers, and financiers together in collaborative, real-world testing environments before market launch, surfacing mismatches between product design and actual use.

A tiered repair and capacity-building model builds inclusion across three interconnected levels:

- **Tier 1:** End-user education - informed ownership, preventive maintenance, quality guidance, and trusted aftersales support embedded in formal supply chains
- **Tier 2:** Freelance technician professionalisation - business, communication and network skills, addressing structural barriers rather than technical skill gaps.
- **Tier 3:** Service centres anchoring the ecosystem, managing complex repairs, stocking parts, and providing escalation pathways and quality assurance.

4. OUTCOMES OBSERVED

The model reduces dependency on external actors, builds local livelihoods, and improves long-term system sustainability (reduced exclusion from technical knowledge and repair services). Living labs generate product improvements and more realistic market strategies. Evidence on failure patterns feeds into procurement and design decisions upstream. Together, the approach demonstrates that inclusion in the solar sector is about access to knowledge, quality, repair services, and livelihoods, not only access to energy.

5. ENABLING CONDITIONS

- **Evidence-led practice:** systematic repair documentation challenges assumptions and targets interventions precisely (recognition of repair as part of the value chain)
- **Recognising and investing in existing capacity:** local technicians typically have the technical skills needed; support targets business skills and network integration.

- **Integration into formal structures:** inclusion in supplier warranty documentation legitimises the repair ecosystem within the solar value chain.
- **Living labs as shared infrastructure:** multi-stakeholder field testing creates learning conditions no single actor could generate alone.

Feedback loop: User interactions and repair data informs training and technician support; living lab findings feed back into product design and procurement; evidence is shared with suppliers, manufacturers, and policymakers and improves user education, and service delivery models

Author: Kinya Kimathi (Kijani Testing)

4.4 POWERE: Institutional co-ownership in Indonesia's remote coastal communities (pre-deployment stage)

ORGANISATION / LOCATION	VALUE CHAIN STAGE	INCLUSION MECHANISM
POWERE; Tamparang, South Sulawesi, Indonesia (remote coastal communities)	Cross-cutting intervention across SVC (community co-design), midstream (deployment governance), and downstream (productive use), with institutional embedding functioning as an ancillary, system-level enabler.	Institutional co-ownership; women as co-designers and co-owners of energy infrastructure through structured, cumulative capacity-building

1. INCLUSION CHALLENGE

In Tamparang's[3] remote island cluster, existing electricity provision (communal diesel generators, private solar panels, mosque-based systems) is governed not by formal energy committees but by social hierarchies. Men who frequent mosques gain easier access; women and households distant from installations are routinely excluded. Infrastructure mirrors, and actively reinforces, existing inequalities. The challenge is not simply deploying floating solar PV to replace diesel, but embedding that infrastructure socially, institutionally, and sustainably.

2. WHERE AND HOW INCLUSION IS EMBEDDED

Inclusion is embedded across a three-phase model: social and institutional grounding before deployment; participatory co-design and institutional embedding during implementation; and adaptive governance and monitoring post-deployment. An inter-structural lens, integrating gender, income, education, lifecycle stage, and sociocultural norms as interconnected dimensions, prevents the programme from treating women as a homogeneous group, instead attending to how different social positions shape relationships to energy infrastructure.

3. MECHANISM DEPLOYED

[3] The name of this settlement has been changed to protect the identity of residents

Women's Action Learning Groups: diverse in age and income (from late teens to 60s), providing structured spaces for cumulative learning, energy priority-setting, and governance co-design. Workshops are sequential and build from energy literacy to collective decision-making to co-ownership, including decisions about siting, maintenance, revenue allocation, and conflict resolution.

Concurrent development of governance, hardware, and 'orgware': Floating solar infrastructure, energy literacy and technical capacity, and governance systems - including financial and business models, conflict resolution mechanisms, and institutional arrangements are developed alongside one another through participatory processes, rather than being introduced post-deployment.

4. OUTCOMES OBSERVED

POWERE is currently at pre-deployment stage in Tamparang. Its outcomes are therefore methodological and make an argument about process, not yet about results. This is a strength as well as a limitation: it demonstrates what rigorous, inclusive pre-deployment grounding looks like in practice, and why it matters. The model establishes that social sustainability is a precondition for technical sustainability, and that pre-deployment grounding is not a delay to implementation, but the foundation for durable and inclusive energy systems.

5. ENABLING CONDITIONS

- **Cumulative, practice-embedded capacity-building:** structured learning that builds progressively toward co-ownership, rather than being delivered as a one-off training event.
- **An inter-structural lens:** attending to intersecting dimensions of exclusion prevents the treatment of marginalised group as homogeneous, enabling more differentiated and inclusive design.
- **Governance developed concurrently with infrastructure:** hardware, software, and 'orgware' (including governance systems) are developed in parallel, rather than sequentially.
- **Pre-deployment grounding as design principle:** social and institutional foundations established before technical deployment, rather than retrofitted afterwards.

Feedback loop: learning from the Action Learning Groups informs co-design of governance structures, siting decisions, and maintenance arrangements, embedding community knowledge into the infrastructure from the outset.

Authors: Chun Chun Yu, Prof Raminder Kaur, and Monika Swastyastu (POWERE)

4.5 ENACT: Community co-ownership of solar energy in Malaysia

ORGANISATION / LOCATION	VALUE CHAIN STAGE	INCLUSION MECHANISM

ENACT; Pos Titom, Pahang, Malaysia (primary); Sabah, Malaysia	Operates as a cross-cutting intervention across SVC- (community co-design), midstream (deployment governance), and downstream (productive use), with institutional embedding functioning as an ancillary, system-level enabler.	Participatory co-design; Village Energy Committees; COMET toolkit; D-RECs as community revenue mechanism

1. INCLUSION CHALLENGE

Despite Malaysia's near-100% national electrification rate, around 400 villages in Sabah and 200 in West Malaysia remain under-electrified. Access is shaped by intersecting factors rather than a single barrier. Formal recognition plays a significant role: villages officially registered with the Department of Orang Asli Development (JAKOA) are typically prioritised for government support and resources, while non-recognised villages, which may be smaller or more geographically fragmented, appear overlooked, regardless of whether they have functioning governance structures of their own. At the same time, economic status can cut across formal recognition: higher-income households or communities with greater purchasing power have sometimes secured their own energy access through diesel generators or privately financed renewable systems, independent of state provision. Kampung Kemiyan illustrates this well, a village outside the formal JAKOA recognition system, that has resourced a diesel generation before external project support arrived.

2. WHERE AND HOW INCLUSION WAS EMBEDDED

ENACT embeds inclusion from the outset of community engagement and before any technology is deployed. The organising principle is co-creation rather than consultation: communities co-design the system and its governance rules, with local expertise treated as equal to technical expertise. At Pos Titom, this meant working with four Indigenous communities (approximately 600 people) through a process that moved from ethnographic listening and social mapping to community-wide consultations, and ultimately to the establishment of Village Energy Committees (VECs) as the governance structure for ongoing operation and maintenance.

3. MECHANISM DEPLOYED

Clustered solar rooftop model: flexible array of modular 3kW systems connecting 2–3 households, bridging the gap between standalone solar home systems and full mini-grids and combining household-level reliability with community-level coordination.

Village Energy Committees: community-led governance bodies of 4–5 members, established through participatory design, with communities contributing to a shared fund for operation and maintenance (tariffs currently range from RM0.35 to RM0.90 per kWh depending on the village) with maintenance fund contributions gradually increasing. This trend is attributed, in part, to growing economic activity as new community businesses come online, though uptake remains slower than anticipated. Trust is built through long-term engagement rather than one-off consultation.

COMET (Community Energy Toolkit): a role-playing game and participatory planning tool used to build energy literacy, explore governance decisions, and make tariff and management choices visible to all community members before deployment.

D-RECs (Distributed Renewable Energy Certificates): Kampung Sempar is Malaysia's first D-REC project; the community receives generation-based revenue with ENACT acting as non-profit aggregator, creating a direct financial return from the infrastructure the community owns.

4. OUTCOMES OBSERVED

At Pos Titom, co-designed energy systems are operational across four Indigenous communities (3 of the 4 are fully operational, with the last 1 awaiting their T&C approval). Village Energy Committees are managing and operating the infrastructure, sustained by community funds and long-term institutional support. New productive-use businesses have been established with backing from local civil society and institutional partners. The D-REC mechanism at Kampung Sempar is generating direct community revenue from solar generation, a first for Malaysia.

The model demonstrates that durable energy access in remote contexts requires social and institutional grounding alongside technical deployment. Communities that co-own their energy infrastructure, including decisions about siting, tariffs, maintenance, and revenue can sustain it differently from those that receive it as an external provision.

5. ENABLING CONDITIONS

- **Long-term community engagement:** trust built through sustained presence, not project cycles — ENACT has worked in some communities for five or more years.

- **Co-design as a non-negotiable principle:** systems and governance rules designed with communities, not for them; local knowledge treated as equal to technical expertise.
- **Participatory tools that make decisions visible:** COMET enables communities to explore energy choices such as tariffs, appliances, governance, before committing to them, building collective understanding and ownership.
- **Innovative financing that returns value to communities:** D-RECs create a financial stake in the infrastructure, aligning long-term community interest with system sustainability.
- **Public-civic partnership for policy influence:** ENACT's involvement in the Sabah RE2 Roadmap (a public-civic partnership for 100% energy access in Sabah) demonstrates how field-based practice can inform state-level planning and regulation.

Feedback loop: learning from community deployments informs tool development (COMET), financing innovation (D-RECs), and policy engagement (Sabah RE2), creating a cycle in which practice shapes both future projects and the wider enabling environment.

Authors: Ayu Abdullah, Wan Nur Sakinah, Tia Najya Effendee (ENACT)

System-led cases

The three cases that follow operate at system level rather than on the ground (or project-level), shaping the conditions, tools, and financing structures within which delivery happens. Taken together, they illustrate how inclusion can be built into the architecture of a programme or sector, rather than left to individual actors to solve alone. In practice, this may involve specialised advisory support, inclusive market research, technical guidance, financing design, and capability building tools that help delivery partners translate inclusion commitments into operational models. Yet this kind of infrastructure has its own resourcing requirements. System-level therefore require sustained funding, institutional recognition, and integration into programme design processes to operate effectively at scale.

4.6 Ashden: Financing refugee-led clean energy enterprises

Embedding inclusion through finance, market access, and local leadership

ORGANISATION / LOCATION	VALUE CHAIN STAGES	INCLUSION MECHANISM
Ashden/THEA programme; East Africa (Uganda, Kenya, Ethiopia in refugee-hosting contexts)	Midstream (distribution & sales), downstream (installation & maintenance), community level	Adapted financing models, enterprise development support, and partnership brokering for refugee-led organisations

1. INCLUSION CHALLENGE

In many refugee-hosting contexts across East Africa, energy access is shaped by overlapping constraints: restricted legal status, exclusion from formal financial systems, and limited integration into national markets. These conditions reinforce dependency on external actors for access to technology, as energy systems are externally financed, installed, and maintained often resulting in limited local ownership or long-term sustainability.

Conventional financing mechanisms exclude refugee-led organisations (RLOs) due to lack of collateral, credit history, or formal recognition. This prevents their participation in distribution, maintenance, and enterprise development which are key entry points into the solar value chain. Displaced communities are routinely positioned as beneficiaries of externally designed solutions, rather than as active participants capable of shaping them.

2. WHERE AND HOW INCLUSION WAS EMBEDDED

The Ashden/THEA model embeds inclusion at the financing and market systems level, through adapted financial mechanisms and institutional partnerships that determine who can participate in the solar value chain from the outset.

The model operates across midstream (distribution and sales), downstream (installation, maintenance, and service provision), and community levels (governance, trust networks, and livelihoods).

Inclusion extends beyond access to technology; encompassing control, ownership, and economic participation: *the ambition is for refugee-led organisations to become recognised market actors, not better-supported beneficiaries.*

3. MECHANISM DEPLOYED

The Ashden/THEA model reframes refugees as energy entrepreneurs and service providers, deploying a combination of financial and institutional innovations:

- **Adapted financing models** that respond to the realities of displacement, including grant-based and flexible funding mechanisms designed for organisations without collateral or credit history.
- **Enterprise development support,** including mentorship, capacity building, and technical assistance for refugee-led organisations entering the solar market.

- **Partnership brokering** to connect RLOs with suppliers, NGOs, and wider market actors, enabling integration into existing solar markets rather than parallel systems.
- **Recognition of local leadership and community insights**, enabling community-led delivery of energy services and legitimising refugee expertise within the value chain.

A GEDSI-informed approach: The model acknowledges intersecting forms of exclusion and that future approaches could more explicitly address: gender (supporting women-led enterprises; addressing barriers to finance, mobility, and decision-making), displacement status (challenging structural exclusion from formal systems), and income and informality (designing financial mechanisms beyond formal employment structures). Disability inclusion is identified as an area requiring further systematic embedding.

4. OUTCOMES OBSERVED

Early evidence suggests the model is producing the following outcomes:

- **Strengthened local energy service delivery** and maintenance capacity, reducing dependence on external actors.
- **Improved alignment** between energy solutions and community needs, reflecting greater local input into design and delivery.
- **Livelihood opportunities** created through energy enterprise, linking economic inclusion to energy access.
- **Greater system sustainability** as locally grounded enterprises develop capacity to operate and maintain energy services over time.

Crucially, the model demonstrates that inclusion can enhance market functionality and support increased capacity building.

5. ENABLING CONDITIONS

Several conditions made this inclusive systems approach possible:

- **Blended finance through Ashden/THEA:** willingness to support inclusive models that recognise the need for different approaches in refugee-led settings.
- **Strong intermediary support (Ashden):** a trusted, specialist organisation capable of brokering relationships, managing flexible finance, and providing sustained enterprise development support.
- **Partnerships with local enterprises:** existing networks and relationships that could anchor refugee-led organisations within wider market systems.
- **Willingness to design upstream:** structural change requires intervention earlier in the value chain (considering inclusion at the deployment stage is insufficient).
- **Feedback loop:** learning from early-stage enterprises is fed back into the refinement of financing mechanisms and support structures, improving alignment with real-world constraints over time.

Authors: Isona Shibata (Ashden)

4.7 Value for Women: Strengthening gender-inclusive technical assistance across clean energy

Making gender inclusion accessible and actionable across clean energy market systems

LOCATION / ORGANISATION	VALUE CHAIN STAGES	INCLUSION MECHANISM

Value for Women (VfW), within the Transforming Energy Access (TEA) programme; Sub-Saharan Africa and South Asia	Upstream research and market development; workforce and talent pipelines; supply chains; governance and accountability	Portfolio-wide GEDSI capacity building; targeted gender advisory support; peer learning and knowledge exchange. Intense GEDSI technical assistance; gender lens diagnostics; Gender Action Plans; inclusive MEL frameworks; capacity building at scale

1. INCLUSION CHALLENGE

Women remain systematically underserved across clean energy markets as customers, workers, and entrepreneurs. Structural barriers for women persist in how energy initiatives are designed and delivered, from limited gender responsive market insights to workforce pipelines that do not actively engage women and procurement systems that exclude smaller women led enterprises. For example although women are primary end-users of household energy, they make up only about 32% of registered off-grid customers.

Technical and field roles also remain male-dominated. Women-led businesses face structural barriers to participating in supply chains: limited access to information, capital, and procurement processes designed for larger, more established actors.

The gap is not only in delivery, but also in the systems that govern it. While many organisations have GEDSI commitments, translating these into operational practice remains a constraint.

Without specialist advisory support, inclusion risks remaining aspirational rather than embedded in programme performance

2. WHERE AND HOW INCLUSION WAS EMBEDDED

VfW is a global organisation that works with the private sector to create better opportunities for women in emerging markets. Within the Transforming Energy Access programme, VfW operates as a system-level advisory partner, supporting multiple delivery organisations to strengthen GEDSI across strategies and operations. Inclusion is embedded not within a single intervention but across the conditions that shape how organisations design, resource, and measure their work.

3. MECHANISM DEPLOYED

Targeted gender advisory support: Intensive technical assistance from Value for Women helped partners turn gender commitments into practical actions through gender diagnostics, Gender Action Plans, and time-bound support to build capacity for implementing and sustaining inclusive energy practices.

GEDSI capacity strengthening: Across the programme, inclusion was advanced through a combination of targeted technical assistance, capacity building, and practical tools that supported partners to operationalise GEDSI within their own contexts. This included: Bootcamps building foundational GEDSI skills and knowledge to design and implement inclusive policies, strategies and programmes; design of GEDSI toolkit and other practical resources; advisory support and technical assistance to select organisations to better reach and support women as

customers, employees, leaders and value chain actors; and dissemination of learnings through publications, blogs and public webinar.

Framework for structured inclusion: a practical 4-point framework helped embed inclusion across our programme: (1) strengthening customer reach through gender-responsive data collection, market research, product/service design and marketing/communications strategies; (2) expanding workforce participation through inclusive recruitment and enabling workplace practices; (3) improving value chain inclusion by increasing visibility and access for women-led enterprises; and (4) reinforcing accountability through integration of GEDSI indicators into MEL systems, supported by clear governance and accountability structures. Together, these mechanisms supported partners to move from policy commitments towards measurable operational change.

4. OUTCOMES OBSERVED

The business case for gender inclusion is well-evidenced: the top 20 most gender-diverse utility firms show 15% higher return on equity than the bottom 20.

For TEA@SUNRISE, VfW supported building of internal GEDSI capacity across the programme with core outcomes:

- **Strengthened GEDSI measurement and accountability** through a network-wide baseline survey, integration of GEDSI into MEL systems, and ongoing plans to track progress.
- **Embedded inclusion into everyday practice** via GEDSI statement/strategy, champions, and mainstreaming GEDSI across webinars, partner calls/recruitment and knowledge-exchange spaces.
- **Expanded inclusive leadership and peer support,** including the growth of the Women in Solar Energy (WISE) network (~40 members) and near gender parity at the symposiums.

- **Overall: cultivated a shared culture of inclusion,** improving who participates, who benefits and how innovation pathways become more equitable. With 340+ TEA@SUNRISE network members and increasing visibility of diverse voices across research and innovation spaces.

Through targeted gender diagnostics, implementation support, and portfolio wide capability building, VfW supported delivery partners to strengthen how inclusion is designed, resourced, and measured within energy initiatives. Early shifts observed include improved use of sex disaggregated market data, more intentional workforce recruitment strategies, and the integration of GEDSI indicators into monitoring and learning systems.

5. ENABLING CONDITIONS

- **Programme-level mandate + delivery support:** TEA's GEDSI statement & strategy (with input from VfW and GDI hub) increased legitimacy and added resourcing; Value for Women further added structured actions embedded in programme design, delivery, and MEL systems.
- **Tiered advisory model (aligned with our organisational readiness):** Portfolio wide capacity building established a shared baseline understanding of gender inclusive practice, while targeted high touch support enabled our organisations to implement deeper operational shifts. This approach allowed us to engage at a level proportionate to capabilities and stage of project.
- **Clear business case for inclusion:** Framing GEDSI as a driver of customer reach, innovation, and sustainability strengthened engagement, particularly among private sector and research partners.
- **Actionable tools and frameworks:** Practical approaches, such as the four-entry-point framework, gender lens diagnostics, and Gender Action Plans, enabled us to operationalise, track, and sustain inclusion.

- **Adaptive learning and feedback loops:** Diagnostics, implementation experience, and peer exchange (e.g. across the network) supported continuous learning, replication, and gradual system-level change.

Feedback loop: diagnostic findings inform GAP design; GAP implementation generates evidence; peer exchange (including the March 2026 webinar) surfaces what is working and what is not, creating an adaptive cycle between evidence, capacity, and practice.

Authors: Value for Women team

4.8 Global Disability Innovation Hub: Disability-inclusive technical assistance in clean energy

Disability-inclusive technical assistance, research methodology, and capacity building across the solar value chain

ORGANISATION / LOCATION	VALUE CHAIN STAGES	INCLUSION MECHANISM
Global Disability Innovation Hub (GDI Hub), working across TEA platform; global	Cross-cutting: upstream research design and market development; workforce; governance; product design and innovation	Disability Support Service (DSS); OPD partnership frameworks; inclusive research methodology; GEDSI strategy and data integration

1. INCLUSION CHALLENGE

People with disabilities represent one in six of the global population, an estimated 1.3 billion people, yet remain among the most systematically excluded from clean energy access. The barriers are structural and multifactorial: e.g. disability-related discrimination and stigma, inaccessible physical and digital environments, lack of assistive technology, and exclusion from the financial and governance systems that shape energy delivery. In the solar sector specifically, disability inclusion has rarely been embedded in product design, workforce development, or governance and is often treated as a downstream adjustment (if at all) rather than an upstream design requirement.

TEA@SUNRISE recognised this gap. However, the technical expertise needed to advance next-generation solar technologies has rarely been paired with the frameworks, tools, or community partnerships needed to ensure those technologies are designed for and with people with disabilities from the outset.

2. WHERE AND HOW INCLUSION WAS EMBEDDED

Disability Support Service (DSS)[v] operates as a system-level enabler, working not to deliver energy projects directly, but to shift how energy actors design, research, and govern their work so that disability inclusion becomes structural rather than incidental. Its cross-platform delivery model embeds disability inclusion across the value chain through targeted technical assistance, capacity building, and the development of practical tools and frameworks. For TEA@SUNRISE network, DSS engagement work moved disability inclusion from a statement of intent to planned operational practice - integrating into research methodology, project design, partner capacity, and data systems.

3. MECHANISM DEPLOYED

Capacity building and knowledge exchange: GDI Hub delivered sessions across the TEA platform and specifically for TEA@SUNRISE at a symposium (approx. 50 attendees in-person and online) an additional survey mapped priorities and identified that many were new to considering disability in their work, informing a tailored programme of support.

OPD partnership guidance: practical frameworks for how energy researchers and businesses can identify, engage, and collaborate with Organisations of People with Disabilities (OPDs) - positioning OPDs as co-researchers and equal collaborators rather than passive participants.

Inclusive research methodology: guidance on disability-disaggregated data collection, accessible engagement tools, ethical frameworks for participation of people with disabilities, and approaches to remuneration and reasonable accommodation.

GEDSI strategy integration: supporting TEA@SUNRISE to develop and launch a GEDSI statement and to integrate disability metrics into network-wide survey instruments.

4. OUTCOMES OBSERVED

Over 30 TEA@SUNRISE partners have been exposed to disability-inclusive research and innovation principles. TEA@SUNRISE launched a GEDSI statement, strategy (development input by GDI hub and VfW) and integrated disability metrics into its survey infrastructure. A guidance note on delivering inclusive next-generation solar research in collaboration with OPDs has been produced for the network. As a proposed pilot -GDI Hub has explored how advances in low-light solar technologies could address barriers to hearing aid adoption (battery charging) in

low-resource settings demonstrating the innovation potential of disability-inclusive thinking within next-generation solar development.

The model demonstrates that disability inclusion in the energy sector requires deliberate system-level support: organisations rarely have the tools, frameworks, or partnerships to embed it independently. Technical assistance that builds these capabilities across a network multiplies impact beyond what individual efforts can achieve.

5. ENABLING CONDITIONS

- **Dedicated technical assistance function:** a specialist disability inclusion role with mandate and resource to provide sustained support rather than one-off interventions.
- **Starting with listening:** the January 2025 partner survey established what network members knew and needed, enabling support to be targeted rather than generic.
- **Practical tools that lower the barrier to action:** OPD partnership guidance, inclusive research methodology, and accessible engagement frameworks give practitioners what they need to act.
- **Platform-level mandate:** TEA@SUNRISE's GEDSI strategy provides institutional legitimacy for disability inclusion to be embedded across funded projects.
- **Positioning OPDs as experts, not subjects:** the 'nothing about us, without us' principle ensures people with disabilities shape the research and interventions that affect them.

Feedback loop: partner survey findings shaped the programme; guidance note content reflects what practitioners requested; a feedback session (GDI hub and TEA@SUNRISE) was designed to consolidate learning - creating an adaptive cycle between evidence, capacity, and practice.

5. Cross-case synthesis: What the cases show together

Read individually, each case demonstrates specific inclusion mechanisms operating at specific points in the solar value chain. Many work across multiple stages, combining approaches that span design, delivery, and governance.

Read together, however, they reveal something more significant: not only *what* inclusion looks like in practice, but **the conditions under which it becomes sustained rather than incidental**. They highlight the relationship between delivery-level action and the system-level conditions that enable it to endure and scale.

This report distils key findings and principles from the case studies; however the appendices also deserve close attention as they contain the partner insights, contextual nuances, and step-by-step approaches that bring these findings to life.

5.1 The Inclusivity Framework in Practice

The cases collectively move along the governance–workforce–infrastructure–ownership continuum, but not uniformly, and not always in the expected direction. SUNSAFE operates most directly at the workforce level, using a technical tool to break the gatekeeping that kept women in retail without credibility. Kijani Testing operates at the infrastructure level, treating repair capacity as a social equity resource, while its living lab approach feeds user and technician knowledge back into product design. ENACT operates at the governance level, redistributing decision-making authority before systems are built. POWERE reaches towards ownership, positioning women not as users but as co-owners of the infrastructure itself. The Inclusion in Pre-

Market Solar Innovation case adds an upstream dimension, embedding inclusion at the stage of market research and technology design, before downstream dynamics have formed.

What this mapping makes clear is that inclusion cannot be achieved at any single level alone. Workforce entry without governance participation reproduces a different form of exclusion - presence without influence. Infrastructure investment without ownership models means communities maintain systems whose value flows elsewhere. Governance without material participation risks becoming procedural rather than transformative.

At the same time, the cases highlight an important distinction between **delivery-level interventions** and **system-level enablers**. Delivery-level initiatives including projects, enterprises, tools, and localised models, are often most effective at shifting outcomes at the workforce and infrastructure levels, where barriers are immediate and actionable. They demonstrate how inclusion can be operationalised in practice.

However, movement into governance and ownership, where decision-making authority and value capture are redistributed, more consistently depends on **system-level conditions**: financing structures, policy frameworks, institutional mandates, and long-term support mechanisms. These are not conditions that individual delivery actors can establish alone.

Several cases illustrate the limits of delivery-level action in isolation. While SUNSAFE expands access to technical roles, it does not on its own reshape market structures. Kijani strengthens repair ecosystems, but depends on wider supplier practices and financing models to scale. This suggests a consistent pattern: **delivery-level innovation can open access, but system-level alignment is required to sustain and deepen inclusion over time**.

5.2 Enabling Conditions

Across the cases, a consistent set of enabling conditions emerges. These operate at both delivery level and system level, and their interaction determines whether inclusive approaches remain localised or become durable over time.

5.2.1 Delivery level

At the **delivery level,** four conditions appear repeatedly:

1. **GEDSI embedded at design stage - not retrofitted.** Across all cases, inclusion mechanisms built into the original plans tend to outperform those added in response to observed exclusion (from previous experience). SUNSAFE designed the app around women's realities from the outset; POWERE made social grounding a precondition of deployment, not a parallel track. Where inclusion is embedded early, it shapes both technical and social outcomes.
2. **Local knowledge treated as expertise.** Cases that positioned community members (and women/marginalised groups in particular) as holders of technical and contextual knowledge, rather than recipients of transferred expertise, are achieving sustainable outcomes. ENACT's Village Energy Committees and POWERE's Women's Action Learning Groups are both structured around this principle while Kijani Testing's living labs integrate user and technician experience directly into product development.
3. **Concurrent development of hardware, software, and 'orgware'.** Where institutional arrangements, financial models, and governance structures are developed alongside technical infrastructure (rather than after it), systems appear more sustainable. Kijani Testing's finding that 60% of failures are preventable points to the same dynamic — technical performance depends on social and institutional support.
4. **Embedded feedback and learning mechanisms:** Programmes that generate and use disaggregated data — including gender and, increasingly, other dimensions of exclusion — are better able to adapt over time. Across the cases, feedback loops between users, implementers, and designers enable continuous refinement rather than static delivery.

5.2.2 System-Level

However, these delivery-level conditions are not sufficient on their own. Their effectiveness depends on a second set of **system-level enablers,** which shape whether inclusive practices can be sustained and scaled:

- **Financing structures that support long-term operation,** not only initial deployment

- **Procurement and programme criteria that prioritise service quality and durability**, rather than cost-per-connection alone
- **Institutional support for capacity-building and technical assistance**, enabling organisations to embed GEDSI in practice
- **Policy and regulatory frameworks that enable maintenance, adaptation, and inclusive ownership models**

System-level actors, including funders, specialised advisory and technical assistance providers, and policy institutions play a critical role in establishing these conditions. Without them, delivery-level innovations remain constrained, often unable to move beyond workforce participation towards governance and ownership.

Taken together, the cases function less as standalone solutions and more as **interdependent components of an inclusive system**. Inclusion and sustainability emerge where delivery mechanisms and system-level enablers reinforce one another across the continuum — linking participation to decision-making, and access to ownership.

5.3 What These Cases Cannot Do

It is important to be clear about the limits of what project-level intervention can achieve. None of these cases transforms the upstream dynamics of the value chain – the concentration of manufacturing in China, the forced labour in polysilicon production, the broader structural barriers linked to global mineral extraction. They do not resolve structural financial exclusion on their own or dismantle inheritance systems. They do not substitute for the policy reform and international governance action that those challenges require.

What they demonstrate is more bounded and more practicable: that within the segments of the value chain where meaningful intervention is possible, inclusion is achievable - and that it produces better outcomes not only for the individuals directly involved, but for the reliability, sustainability, and trustworthiness of next generation solar systems themselves. The inclusion argument is a technical, structural and economic one as well as a matter of equity.

6. Implications for Policy and Practice

The following implications are drawn directly from the case study evidence. They are organised around an inclusivity framework rather than by institutional actor, because the evidence suggests that the level at which intervention occurs matters more than which actor delivers it.

6.1 At the governance level

Co-design mechanisms should be a programme requirement, not an optional enhancement. The COMET simulation tool and Village Energy Committees (ENACT) and POWERE's Women's Action Learning Groups both demonstrate that communities can exercise real governance authority when given the structure and time to do so. This requires upfront investment in process, which development funders, including FCDO, need to protect when timelines come under pressure.

6.2 At the workforce level

Digital decision-support tools like SUNSAFE represent a scalable (and data gathering) mechanism for lowering technical entry barriers — particularly for women in retail and distribution roles. The model is transferable across solar technology types and country contexts. Investment in this type of tool, combined with gender-responsive training design, should be a priority for programmes working on workforce inclusion.

6.3 At the infrastructure level

Repair ecosystems can keep products, people, and communities connected thus supporting inclusion in practice. Funding models that stop at hardware installation are structurally

incomplete. Development partners should require that programmes include provision for local technician training, spare parts access, and after-sales support as non-negotiable components and not optional add-ons to be cut when budgets tighten.

6.4 At the ownership level

Ownership models matter more than access alone. PAYG solar and Energy-as-a-Service approaches reduce upfront capital barriers, but the more transformative models, like POWERE's women-led co-ownership of FPV infrastructure - link energy access directly to economic agency. Where financing mechanisms and land/asset ownership laws systematically exclude women, subsidy and incentive frameworks need to be redesigned accordingly.

6.5 On measurement

Gender and inclusion metrics need to move beyond headcounts. Counting how many women or persons with a disability are present does not tell us whether they are shaping decisions, accessing benefits, or building durable economic agency. Programmes should be required to report on the quality of participation, the distribution of benefits, and the degree to which decision-making authority is genuinely shared. Appendix A of this paper suggests a practical framework for more meaningful inclusion metrics.

7. Conclusion

The cases presented in this paper do not prove that solar value chains are inclusive. They demonstrate something more precise: that more inclusive outcomes are possible, and that it must be designed in from the outset, institutionally embedded during implementation, and sustained beyond the life of individual project cycles.

SUNSAFE shows that technical expertise can be democratised when tools are built around the realities of excluded users. Kijani Testing shows that repair ecosystems are not peripheral service delivery, but core social infrastructure. ENACT shows that communities can exercise genuine governance authority when co-design is taken seriously. POWERE shows that renewable infrastructure can be embedded in social systems rather than imposed upon them, but only when social and institutional groundwork precedes technical deployment. The importance of inclusive market research at the earliest stages of the value chain is emphasised: where user priorities, constraints, and decision-making processes are embedded into technology and policy design from the outset, reducing the risk of misalignment between what is delivered and what is needed.

The cases also clarify a critical distinction. **Inclusion is delivered through projects (and business models), but it is sustained and scaled through systems**. Delivery-level innovations such as tools, training models, repair ecosystems, and co-design processes demonstrate what is possible in practice. System-level enablers, including financing mechanisms, specialised gender advisory and technical assistance, partnership platforms, and policy engagement determine whether those practices remain localised or become embedded as norms across the sector.

Neither operates effectively without the other. Delivery without system support remains fragmented and fragile; system-level commitments without grounded delivery lack credibility and traction. Inclusion is therefore not the product of a single intervention, but of alignment between practice and system design.

Empirically, the cases show that GEDSI-led approaches improve equity outcomes and system performance. Inclusive design produces more reliable technologies, stronger maintenance ecosystems, better alignment with user demand, and greater trust in energy services. Inclusion, in this sense, is not an add-on to energy access, but a condition of its durability.

At the same time, the limits of project-level intervention remain clear. None of these cases transforms the upstream dynamics of the value chain: the concentration of manufacturing, the conditions of extraction, or the structural inequalities embedded in global supply chains. **These are system-level challenges that require policy reform, regulatory change, and international coordination**.

The gap between what delivery-level interventions can achieve and what systemic transformation requires is the **central design challenge for the sector**. Bridging it requires deliberate coordination: aligning finance, policy, gender and disability advisory technical assistance, and evidence systems with the inclusive practices already being demonstrated on the ground.

This is where the next phase of work for the TEA@SUNRISE network sits - not only documenting what works, but shaping the conditions under which it can scale. Inclusion, as these cases show, is not peripheral to solar transitions. It is a **structural condition of whether they are equitable, durable, and viable at scale**.

Closing vignette: When inclusion is designed in

In a similar rural setting, a new generation of solar programmes begins from a different premise: that access alone is not success, and that systems must be designed for how they will actually be used over time.

Before installation, communities are engaged and included in understanding their specific energy requirements, in siting decisions, in appreciating system limits, likely demand growth, and trade-offs between affordability and service levels. Procurement criteria move beyond cost-per-connection to include minimum service standards, maintenance provision, and long-term performance.

Systems are designed with realistic usage patterns in mind, including the likelihood of appliance uptake. In some cases, this means clearly defined service levels; in others, it requires planning for expansion from the outset. Expectations are made explicit and shared.

Local operators receive structured, ongoing training rather than one-off instruction, supported by accessible tools, remote assistance, and clear maintenance protocols. Repair systems are developed alongside installation, with supply chains for spare parts and pathways for technician support.

Financing and regulatory frameworks are adjusted to reflect long-term operation, allowing for maintenance, replacement, and adaptation. Where communities contribute resources, governance structures ensure they also participate in decision-making.

Over time, systems continue to function — not perfectly, but reliably enough to maintain trust. The difference is not technological, but in how systems are designed, supported, and governed. Energy access becomes an ongoing service, not a one-time delivery.

[i] Value for Women contributes to the Transforming Energy Access ecosystem through technical gender inclusion support that combines market research, programme design inputs, operational guidance and evidence generation. This work has supported energy companies and partners to strengthen inclusive recruitment approaches, improve engagement with women customers, pilot workforce participation strategies and develop practical tools that inform wider replication across the sector. For further detail see: Powering Inclusion: Tested Approaches for a Gender-Inclusive Energy Transition, Value for Women, 10 March 2026; and Gender Equality, Disability & Social Inclusion (GEDSI) Toolkit: Guide and Overview, Value for Women, 1 March 2025.

[ii]: https://ashden.org/transforming-humanitarian-energy-access/ Ashden facilitates delivery of the Transforming Humanitarian Energy Access (THEA) programme by designing and delivering inclusive financing mechanisms and partnerships that enable locally led, particularly refugee-led, clean energy enterprises to participate in and shape sustainable energy delivery models.

[iii] Powering Renewable Energy Opportunities - https://preo.org

[iv] https://sunsafe-energy.com

[v] Disability Support Service (DSS: Transforming Energy Access (TEA) platform, supported through UK aid from the UK government and led by the Carbon Trust, developed the Disability Support Service (DSS) in partnership with the Global Disability Innovation Hub (GDI Hub) to co-design and deliver disability-inclusive, accessible, and affordable clean energy solutions for equal socio-economic participation of people with disabilities. DSS is a cross-platform delivery service that offers training, innovation support, and technical assistance (TA) and produces practical knowledge outputs for the TEA network by blending expertise in disability inclusion, innovation, assistive and accessible technology (AAT), and inclusive design.