GHANA'S PHOTOVOLTAIC INDUSTRY

Localisation, Decent Work, and Gender Equity in a Growing Renewable Energy Market

A Case Study

September 2026

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JUST ENERGY TRANSITION:
Localisation, Decent Work, SMMEs,and Sustainable Livelihoods

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LIST OF ABBREVIATIONS AND ACRONYMS

AfCFTA	African Continental Free Trade Area
AGI	Association of Ghana Industries
AGSI	Association of Ghana Solar Industries
AGSI ESC	AGSI Energy Service Centre
BOS	Balance-of-system production
BPA	Bui Power Authority
CBAM	Carbon Border Adjustment Mechanism
CBOs	Community-based organisations
CSR	Corporate social responsibility
EU	European Union
GPN	Global Production Network
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
ILO	International Labour Organization
IRENA	International Renewable Energy Agency
MOU	Memorandum of understanding
NETF	National Energy Transition Framework
PPAs	Power Purchase Agreements
PV	Photovoltaic
REMP	Renewable Energy Master Plan
SMMEs	Micro, small, and medium enterprises
SUNREF	Natural Resources and Energy Finance
TVET	Technical and Vocational Education and Training
UN	United Nations
UNSD	United Nations Statistics Division
VRA	Volta River Authority
WIPO	World Intellectual Property Organization

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EXECUTIVE SUMMARY

Ghana's solar photovoltaic (PV) sector is at a pivotal stage. By the end of 2023, installed solar capacity reached approximately 81 megawatts (Energy Commission of Ghana, 2025), falling short of the Renewable Energy Master Plan's first-cycle milestone of 130 megawatt peak for 2020 (Ofori, Osman and Djangba, 2025). The commercial and industrial solar market is nonetheless expanding rapidly, with projected compound annual growth rates exceeding 39% through 2031 (Mordor Intelligence, 2026). National policy ambitions reflect this potential: The Ministry of Energy (2021) targets 10% renewable energy in the national generation mix by 2030 (Ofori et al., 2025), while the Local Content and Local Participation Regulations (Government of Ghana, 2017) set targets of 80 to 90% local participation in solar PV manufacturing.

Developing a domestic manufacturing base has significant job and revenue potential. Solar PV panel production generates approximately 1,970 full-time equivalent jobs per gigawatt of production capacity, more than five times the labour intensity of inverter production (SolarPower Europe, 2023). In practice, however, the Ghana's solar industry remains concentrated in the final stages of the supply chain, primarily importing, installing, and maintaining equipment rather than manufacturing. Consequently, much of the value generated by the expanding solar market flows outward rather than building domestic industry.

The economic stakes of addressing this structural gap are considerable. Ghana's solar PV import bill nearly doubled from approximately US$ 7.8 million in 2018 to US$17.6 million in 2023 (United Nations Statistics Division [UNSD], n.d.)[1], reflecting the outward flow of value. Capturing even a portion of the production currently imported would generate substantial employment at skill levels that build lasting industrial capability. The Renewable Energy Master Plan (REMP) envisions a total investment requirement of $5.6 billion over twelve years, approximately US$460 million annually, with 80% expected from the private sector (Ofori et al., 2025). Deepening local manufacturing capability would redirect a significant share of this investment into Ghana's industrial economy. The employment potential is equally substantial. The REMP targets the creation of 220,000 jobs from renewable energy development (Ofori et al., 2025), while the National Energy Transition Investment Plan projects 400,000 net new jobs, with 80% to be directly stimulated by solar PV and electric vehicle charging infrastructure (Ofori et al., 2025).

Across the electricity sector, the National Energy Transition Framework (NETF) projects approximately 1.37 million direct, indirect, and induced jobs, including 172,000 directly in constructing renewable generation assets (Ofori et al., 2025). Globally, solar PV already supports approximately 7.2 million jobs (International Renewable Energy Agency [IRENA] and International Labour Organization [ILO], 2026), concentrated overwhelmingly in manufacturing economies. The central question for Ghana

[1] UN Comtrade data on solar PV imports to Ghana (HS Code 854140) were drawn from the UN Comtrade international trade statistics database (https://comtradeplus.un.org).

is whether it captures a share of this employment dividend through deliberate industrial policy or if it continues to function as a consumer market for technologies and the jobs they create elsewhere. This case study examined Ghana's solar PV industry through a Global Production Network (GPN) framework, assessing the prospects and conditions for expanding local manufacturing, creating decent employment, and advancing gender equity. It drew on original primary research, including a structured firm-level survey of 16 licensed solar companies, in-depth interviews with stakeholders across government, industry, labour, civil society, and university academics, and an analysis of published policy documents. The study identifies the structural factors that currently constrain Ghana's ability to create and capture a larger share of the value generated by its solar market.

The evidence shows that Ghana's participation in the solar PV supply chain is concentrated in the latter stages, including installation, distribution, retail, and maintenance. Local manufacturing of core components, including solar cells, modules, and inverters, remains minimal, though nascent assembly activity suggests domestic production is within reach. Chinese firms account for approximately 62% of global module production capacity (WoodMac, 2025), and China holds approximately 34% of global solar PV patents registered between 2016 and 2025 (World Intellectual Property Organization [WIPO], 2025)[2]. In addition, Chinese manufacturers operate with state-backed financing and vertically integrated supply chains that allow them to supply modules at prices domestic assembly cannot currently match (International Energy Agency [IEA], 2022). This concentration of manufacturing and technological ownership narrows options for countries seeking to enter higher stages of the supply chain. Moving beyond this downstream position presents several structural challenges.

Access to manufacturing-grade finance at appropriate tenures is the most consistently cited structural barrier, with the cost and tenure of domestic credit misaligned with the longer payback periods of manufacturing investment (Sackey, Owusu-Manu, Asiedu and Jehuri, 2020). Policy implementation is inconsistent: local content targets requiring 80–90% local participation in solar PV manufacturing by 2025 have not been tracked, communicated, or enforced, and most firms consulted for this study were unaware that such targets existed (Ofori et al., 2025). Workforce competencies in manufacturing activities, including quality assurance, production management, and precision assembly, remain limited, and Ghana's technical and vocational education system has not been systematically aligned with sector requirements (Owusu-Agyeman and Aryeh-Adjei, 2024). Finally, the absence of infant industry protection leaves nascent domestic production initiatives exposed to subsidised import competition at an early and fragile stage of development.

These challenges have implications for decent work. The survey results show that employment in Ghana's solar sector is predominantly short-term and project-based: workers are engaged for the duration of installation projects and released when those projects end, with limited access to formal labour protections or social security. This pattern is a direct structural consequence of Ghana's position in the downstream market. Because manufacturing has not yet been fully developed in this sector, the dominant form of solar employment is installation, which is inherently project-bounded and cyclical, generating intermittent income rather than stable careers. The unpaid care and domestic work that sustains this workforce, including childcare, cooking, water collection, and caring for family members, falls disproportionately on women, who perform approximately 3.4 times more unpaid

[2] WIPO data on global solar PV patent filings were drawn from the WIPO IP Statistics Data Center (https://www.wipo.int/ipstats/).

work than men (African Development Bank, 2022), directly constraining their availability for mobile, time-intensive, and field-based roles.

Women represent approximately 21% of energy sector employment in Ghana (African Development Bank, 2022), and are significantly underrepresented in technical, managerial, and field-based positions. Their underrepresentation reflects several intersecting structural dynamics: informal recruitment through male-dominated professional networks; the cultural framing of field installation and rooftop work as physically masculine; and technical and vocational training that has not actively opened pathways for women into solar PV competencies (Lijfering and van der Veen, 2024; Nelson and Kuriakose, 2021). The characteristically thin margins of this import-dependent distribution sector give solar firms little capacity or commercial incentive to invest in gender inclusion outside donor project cycles. Only two of the sixteen firms surveyed have a formal gender policy, and when donor funding closes, gender initiatives close with it.

The case study identified concrete opportunities for Ghana to create and capture more value from its solar market: local assembly of solar modules; manufacturing components such as mounting frames, cables, and packaging, leveraging Ghana's existing industrial capabilities; long-term operations and maintenance services; and recycling solar panels at the end of their useful life. Realising these opportunities requires deliberate policy alternatives: replacing import-friendly tax structures with incentives for local assembly, creating financial instruments calibrated to manufacturing investment, using government procurement to generate predictable demand for locally produced goods, expanding skills training beyond basic installation, and embedding gender equity as a measurable condition in energy sector licences and contracts.

Ghana's renewable energy transition will not automatically deliver inclusive industrial development. Without deliberate policy choices, the country risks remaining a passive consumer of technologies produced elsewhere.

1. INTRODUCTION

Ghana's solar photovoltaic (PV) sector offers a significant opportunity not only to expand renewable energy access but also to advance a just social transition — that is, a shift away from carbon-intensive energy systems that is managed in ways that are fair and inclusive, generating economic opportunities and creating and retaining value domestically rather than replicating established patterns of dependence. The commercial and industrial solar market is projected to grow at a compound annual growth rate of 39.24% through 2031 (Mordor Intelligence, 2026), while the Renewable Energy Master Plan (REMP) targets 1,363 megawatts of cumulative renewable energy capacity by 2030 (Ministry of Energy, 2019). Despite this potential, solar PV currently accounts for only about 2% of Ghana's installed generation capacity (Energy Commission of Ghana, 2025), and domestic manufacturing remains negligible: only two (12.5%) of firms surveyed for this case study reported any manufacturing or assembly activity, while six (37.5%) indicated that local Small, Micro, and Medium Enterprises (SMMEs) play no role in solar PV component manufacturing. As a result, Ghana's solar market growth has translated into a growing import bill rather than a domestic industrial development plan. Imports of solar PV panels and components under the Harmonised System Code 854140 nearly doubled between 2018 and 2023, rising from US$ 7.8 million to US$15.9 million (UNSD, n.d.), with those funds flowing outward rather than supporting local producers, workers, and businesses.

This study examined what would need to change for Ghana's solar PV sector to contribute to a just energy transition. Although localisation remains in its early stages, the current situation demonstrates proof of concept. At least one Ghanaian firm has established the technical feasibility of local module assembly, systems integrators are developing engineering expertise through deployment, and Ghana's industrial base, including aluminum smelting capacity, cable manufacturing, and bauxite and silicon deposits, provides inputs directly relevant to balance-of-system (BOS) production. The key structural barriers to expanding domestic manufacturing and to creating and capturing more value from the sector's growth include inconsistent policy implementation, identified as a major challenge by fourteen (87.5%) of the firms surveyed for this case study, fiscal incentives that favour finished imports over locally assembled products, limited access to manufacturing finance, and gender norms that restrict women to non-technical roles.

Unlocking the sector's potential will require five important local content requirements. First, enforceable obligations for companies operating in the sector to source specified shares of goods, services, and labour from domestic suppliers; second, targeted industrial financing calibrated to the longer payback periods of manufacturing investment; third, government procurement structured to favour locally produced goods and create stable, predictable demand for domestic manufacturers; fourth, enhanced skills development beyond basic installation; and, finally, the integration of gender equity into both government energy and industrial policy and the operational practices of firms in the sector.

This case study uses the Global Production Network (GPN) framework as its primary analytical approach. Drawing on Henderson, Dicken, Hess, Coe and Yeung (2002) and Coe, Dicken, and Hess (2008), the framework defines GPNs as cross-national networks through which value is created,

enhanced, and captured. The framework goes beyond trade flows to examine the power relations, institutional contexts, and social conditions that determine who benefits from production networks. This enables an analysis of Ghana's industrial positioning alongside the governance mechanisms, social norms, and labour conditions that will determine whether the energy transition achieves structural transformation (Gereffi, Humphrey, and Sturgeon, 2005).

The case study uses a mixed-methods empirical design.[3] A structured firm-level survey was administered to companies licensed by the Energy Commission of Ghana to import, install, and maintain solar PV systems, yielding 16 complete responses. This was complemented by 19 in-depth, semi-structured interviews with a selected range of stakeholders from government ministries, regulatory bodies, industry associations, labour unions, civil society, and academia. The findings were triangulated with desktop research covering policy documents, international organisation reports, and peer-reviewed literature.

This study presents the first systematic empirical assessment of Ghana's solar PV sector, using an integrated framework that combines GPN theory, just transition principles, and gender equity. The analysis reveals firm-level realities and policy dynamics that aggregate statistics or high-level policy reviews tend to overlook. The study examined how current decisions on industrial policy, labour standards, and gender inclusion will determine whether Ghana's clean energy transition fosters broad-based development or perpetuates established patterns of economic dependence. The study asks two related questions: to what extent is the solar PV production network being localised in Ghana, and is that localisation structured to generate decent work and gender equity?

The case study is organised as follows. Section 2 maps Ghana's current role in the global solar PV production network and examines who creates and captures value in the sector, establishing a baseline picture of localisation and the scope for domestic industrial integration. Section 3 analyses the quality of employment being generated in Ghana's solar sector, traces how work is evolving, and draws out the relationship between decent work outcomes and localisation. Section 4 then examines the gendered dimensions of solar sector participation, including dynamics within the workplace and in the broader sphere of social reproduction, and analyses the relationship between gender equity and localisation. Section 5 identifies and examines the key structural factors and actors, including local firms, government, global lead firms, financial institutions, and civil society, that explain the outcomes documented in the preceding sections and must be addressed to produce different outcomes. In conclusion, Section 6 synthesises the key challenges and opportunities arising from the analysis and presents concrete, targeted policy recommendations structured around those findings.

[3] For a full description of the research methodology, including the survey design, sampling frame, interview protocol, and ethical considerations, see Appendix A.

2. LOCALISATION AND STRUCTURAL TRANSFORMATION

This section maps Ghana's current role in the global solar PV production network, identifies where, how, and by whom value is created, and analyses patterns of value capture. The findings show that Ghana's participation remains concentrated in downstream deployment and utilisation, while manufacturing largely occurs outside the country and end-of-life activities remain underdeveloped. Consequently, local firms capture value mainly through relatively low-margin activities such as systems integration, installation, and maintenance, while foreign firms with access to manufacturing capabilities, vertically integrated supply chains, and more favourable financing capture a larger share of value through component supply and grid-scale projects.

Workers' value capture is constrained by project-based employment, community benefits remain largely indirect, and available development finance is disproportionately directed toward deployment rather than domestic manufacturing. Although limited module assembly and emerging systems-design capabilities indicate some potential for upgrading, deeper localisation remains constrained by access to finance, policy implementation gaps, capability development, and the competitive conditions facing domestic firms.

The section draws on semi-structured interviews with government officials, regulatory authorities, industry association representatives, renewable energy entrepreneurs, and academics, as well as a firm-level survey of 16 licenced solar PV companies, secondary trade data, and a review of Ghana's policy landscape.

2.1 Ghana's Role in Solar PV Production Networks

The solar PV production network operates across three stages. First, the manufacturing stage encompasses silicon extraction, polysilicon refining, ingot and wafer production, cell fabrication, and module assembly. Second, the deployment and utilisation stage covers sales, system design, installation, operations, and maintenance. Third, the end-of-life stage involves decommissioning, recycling, and material recovery. Understanding who creates value at each stage of the production network reveals Ghana's current industrial position as well as the gap that must be closed to achieve meaningful localisation.

Value creation in the manufacturing stage is dominated by a small number of global lead firms, primarily based in China. According to the 2024 Wood Mackenzie rankings, Chinese companies occupy nine of the top thirteen global manufacturing positions and collectively account for approximately 62% of global production capacity and 82% of global shipments (WoodMac, 2025). China also accounts for approximately 34% of all solar PV patent filings recorded globally between 2016 and 2025, based on data from the World Intellectual Property Organization (WIPO) Statistics Data Center (2025). The

International Energy Agency (IEA) confirms that this concentration of manufacturing capability, economies of scale, and intellectual property creates high barriers to entry, particularly in cell and wafer production (IEA, 2022). Ghana currently has no meaningful participation in this stage. Research on global value chains confirms that the path from downstream services to manufacturing is not automatic; rather, it requires deliberate institutional support, capacity development, and market positioning (De Marchi, Giuliani, and Rabellotti, 2018).

Value creation in the deployment and utilisation stage is where Ghana's domestic firms and workers are most active. Semi-structured interviews with industry association representatives, regulatory officials, and renewable energy entrepreneurs confirmed that Ghanaian firms operate primarily as buyers and service providers rather than as manufacturers. Licensed firms import solar modules, inverters, batteries, and mounting hardware and combine them with locally delivered installation, engineering, and maintenance services. According to the Energy Commission of Ghana's register of licensed firms, approximately 90% of licensed solar PV firms are located in the Greater Accra Region, indicating a geographically concentrated deployment market with limited industrial dispersion (Energy Commission of Ghana, n.d.).

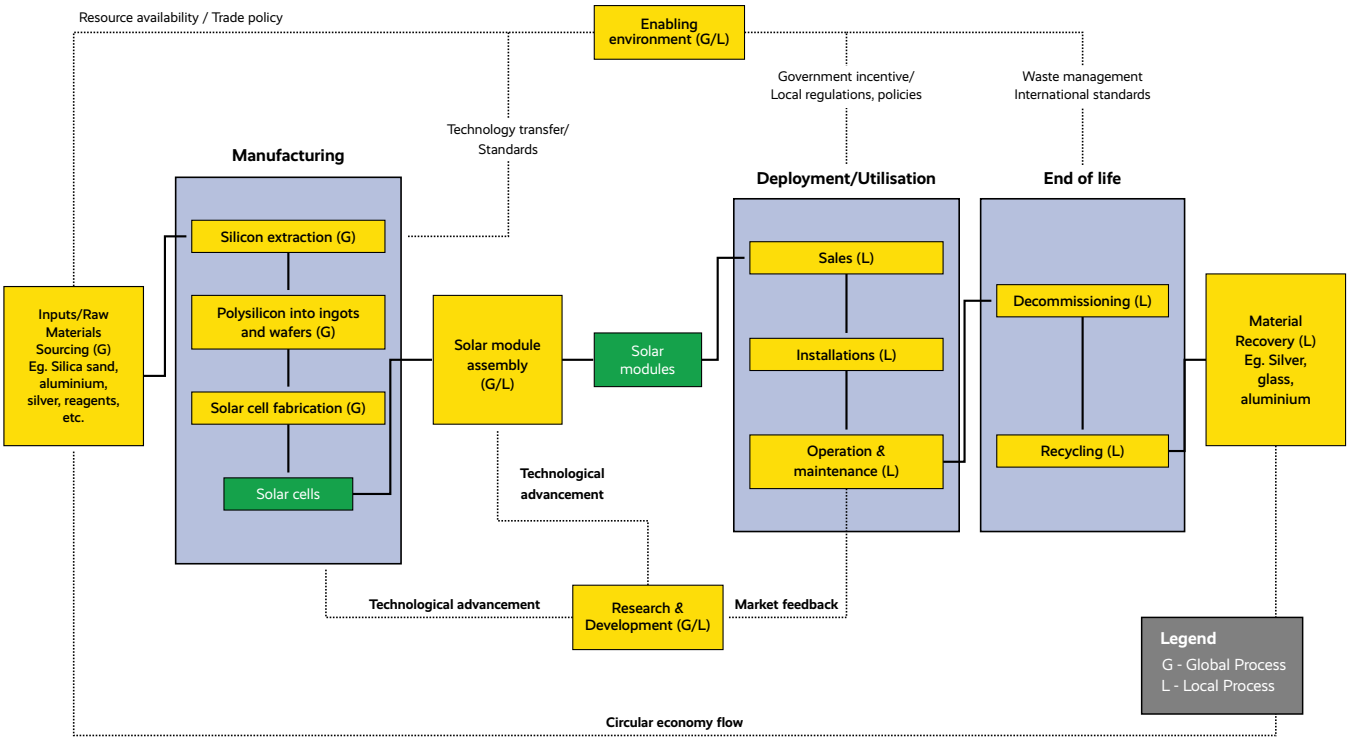
Several non-firm actors are also integral to the production network. The Energy Commission of Ghana is the principal regulator, mandated with issuing licences, setting technical standards, and maintaining the public register of licensed firms. The Ghana Standards Authority certifies solar PV components to national and international standards. Industry associations, including the Association of Ghana Solar Industries (AGSI) and the Association of Ghana Industries (AGI) through its Energy Service Centre (ESC), provide training, certification support, market advocacy, and business networking. In 2025, the AGI ESC organised the Ghana Renewable Energy and Efficiency Business-to-business Expo to facilitate commercial linkages (AGI ESC, 2025). State-owned enterprises, including the Bui Power Authority (BPA) and the Volta River Authority (VRA), participate in utility-scale solar deployment through engineering, procurement, and construction contracting but do not manufacture components. International development finance institutions, notably the African Development Bank and the International Finance Corporation (IFC), provide capital for large-scale deployment projects. The African Development Bank has supported BPA's solar project in Yendi, a town in Ghana's Northern Region, while the IFC arranged a US$130 million financing package for a proposed utility-scale solar park (Mordor Intelligence, 2026).

Two Chinese companies, BXC Solar and Meinergy Technology Limited, occupy a distinctive position in the network as the only private solar firms to have secured Power Purchase Agreements (PPAs) with the Government of Ghana (Energy Commission of Ghana, n.d.). Their competitive advantage stems from access to subsidised, concessional, state-backed financing, and vertical integration with global supply chains operating at significant economies of scale (IEA, 2022).

The end-of-life management stage remains largely undeveloped in Ghana. Despite the Hazardous and Electronic Waste Control and Management Act (No. 917 of 2016), no official documentation exists on solar PV waste management practices (Agyeman, Quansah, Ntiamoah, Mensah and Ramde, 2025). As Ghana's installed capacity is projected to grow in the coming decades, this gap will become increasingly consequential for both environmental management and potential industrial opportunities.

Figure 1 presents the general structure of the solar PV production network and overlays Ghana's current position, with annotations indicating activities undertaken locally (L) and globally (G).

Figure 1: Solar PV production network and Ghana's current position, with activities annotated as local (L) or global (G)



During the deployment and utilisation stage, a limited number of firms are developing capabilities in customisation and systems design, adapting imported technologies to local climatic conditions, customer requirements, and grid characteristics. These activities mark the early stages of functional upgrading, as firms transition from product distribution to technical service provision. A firm-level survey of 16 licensed solar PV companies found that 62.5% (ten firms) of respondents are solar energy solution providers and systems integrators, 25% (four firms) primarily serve as product suppliers and distributors, and only 12.5% (two firms) reported involvement in component assembly or light manufacturing. These findings align with evidence from the semi-structured interviews with industry experts and renewable energy entrepreneurs, who confirmed that the sector has evolved primarily as a deployment and services market. As one renewable energy entrepreneur stated:

> *'I had an opportunity to send people to China to go and learn how to assemble inverters and repair them when they are faulty. But I had a challenge: I would send people there just to train them, and when they came, they worked with me for one or two years and then left. What do I do?'*

This account illustrates a structural tension at the heart of workforce capability development in the sector. Specifically, it concerns building the technical skills required to engage in higher-value activities such as assembly, component production, and quality assurance. From an employer perspective, the risk of losing trained staff discourages sustained investment in employee development. This framing, however, captures only one side of the dynamic. From the worker's perspective, upward career mobility after training may reflect genuine labour market opportunity: evidence from the semi-structured interviews indicates that workers who acquire higher technical skills are more likely to secure repeat contracts or supervisory roles and to command better remuneration than those who remain in lower-skilled positions (see Section 3.1). Where employers do not adapt pay or progression pathways to reflect workers' higher qualifications, departure may represent a rational response to systemic weaknesses in remuneration and career progression, rather than simply an individual retention problem. The available evidence does not definitively establish whether workers move on primarily to access higher wages or more stable employment — or both — but the underlying dynamic is clear: without structured mechanisms that align firm investment in training with workers' career advancement, this tension is likely to persist as a brake on the sector's capability development.

2.2 Current Patterns of Value Capture

Value capture is the extent to which different actors benefit from the value generated across the solar PV production network. In Ghana, value capture is heavily skewed toward the deployment stage, with significant outflows from the manufacturing and technology segments to matured industries in China and other developed markets.

The actor categories used here are a study-specific analytical choice, not a claim that all GPN approaches use the same actor set. Consistent with this case study's integrated GPN, just transition, and gender-equity framework, the analysis includes actors that either directly capture value from Ghana's solar PV sector or materially shape how that value is created, distributed, and retained domestically.

In Ghana's solar PV context, four considerations shape the actor set presented here. First, firms are disaggregated into local and foreign companies because the structural distinction between these two groups is analytically central to the localisation question: local and foreign firms occupy fundamentally different positions in the network, capture value through different mechanisms, and face different constraints. Second, financiers are included as a distinct actor category because access to finance is the most consistently cited structural barrier to industrial upgrading across all research for this study, making financial actors a determinative force in shaping who can participate in higher-value network activities and who cannot. Third, state institutions are included because Ghana's government functions simultaneously as regulator, anchor customer, and policymaker in the solar sector. These roles give the state a direct stake in value flows that extend well beyond standard regulatory functions. Fourth, communities are included because the study's just energy transition framing requires attention to who bears the social costs and receives the livelihood benefits of the energy transition at the local level. This dimension is not always captured by standard GPN analyses, which typically focus on firm and state actors, but it is directly relevant to the questions this study asked.
Workers capture value through wages and employment benefits, while local and foreign firms capture

commercial margins and project revenues. State institutions capture fiscal and state-enterprise revenues, while financiers earn financial returns and influence capital allocation. Communities receive primarily indirect benefits through energy access, local employment, and corporate social responsibility interventions. Including these actors enabled the analysis to examine not only firm-level returns but also the institutional and distributional dimensions of value capture central to this study.

For this study, the state-institution category is informed by interviews with officers from three organisations, namely the Committee on Energy (also referred to as the Select Committee on Energy) in Ghana's Parliament, the Ministry of Energy and Green Transition, and the Energy Commission of Ghana (see Appendix C for the full stakeholder category framework). Evidence on state institutions' (or the states) value capture also draws on the policy, fiscal, and secondary-data analysis used in the study, rather than on interviews alone. Table 1 summarises the distribution of value across major actor categories, drawing on a firm-level survey, semi-structured interviews, secondary trade data, and policy analysis.

Table 1: Distribution of value among the major actor categories

Actor	Nature of Value Capture	Key Observations
Workers	Wages from technical and service roles	• Contract-based employment limits value capture • Wages fall below market benchmarks for comparable technical roles • Households absorb income volatility by diversifying and borrowing informally
State Institutions	• Corporate taxes • 8% repatriation tax on foreign profits • Revenues from state-owned enterprise solar operations	• Limited value from manufacturing or supply chain • Growing import bill represents outflows of potential domestic value • Fiscal returns would be substantially higher under a manufacturing-led sector
Foreign Companies	• Manufacturing margins on imported components • Project revenues • PPAs for grid-scale generation	• Chinese firms with PPAs capture significant value • Dominance reinforced by state-backed financing and vertical integration across the supply chain

Actor	Nature of Value Capture	Key Observations
Communities	• Some energy access benefits • Limited employment income from installation projects	• Corporate social responsibility (CSR) contributions remain largely philanthropic • Sustained community economic benefit from the solar sector is limited • No formal community benefit agreements documented
Financiers	• Interest returns on concessional loans (African Development Bank, IFC) • Sustainable Use of Natural Resources and Energy Finance (SUNREF) scheme returns	• Finance primarily supports deployment assets rather than manufacturing • Sovereign guarantees reduce financial risk for lenders • Manufacturing investment remains largely unfinanced
Local Companies	• Margins on systems integration, installation, and maintenance services	• Confined to the lowest-margin downstream activities • High domestic borrowing costs constrain profitability and reinvestment capacity • No participation in higher-margin manufacturing or assembly

Workers in Ghana's solar PV sector derive most of their value from wages in technically skilled roles, as shown in Table 1. The firm-level survey found that all 16 surveyed firms employ workers with bachelor's degrees, and twelve (75%) also employ staff with postgraduate training, reflecting the engineering and project management requirements of systems integration work. Six (37.5%) firms employ vocationally trained workers, whose practical skills are central to installation and maintenance services. Despite this educational profile, the employment structure limits workers' ability to capture value. Project-based contracting makes income intermittent and insecure. Wages are widely perceived as insufficient relative to household responsibilities. Households respond by diversifying income and borrowing informally between pay cycles. Semi-structured interviews with labor union representatives and workers confirmed trends in global research that gender disparities compound these challenges: women perform approximately 3.4 times more unpaid care work than men, averaging 15.5 hours per week compared with 4.6 hours for men (African Development Bank, 2022), further constraining their capacity to participate in and benefit from sector employment.

The state's value capture from the sector is structurally constrained by Ghana's downstream-only industrial position. Although the state collects corporate taxes, (an 8%) repatriation tax on profits earned by foreign investors, and revenues from state-owned enterprise solar operations, the fiscal take would be substantially larger in a manufacturing-led solar sector. Ghana's growing import bill

for solar PV components, which nearly doubled from approximately US$7.8 million in 2018 to US$15.9 million in 2023 (UNSD, n.d.), represents an ongoing outflow of potential domestic value-added.

Foreign companies, particularly the two Chinese firms with PPAs, capture most of the value from Ghana's solar market. Their vertically integrated supply chains, state-backed financing, and control of the highest-margin manufacturing segments enable them to extract returns from both component supply and grid-scale generation.

Community value capture is primarily indirect, stemming from improved energy access, and is not accompanied by sustained economic participation. The semi-structured interviews with civil society representatives confirmed that CSR contributions from solar firms remain largely philanthropic and are not structured through formal community benefit agreements or participatory mechanisms.

Financiers, including the African Development Bank and IFC, capture value through interest on concessional loans and risk-managed financing arrangements. Sovereign guarantees from the Ghanaian government further reduce lenders' financial risks, making deployment finance relatively attractive, while manufacturing investment, which lacks comparable guarantees, remains structurally underfunded (IFC, 2021).

Local companies are confined to the lowest-margin activities in the value chain. The firm-level survey found that ten (62.5%) of firms identified limited access to finance as a major structural constraint, and twelve (75%) reported financing difficulties as a significant operational challenge. High domestic borrowing costs constrain profitability and limit the reinvestment capacity needed to upgrade to higher-margin activities (Sackey *et al*., 2020).

Taken together, these patterns suggest a markedly asymmetric distribution of power within Ghana's solar PV production network. Corporate power is concentrated among foreign firms that control higher-value manufacturing activities, intellectual property, technology, vertically integrated supply chains, and access to comparatively favorable financing (IEA, 2022; also see Section 4.2.2). Financial actors also exercise significant leverage through decisions about which segments of the production network receive capital, with available development finance concentrated more heavily on deployment than on domestic manufacturing.

State institutions possess formal power through regulation, local-content rules, procurement, standards, and fiscal incentives, but implementation and coordination gaps constrain their capacity to redirect investment and value toward domestic production. Ghana's failure to develop manufacturing, and its policy instruments, while formally ambitious, have not been consistently translated into enforcement mechanisms that can reshape these power dynamics (Ofori *et al*., 2025). Local firms, workers, and communities therefore occupy comparatively weaker power positions. Since local firms depend heavily on imported technologies and costly domestic finance, Ghanaian workers have limited bargaining power under project-based employment arrangements, and community benefits remain largely mediated through informal CSR rather than through enforceable benefit-sharing mechanisms. This power imbalance directly shapes the industrial policy challenge. The actors with the greatest capacity to invest in upgrading (that is, foreign firms and international financiers) have limited structural incentives to do so in ways that build domestic capability, while the actors with the greatest

developmental interest in upgrading (local firms, workers, and state institutions) lack the capital, technology, and market access to pursue it independently. Closing this gap is the central task of industrial policy; Section 6.3 addresses it further through its recommendations.

2.3 Localisation and Industrial Development

Ghana's solar PV sector has made little progress toward economic upgrading. Activity remains concentrated at the downstream end of the production network, with most firms engaged in distribution, systems integration, installation, and after-sales services. Manufacturing capability is essentially absent from the national industrial landscape, except for a single small-scale module assembly initiative that sources cells from international suppliers and assembles them domestically. This initiative demonstrates that local production is technically feasible, even if the business environment has not yet enabled growth at scale.

Previous assembly attempts failed when enabling conditions were not sustained. One example is Strategic Power Solutions, which operated a solar-module assembly facility in Ghana in 2016 (Kenning, 2016) but later ceased operations. Semi-structured interviews with renewable energy entrepreneurs and industry experts indicated that earlier assembly initiatives collapsed following shifts in fiscal policy, including the withdrawal of import-duty for competing finished products and changes to electricity tariff structures that increased operating costs for assembly facilities. While the available evidence does not establish that these specific policy changes caused the closure of Strategic Power Solutions, the broader pattern is consistent with the findings of Semelane, Nwulu, Kambule and Tazvinga (2021), who found in South Africa that technically viable localisation initiatives may struggle to withstand competition from subsidised imports without sustained and coherent policy support.

The firm-level survey found that six (37.5%) firms maintain informal or occasional supply arrangements with foreign companies, three (18.75%) have formal long-term supplier relationships, and three (18.75%) participate in joint ventures. These partnerships facilitate access to technology, trade credit, and markets. However, investment patterns indicate that upgrading remains aspirational for most firms: eight (50%) invest in design, marketing, logistics, and research-related activities, while three (18.75%) have made investments specifically aimed at improving production efficiency or product quality. No surveyed firm reported targeted investment in formal workforce reskilling, despite the recognised importance of skills development. Concerns about employee career mobility after receiving firm-sponsored training remain a significant disincentive to train and develop employees.

The sector's localisation trajectory is also shaped by the absence of a coherent industrial policy. The National Development Planning Commission, which could, in principle, provide long-term continuity, serves only an advisory function and lacks binding authority (Ofori et al., 2025). Frequent institutional restructuring following changes in government disrupts investor confidence and the continuity of localisation support programmes.

Despite these constraints, Ghana's solar market growth trajectory offers a meaningful opportunity for localisation. The commercial and industrial solar market is projected to grow by 39.24% annually by 2031 (Mordor Intelligence, 2026; IEA, 2024). If Ghanaian government procurement commitments

meaningfully include local participation requirements, this demand pipeline could provide the market certainty needed to attract manufacturing investment. See Section 5 for an analysis of key factors and actors that support or hinder localisation and Section 6 for a synthesis of possible opportunities and challenges.

3. DECENT WORK

This section examines the quality of employment in Ghana's solar PV sector, traces the evolution of work over time, and assesses the relationship between decent work outcomes and localisation. The evidence is drawn primarily from semi-structured interviews with renewable energy entrepreneurs, firm managers, labour union representatives, government officials, and workers, as well as from a firm-level survey of 16 licensed solar PV companies. The ILO defines decent work as 'productive work for women and men in conditions of freedom, equity, security and human dignity', organised around four pillars: employment creation, rights at work, social protection, and social dialogue (ILO, 2018). This framework guides the analysis throughout this section.

3.1 Work in the Solar PV Sector

Employment in Ghana's solar PV sector is concentrated in downstream deployment activities, including system design, installation, distribution, operations, and maintenance. The dominant employment model is project-based and contract-driven: firms retain small permanent cores of senior engineers and project developers while engaging installation workers flexibly as contracts materialise. This pattern is a direct structural consequence of Ghana's position in the downstream market. Because the sector has not yet developed manufacturing, installation is the dominant form of work and is inherently project-bounded and cyclical. This does not imply that manufacturing employment is automatically higher quality; manufacturing work can itself be precarious, informal, and poorly remunerated, as Ghana's broader industrial labour market demonstrates (Baffour and Abbey, 2023; Gradín and Schotte, 2020). The structural point is more specific: installation work is organised around discrete project contracts by its very nature, generating employment that begins and ends with each project, whereas manufacturing and long-term operations and maintenance activities create the conditions for more continuous employment relationships, though whether those relationships deliver decent work outcomes depends on the policy and regulatory environment in which they operate.

The firm-level survey of 16 licensed solar PV companies found that all respondents employ workers with bachelor's degrees, and twelve (75%) also employ staff with postgraduate education. Six (37.5%) employ vocationally trained workers whose practical skills are essential for installation, electrical systems work, and maintenance. This educational profile diverges from characterisations of solar installation workforces in developing countries as a 'precariat' of precarious, semi-skilled labour (Nizam, Behrani and Rameli, 2025; Stock, 2021). While the firm-level survey confirms the prevalence of precarious contract employment, it diverges on the skills dimension: the workforce is demonstrably better qualified than a low-skilled framing implies. The principal decent work challenge in Ghana's solar sector therefore relates to structural employment conditions rather than to worker capability. Owusu-Agyeman and Aryeh-Adjei (2024) note that Ghana's Technical and Vocational Education and Training (TVET) systems have not been systematically updated to incorporate solar PV competencies, creating a mismatch between formal educational offerings and sector requirements.

A semi-structured interview with the Chief Executive Officer of a leading solar company illustrated the structural dynamics of employment in the sector:

> *'Most of our workers are not retained. They work on a contract basis, simply because contracts are not steady'.*

This account points to the demand side of non-retention. The stop-start nature of project-based solar work leaves firms with neither the commercial need nor the financial capacity to maintain large permanent workforces between contracts. The pattern may, however, also operate on the supply side for some workers. The semi-structured interviews found that more highly skilled workers are better positioned to secure repeat contracts or supervisory roles and that workers who receive firm-sponsored training may subsequently move to better-remunerated or more stable employment opportunities elsewhere (see also Section 3.2). The available evidence does not allow these two dynamics — firm-side release and worker-side mobility — to be disaggregated, but both are consistent with an employment structure in which project cycles, rather than long-term workforce strategies, determine who works, for how long, and under what conditions.

Wages are widely perceived as falling below market benchmarks for comparable technical roles in other sectors. One worker interviewed for this study observed that their salary and working conditions were slightly below market benchmarks compared with workers performing equivalent roles elsewhere, though the supporting evidence does not allow precise identification of the sectors workers were comparing. Plausible points of comparison in Ghana's technical labour market include public-sector engineering roles, which offer greater job security and stronger conditions of service than private-sector equivalents (Baffour and Abbey, 2023), and technical roles in oil and gas or construction, where wages and employment stability tend to be higher (ILO, 2018). The semi-structured interviews with workers revealed that many workers support extended family networks of eight or more dependents on incomes that are neither continuous nor sufficient.

Across the ILO's decent work dimensions, Ghana's solar sector performs poorly. Rights at work, including safe working conditions, fair contracts, and freedom from discrimination, are formally guaranteed by Ghana's labour law but are unevenly enforced, particularly for informal and subcontracted workers. The semi-structured interviews with labour union representatives and workers revealed instances in which Ghanaian solar installation workers were required to supply their own personal protective equipment while expatriate workers on the same sites received employer-provided safety gear. They also reported technical quality concerns, including mounting heavy inverters on structurally inadequate supports, pointing to deficiencies in engineering supervision, professional certification, and quality assurance. These findings align with Baffour and Abbey's (2023) analysis of Ghana's private sector, which shows that private-sector employment is associated with greater insecurity and weaker conditions of service than public-sector employment.

Access to social protection is limited for contract and informal workers, reflecting the broader employment insecurity associated with project-based work in the sector. This may result from employers not enrolling contract workers in formal social protection arrangements or from project-based

mobility disrupting registration continuity. The data gathered for this study did not systematically capture the average duration of solar installation contracts (whether measured in days, weeks, or months) or the minimum contract length required under Ghana's social protection framework to qualify for formal registration. Both gaps are important areas for future empirical work. Quantifying typical contract durations would enable a more accurate assessment of the proportion of solar workers structurally excluded from social protection, and mapping the registration threshold against actual contract patterns would clarify the scale of the protection deficit and the policy changes needed to close it.

Working conditions in the solar sector align with established patterns in Ghana's broader labour market. Gradín and Schotte (2020) documented how routine manual roles in the industrial sector receive lower wages and fewer benefits than non-routine technical or managerial positions. In the solar sector, core permanent staff and contract installation workers face similar disparities. Without structured skills pathways linking installation roles to higher-value technical and supervisory positions, these inequalities are likely to persist and may widen as automation expands across the value chain.

3.2 Trajectories of Work

Global solar PV employment has grown substantially. In 2024, solar PV supported approximately 7.2 million jobs worldwide, making it the largest employer in the renewable energy sector (IRENA and ILO, 2026). China alone accounts for approximately 58% of global solar PV employment (IRENA and ILO, 2026), reflecting its dominance in manufacturing segments such as polysilicon, wafers, cells, and modules. This concentration highlights the transformative employment potential of higher-value production activities, in sharp contrast to Ghana's downstream-only position.

Ghana's national policy frameworks project a markedly different employment trajectory. The NETF projects approximately 1.37 million direct, indirect, and induced jobs in the electricity sector over the transition period, with 52% anticipated in the construction and installation subsectors (Ofori et al., 2025). The National Energy Transition Investment Plan targets 400,000 net new jobs from transition investments, with 80% expected to be directly stimulated by solar PV and electric vehicle charging infrastructure (Ofori et al., 2025). Although these aggregate projections are plausible if deployment targets are met, they do not address the quality of employment that will result. The semi-structured interviews with industry experts and academic researchers conducted for this study highlighted this distinction:

> *'We cannot classify it as decent work, as a lot of them are short-term, mainly on a contract basis. As and when the solar companies have jobs, they come and call you to come as an installer. A lot of them do not have permanent employment'.*

This characterisation reflects a pattern that extends beyond Ghana. Global evidence consistently shows that solar PV employment concentrated in installation and project development is inherently

more project-based and sensitive to demand cycles than employment in manufacturing or long-term operations and maintenance (IRENA and ILO, 2026; Edze, 2025; Strietska-Ilina, O., Hofmann, C., Durán Haro, M., and Jeon, S., 2019). Global research also shows that high aggregate job numbers can coexist with relatively weak employment security in countries where deployment is dominated by small- and medium-scale projects rather than integrated manufacturing ecosystems (IRENA and ILO, 2026; Edze, 2025; Strietska-Ilina et al., 2019). Countries with more developed solar manufacturing industries tend to generate more sustained employment absorption (IRENA and ILO, 2026). This does not mean manufacturing employment is automatically higher quality (as noted in Section 3.1, employment quality depends on the policy and regulatory environment in which it operates), but it does mean manufacturing creates conditions for more continuous employment relationships than project-based installation alone. Ghana's challenge is therefore not unique, but it is acute. The country's confinement to downstream installation activities places it in the segment of the global industry where employment precarity is most structurally entrenched.

The firm-level survey found that fifteen (93.75%) provide training on an *ad hoc* basis, while only seven (43.75%) offer formal, structured training programmes. Although thirteen (81.25%) firms identify workforce training as their primary adaptive strategy, none reported targeted investment in formal reskilling or upskilling. Semi-structured interviews with firm managers revealed that concerns about staff retention after firm-sponsored training are a significant disincentive. Training is typically task-specific and project-oriented rather than structured to develop transferable skills or career progression pathways.

Despite these constraints, targeted interventions can still support a positive trajectory. The firm-level survey found that about half of firms struggle to recruit workers with adequate skills at the junior and operational levels, indicating a mismatch between TVET outputs and sector requirements. Lijfering and van der Veen (2024) document similar gaps in their analysis of TVET greening in Ghana's solar sector, noting that aligning the curriculum with renewable energy activities can improve both the quality and inclusiveness of green employment. Semi-structured interviews with firm managers and industry association representatives also indicated that working alongside international partners with clear employment standards can raise expectations and practices among local subcontractors, suggesting that contractual labour requirements in publicly financed solar projects can drive systemic improvements.

3.3 Decent Work and Localisation

The relationship between decent work and localisation in Ghana's solar PV sector is structural rather than incidental. The project-based employment pattern that characterises the sector is a direct product of Ghana's confinement to downstream deployment activities. Because installation is the primary form of solar work, employment is inherently cyclical and contract-driven, creating a volatile income environment for workers that reinforces rather than alleviates livelihood precarity. A sector that develops manufacturing could generate conditions more conducive to continuous employment relationships, including more persistent demand for workers' time, clearer pathways for skills accumulation, and longer-term operations and maintenance functions that do not terminate with individual project cycles. This is not to suggest that employment in solar manufacturing is automatically more stable or of higher quality, as broader evidence from Ghana's industrial labour

market shows that precarious, informal, and contract-based employment is also prevalent in manufacturing (Baffour and Abbey, 2023; Gradín and Schotte, 2020). Rather, the structural conditions for sustained employment relationships are more present in manufacturing and long-term service activities than in project-bounded installation work, and whether those conditions translate into decent work outcomes depends critically on the policy and regulatory environment in which the sector operates.

Conversely, the decent work deficit itself constrains localisation. Without formal labour standards embedded in sector regulation, firms face little incentive to invest in training, certification, or workforce development. The absence of structured skills pathways means that even the technical competencies being accumulated informally through installation work are not being consolidated into the manufacturing capabilities that localisation requires. The weak institutionalisation of trade union representation further reduces pressure on firms to improve employment conditions or commit to localisation strategies that could create more permanent workforces.

Addressing the decent work deficit and advancing localisation are therefore complementary rather than competing objectives. Given the prevalence of project-based and contract employment, this also requires stronger alignment among renewable energy deployment, labour regulation, and social protection systems, along with improved access to formal protections for workers whose employment remains intermittent. Section 5 examines the key factors and actors that shape both outcomes, including government policy, financial actors, global governance, and firm-level strategies.

4. GENDER

Gender equity is a foundational dimension of a just energy transition. This section examines the gendered dynamics of participation in Ghana's solar PV sector, both in the workplace and in the broader context of social reproduction. It concludes by assessing the relationship between gender equity and localisation. The evidence draws on semi-structured interviews conducted for this study with firm managers, government officials, parliamentary representatives, labour union officials, civil society representatives, and academic researchers, as well as a firm-level survey of 16 licensed solar PV companies and secondary data from the African Development Bank and the Ghana Statistical Service.

4.1 Gender at Work

Women remain significantly underrepresented across Ghana's solar PV sector. The firm-level survey found that fourteen (87.5%) firms report that women make up less than half of their workforce, and one firm employs no women. Only one firm reports a majority-female workforce. According to the African Development Bank's green jobs survey for Ghana, women account for approximately 21% of employment in the energy sector, concentrated predominantly in non-technical, administrative, and clerical roles (African Development Bank, 2022). The same survey indicates that only 14.9% of energy sector firms have female managers, compared with 85.1% with male managers. This disparity reflects both the technical orientation of energy sector work and the structural barriers that limit women's advancement to senior positions in private enterprises.

Within the solar PV value chain, women's participation is primarily concentrated in non-technical commercial functions, including customer relations, sales, administration, and marketing, as well as in clean cooking value chains. Prevailing social norms and the masculine framing of physical fieldwork constrain participation in technically intensive, field-based roles such as panel installation, roof mounting, electrical systems commissioning, and site operations. Nelson and Kuriakose (2021) document a similar pattern across developing countries, where women's participation in renewable energy is concentrated in end-use applications, distribution, and community-facing roles. Semi-structured interviews with civil society representatives, government officials, and industry association representatives conducted for this study confirmed this pattern, with one stakeholder observing:

> *'We've often limited women to clean cooking, as if they are only interested in cooking. But the solar aspect, maybe because we have framed it around climbing and similar tasks, is seen as not fitting women. I think we should open space and allow women to qualify and participate.'*

The firm-level survey found that eight (50%) of the 16 firms surveyed have not considered developing

a gender policy, two (12.5%) have a formal gender policy in place, and four (25%) are currently developing one. This pattern reflects the predominance of small-scale firms in the sector, where formal human resources systems are often absent. However, while small-scale and informal enterprises in Ghana's broader economy tend to hire more women than larger formal firms, this dynamic does not apply in the clean energy sector: Solar PV firms operate within a formally regulated licensing framework that requires technical credentials, access to capital, and regulatory compliance, resources from which women are disproportionately excluded given their concentration in Ghana's informal economy, where approximately 90.9% of employed women work, compared with 81% of men (African Development Bank, 2022). Women's high representation in the informal sector therefore generates no corresponding traction in licensed solar employment. An analysis of Ghana's policy landscape confirms that although major energy policy frameworks increasingly incorporate gender as a cross-cutting consideration, these commitments lack sector-specific and enforceable instruments (Ofori et al., 2025). Gender inclusion in the renewable energy sector is shaped primarily by donor project cycles rather than by institutionalised operational requirements.

The semi-structured interviews with labour union representatives highlighted a critical labour rights dimension of gender equity in the workplace. Ghana's labor law mandates three months of maternity leave, which sets a minimum standard but is inconsistently applied, particularly in the informal and contract-based employment arrangements prevalent in the solar sector. Ensuring enforcement for all workers, not only those on permanent contracts, is a prerequisite for women's sustained participation in the value chain.

Educational access alone has not led to equitable participation in Ghana's solar sector, particularly in technical and field-based roles. Available evidence does not establish gender parity in the technical and vocational pathways that feed into solar PV employment. Instead, the evidence points to structural barriers: Solar firms predominantly recruit through male-dominated professional networks; field-based work is often framed as masculine; and training programmes have not consistently created explicit pathways for women's participation. Addressing these structural barriers through network diversification, targeted recruitment, and inclusive training design is as important as expanding educational access. Characterisation of this exclusion as occupational segregation, rather than simply a skills gap, better reflects the structural and normative dimensions of the problem.

4.2 Gender and Societal Expectations

Beyond formal employment structures, gendered household dynamics and social norms fundamentally shape who can participate in Ghana's solar sector, on what terms, and with what outcomes. Women perform approximately 3.4 times more unpaid care and domestic work than men, averaging 15.5 hours per week compared with 4.6 hours for men (African Development Bank, 2022). This unequal distribution directly constrains women's availability for technically demanding, time-intensive, and field-based work, limiting their ability to participate in roles that require extended hours, travel, or physical presence at remote installation sites.

Household economic structures create additional pressures. Ghana's Living Standards Survey 7 (GLSS 7) shows that households allocate about 45.4% of income to food, and housing, education,

transportation, and clothing account for an additional 43.3% of expenditure (Ghana Statistical Service, 2019). For solar sector workers earning modest, intermittent wages, these obligations significantly intensify livelihood pressures.

The predominance of women in informal economic activity limits their access to formally regulated, technically licensed segments of the solar PV sector. Women own approximately 37.9% of Ghanaian businesses, reflecting a significant entrepreneurial presence, yet most operate informally and lack access to formal finance, professional networks, regulatory support, and institutional resources (African Development Bank, 2022). Entering a formally licensed sector such as solar PV requires overcoming both practical barriers, including access to capital, credentials, and professional connections, and cultural barriers rooted in gendered expectations about appropriate work and occupational spaces.

The energy system itself reflects and reinforces gendered household divisions. Despite improvements in national electricity access, cooking and other traditionally feminised domestic tasks still rely on conventional fuels, including charcoal, firewood, and liquefied petroleum gas, even in households connected to the electricity grid (Ali, Yaotse, Obeng, Gyamfi, Osman, Adoko and Narra, 2024).

4.3 Gender and Localisation

The relationship between gender equity and localisation is direct and structural. Ghana's confinement to downstream deployment activities reinforces gender-based occupational segregation. The dominant employment forms in installation and services are project-based, physically demanding in the field, and informally recruited through male-dominated professional networks, systematically excluding women. A sector that successfully localised into manufacturing and BOS production could potentially generate a wider range of occupational roles, including quality assurance, production management, technical training, and research and development, that are more accessible to women.

The reverse relationship also holds: advancing gender equity would support localisation outcomes. Women's inclusion in technical solar roles and in entrepreneurship within the sector would expand the pool of workers and business leaders capable of driving capability upgrading. An additional dimension of this relationship deserves attention: localisation itself, through the creation of geographically proximate employment opportunities, can improve women's labour market participation, given that women's disproportionate responsibility for childcare and household maintenance constrains their ability to take up mobile, field-based, or time-intensive roles (African Development Bank, 2022; Alam, Kurshitashvili, Dominguez Gonzalez, Gonzalez Carvajal and Baruah, 2022). Creating locally situated work opportunities within Ghana's solar sector could therefore give women a relative advantage in accessing employment that would otherwise be structurally out of reach. It should be acknowledged, however, that this dynamic risks reinforcing rather than transforming the gendered division of domestic labour on which it depends: Policies designed to support women's participation through localised employment should therefore be complemented by measures that address unpaid care burdens more directly, rather than treating women's proximity to home as a fixed condition to be accommodated.

International evidence consistently identifies enabling factors to increase women's participation in technical renewable energy roles: visible female role models in engineering and technical leadership;

structured pathways from education to employment that connect women to industry before occupational norms harden; explicit gender targets in publicly financed project training and recruitment; and, critically, retention and advancement mechanisms, including enforceable maternity protections, transparent promotion pathways, and structured leadership development, that ensure women who enter the sector are supported in remaining and progressing within it (Nelson and Kuriakose, 2021; Ofori et al., 2025). Each of these is actionable within Ghana's existing policy framework.

The firm-level survey found that eight (50%) firms have no gender policy and have not considered developing one. Semi-structured interviews with parliamentary representatives highlighted a practical mechanism for change:

> *'If government wants to procure any of these SMMEs to install, then that SMME should have a gender policy, not only in administration, but also including women engineers and technicians'.*

Linking procurement eligibility to measurable gender-inclusion commitments would create a market-based mechanism that complements regulatory requirements and voluntary firm-level action. Government-financed solar projects could require contractors to demonstrate gender policies and measurable efforts to recruit, retain, and advance women in technical and decision-making roles, with gender-disaggregated monitoring and accountability. This would move beyond general nondiscrimination commitments toward targeted measures that address persistent structural underrepresentation, consistent with the broader affirmative-action orientation of Ghana's gender policy framework. Section 5 examines the key factors and actors that shape gender equity outcomes in the sector and their relationship to localisation and decent work.

5. KEY FACTORS AND ACTORS SUPPORTING OR PREVENTING LOCALISATION, DECENT WORK, AND GENDER EQUITY

This section examines the structural factors and actors that together explain the outcomes presented so far in Sections 2, 3, and 4. Drawing on the framework of actors and dynamics presented in Table 2, this section analyses how each shapes outcomes across the three core objectives of localisation, decent work, and gender equity. The evidence integrates findings from the semi-structured interviews with government officials, regulatory authorities, industry association representatives, renewable energy entrepreneurs, financial institution representatives, labour union officials, civil society representatives, and academic researchers, along with a firm-level survey of 16 licensed solar PV companies, secondary literature, and the Ghana Renewable Energy Policy Scan (Ofori et al., 2025).

Table 2: Actors and Dynamics that Facilitate or Impede Localisation, Decent Work, and Gender Equity in Ghana's Solar PV Sector

Actor/ Dynamic	Support for Localisation, Decent Work, and Gender Equity	Impediments to Localisation, Decent Work, and Gender Equity
Local Context	• Natural resource endowments (bauxite, aluminium, silicon, and copper) • Existing domestic industrial base • Aluminium smelter at Tema Heavy Indutrial Zone, Greater Accra Region • Large and growing solar market	• High financing costs • Unreliable energy supply • Spatial concentration of firms in the Greater Accra Region • Limited industrial cluster development • Manufacturing sector's historically slower average growth rate of 3.7% from 2014 to 2025 (World Bank, 2025)

Actor/ Dynamic	Support for Localisation, Decent Work, and Gender Equity	Impediments to Localisation, Decent Work, and Gender Equity
Network Context	• African Continental Free Trade Area (AfCFTA) creating potential for regional market access and export of assembled components	• Chinese and Indian industrial policy and economies of scale • Patent concentration in China (about 34% of global solar PV patent filings between 2016 and 2025) limiting technological autonomy (WIPO, 2025) • Technology transfer is largely unidirectional, flowing from global lead firms to Ghanaian distributors and other local firms
Firms	• Partnerships with foreign firms providing market access and some learning • Horizontal firm collaboration on project delivery • AGSI and AGI-ESC providing training, market intelligence, and advocacy	• Power asymmetries with global lead firms • Relationships project-based and informal • six (37.5%) of the surveyed firms report foreign partners uninterested in technology transfer • Limited resources of industry associations relative to scale of challenge
Government	• Formally ambitious policy commitments to local content • Progressive regulatory standards framework • State enterprise platforms (BPA, VRA) for public solar investment	• Implementation gap: eleven (68.75%) of firms surveyed for this study report policies exist but are not effectively implemented • No unified industrial policy • Fiscal incentives favour imports • Procurement design excludes local firms
Global Governance Actors	• EU CBAM creating incentives for lower-carbon production • IEC and International Organization for Standardization standards creating quality benchmarks	• Chinese and Indian industrial policy and economies of scale • Patent concentration limiting technological autonomy • No formal bilateral technology transfer obligation in Ghana-China bilateral solar arrangements

Actor/ Dynamic	Support for Localisation, Decent Work, and Gender Equity	Impediments to Localisation, Decent Work, and Gender Equity
Financial Actors	• African Development Bank and IFC expanding energy access • SUNREF concessional credit programme channelled through CalBank	• Development finance oriented toward deployment, not manufacturing • Domestic credit market short-tenor and expensive • Manufacturing payback periods misaligned with standard lending terms
Trade Unions and Workers	• Potential for labour organisations to shape employment conditions and embed just transition objectives • ILO decent work framework provides normative anchors	• No sector-specific union • Limited collective bargaining • Project-based employment structure makes organising difficult • Link between precarious employment and weak localisation incentives
Communities	• Community-based organisations (CBOs) with demonstrated capacity for advocacy in other sectors • Civil society engagement in clean energy governance	• Limited direct engagement with solar sector to date • CSR contributions remain modest • No formal community benefit agreements • Engagement largely tokenistic

5.1 Local Context

Ghana's industrial base includes several resource endowments directly relevant to solar PV manufacturing. The country has substantial bauxite reserves and an operational aluminum smelter in Tema High Industrial Zone in the Greater Accra Region. Aluminium is a critical input in solar PV systems: approximately 21 tons of aluminum are required per megawatt of installed capacity (European Aluminium, 2022). Scaling solar deployment to meet national targets could therefore generate domestic demand for aluminium fabrication, provided structural constraints on the smelter's output, notably the absence of a domestic alumina refinery, are addressed. Silicon deposits, copper for electrical wiring, and an established cable manufacturing industry further strengthen the case for local BOS production. Semi-structured interviews with industry association representatives and renewable energy entrepreneurs highlighted these interconnections:

'When it comes to solar, we have the smelter here for aluminium trusses. We have cement for concrete. We have silicon here. Our cable manufacturing companies are already locally present; those are areas where we already have capability that can support the renewable energy sector'.

Despite these endowments, the broader industrial context poses significant constraints on localisation, decent work, and gender equity. Ghana's manufacturing sector grew at an average annual rate of 3.7% between 2014 and 2025, compared with 5.1% for services and 4.7% for agriculture (World Bank, 2025). This structural underdevelopment of manufacturing has several direct implications: the sector lacks specialised solar PV manufacturing parks, silicon processing facilities, and the necessary electronics manufacturing infrastructure needed to move into higher-value production segments. The spatial concentration of 90% of licensed solar PV firms in the Greater Accra Region (Energy Commission of Ghana, n.d.) further limits the geographic spread of sector benefits and reinforces inequalities between urban and rural employment. These contextual constraints affect all three objectives of the Just Energy Transition. First, they impede localisation by limiting the industrial cluster development needed to deepen supply chains. Second, they constrain decent work by concentrating employment geographically, and, finally, they affect gender equity by concentrating economic opportunities in an urban environment where formal labour markets are more accessible to men than to women.

5.2 Network Context

Ghana's position within the global solar PV production network is structurally subordinate. As a buyer and installer of manufactured components, Ghana engages in the network's lowest-margin activities, while global lead firms in China, Germany, Japan, South Korea, and the United States,control the highest-value manufacturing and technology segments (WIPO, 2025; WoodMac, 2025). This network position shapes all three core outcomes. For localisation, this means that upgrading into manufacturing requires overcoming entrenched competitive advantages held by leading firms with substantial scale, intellectual property, and state support. Research on global value chains confirms that the trajectory from downstream services into manufacturing in the energy sector is not automatic and requires deliberate institutional support, capability development, and market positioning (De Marchi, Giuliani, and Rabellotti, 2018).

The AfCFTA could significantly improve Ghana's position in the network. Solar PV components generally meet AfCFTA rules of origin, which determine whether goods qualify as originating within an AfCFTA State Party. Goods may qualify by being wholly obtained there or by undergoing sufficient transformation through criteria such as value addition, changes in tariff classification, or specified processing. Meeting these requirements can enable qualifying products to benefit from preferential intra-African trade, creating export opportunities for assembled BOS components and locally

produced materials (Boakye and Ofori, 2022). However, realising this regional opportunity requires first developing domestic manufacturing capability, which most Ghanaian firms have not yet achieved.

5.3 Firms

For this analysis, firm-level dynamics were examined across three dimensions that jointly affect localisation, decent work, and gender equity: buyer-seller relationships with global lead firms, individual firm investment and adaptive strategies, and the collective role of industry associations.

In their buyer-seller relationships with global lead firms, Ghanaian solar companies occupy structurally subordinate positions. The firm-level survey found that six (37.5%) firms maintain informal supply arrangements, three (18.75%) have formal long-term supplier relationships, and three (18.75%) participate in joint ventures. These relationships provide access to technology, trade credit, and occasional training but position local firms as buyers and distributors rather than producers. Technology transfer within these partnerships is largely unidirectional, flowing from global lead firms to Ghanaian distributors without reciprocal knowledge exchange that would support domestic capability development. The dominance of informal, socially mediated inter-firm relationships, maintained through professional networks and personal trust rather than formal institutional mechanisms, reflect adaptive strategies in an uncertain market but limits scalability (Kuada and Mensah, 2020).

The firm-level survey found that eight (50%) of firms view foreign partners as supportive of technology transfer, while about six (37.5%) regard them (foreign partner firms) as uninterested in substantive capability development. This finding contrasts with classical global value chain frameworks which note how leading firms closely guard proprietary manufacturing knowledge (Gereffi, Humphrey, and Sturgeon, 2005; Henderson et al., 2002). The likely explanation is that systems integration-level knowledge, such as installation methods, product configuration, and technical troubleshooting, poses less proprietary risk than core manufacturing intellectual property. Research on technology transfer in global value chains confirms that knowledge sharing is more likely in the service and assembly segments of production networks than in core manufacturing (De Marchi, Giuliani, and Rabellotti, 2018). Edze (2025) further argues that effective local content frameworks must pair formal participation targets with enforcement mechanisms and structured training linkages to convert partnerships into capability development.

A gap in Ghana's network of bilateral economic relationships concerns technology transfer obligations for solar-specific technology with China. The two Chinese firms with PPAs, BXC Solar and Meinergy Technology Limited, operate as vertically integrated entities and have no documented obligations to transfer technology or develop local supply chains. The semi-structured interviews with government officials and industry association representatives found no formal bilateral agreements between Ghana and China that require technology transfer as a condition for solar market access or state-backed project financing. This represents a missed negotiating opportunity. Ghana could leverage its status as a growing solar market to establish a formal quid pro quo with foreign firms: in exchange for PPA awards, favourable procurement positioning, and/or access to concessional state financing, foreign firms could be required to demonstrate measurable contributions to domestic capability development through joint ventures, skills programmes, and supplier development initiatives.

Individual firm adaptive strategies show emerging but fragile capability building. The firm-level survey found that ten (62.5%) firms pursue foreign partnerships or joint ventures, eight (50%) collaborate with other local firms, and thirteen (81.25%) invest in workforce training. However, none reported targeted investment in formal reskilling or upskilling, and the survey findings confirmed the tension between training aspirations and the retention disincentive noted in the stakeholder interviews. Regarding gender equity, the survey found that eight (50%) the firms have no gender equity policy and have not considered developing one, while two (12.5%) have a formal gender policy in place. Gender inclusion at the firm level is currently driven largely by donor project requirements rather than operational strategy.

Industry associations play an increasingly structured yet limited role in Ghana's emerging solar industry. For example, AGSI provides training, certification support, and market advocacy. The AGI Energy Service Centre organised the 2025 Renewable Energy and Efficiency Business-to-business Expo to facilitate commercial linkages (AGI ESC, 2025). These initiatives are important foundations but remain constrained in their ability to influence procurement regulations, enforce standards, or advocate effectively for the industrial financing mechanisms the sector requires. Regarding firms' corporate social responsibility in host communities, CSR contributions remain predominantly philanthropic rather than structured through community benefit agreements or formal investment commitments. The absence of formal community benefit arrangements also limits the potential for CSR to contribute systematically to gender-equity objectives. A more structured approach could link community engagement to participatory benefit mechanisms and explicit support for women's economic participation and entrepreneurship in host communities. However, the appropriate financing mechanism and the level of any mandatory corporate contribution would require separate legal, fiscal, and empirical assessment.

5.4 Governments

Ghana's policy framework formally commits to localisation, decent work, and gender equity in the solar PV sector, yet a persistent gap remains between policy design and implementation. Six key policy instruments shape this environment: the National Energy Policy, the Renewable Energy Master Plan, the National Energy Transition Framework, the National Energy Transition Investment Plan, the National Gender Policy, and the National Green Jobs Strategy (Ofori et al., 2025). Collectively, these instruments address local content and manufacturing participation, gender mainstreaming, skills development, and employment generation.

In the firm-level survey, 11 of the 16 surveyed firms reported that while policies supporting local manufacturers exist, they are either not implemented effectively or do not provide meaningful support. A semi-structured interview with an industry veteran with two decades of experience in the sector highlighted the implementation gap:

> *'A lot of these policies that you mentioned, this is the first time I am hearing of them. I have been in the solar industry for about 20 years now, and I've never even heard of them'.*

Furthermore, semi-structured interviews with government officials and industry association representatives revealed the structural causes of this gap that extend beyond administrative shortcomings. Ghana lacks a unified industrial policy that integrates localisation, SMME development, and gender inclusion within a coherent, cross-sectoral framework. The National Development Planning Commission, which could provide long-term continuity, serves only an advisory function and lacks binding authority. Frequent institutional restructuring following electoral transitions disrupts continuity and undermines investor confidence. Fiscal incentives currently favour finished solar product imports over domestically assembled alternatives, a structural contradiction that undermines the localisation objectives stated in policy frameworks. Procurement processes for government-supported solar projects are not systematically used to require firms to demonstrate gender equity practices or compliance with labour standards.

The state's capacity to influence firms toward localisation is strong in regulatory design but structurally constrained in implementation. Public procurement for solar deployment, including public facility electrification and rural access programmes, remains an underutilised industrial policy instrument. If procurement conditions are redesigned to prioritise local participation, the state could use public demand to provide the market certainty needed to support domestic manufacturing investment.

5.5 Global Governance Actors

Global governance actors influence Ghana's solar PV sector through technical standards, trade rules, and the industrial policies of major manufacturing economies. Their effects are not uniformly restrictive. International standards such as those developed by the IEC and ISO can raise entry costs for emerging Ghanaian manufacturers because compliance requires testing, certification, and technical capacity. At the same time, meeting these standards can strengthen product credibility and facilitate access to regional and international markets. Similarly, evolving trade measures such as the EU's CBAM may create additional compliance requirements, but could also create opportunities for lower-carbon production if Ghana develops manufacturing capacity that meets the necessary standards.

The policies of major manufacturing economies actively shape the competitive environment. China's subsidised energy, concessional state-backed financing, and vertically integrated supply chains have enabled its firms to dominate global module production at prices that Ghanaian manufacturers cannot match in the near term (IEA, 2022). India's Production-Linked Incentive scheme ties government subsidies directly to domestic production, rapidly scaling India's manufacturing capacity. The United States' moves towards protectionism is driving significant investment in American solar manufacturing. These policies shape price signals, competitive pressures, and investment flows within which Ghana's localisation strategy must operate.

Global governance frameworks provide normative anchors for decent work and gender equity but offer limited enforcement mechanisms. The ILO's decent work agenda and global renewable energy employment standards set benchmarks, but translating them into enforceable labour conditions in Ghana's solar sector depends on domestic implementation capacity, which is currently insufficient (ILO, 2018; IRENA and ILO, 2026).

5.6 Financial Actors

Access to finance is the most consistently cited structural barrier to industrial upgrading in Ghana's solar PV sector (Sackey et al., 2020), a finding confirmed by both the firm-level survey and semi-structured interviews. The firm-level survey found that ten (62.5%) firms identified limited access to finance as a major structural constraint to manufacturing participation, while twelve (75%) reported financing difficulties as a significant operational challenge. This structural issue extends beyond access to funds. The business models of solar energy firms, characterised by long payback periods, project-based revenue streams, and capital requirements that rise substantially when moving from distribution to assembly or manufacturing, are fundamentally misaligned with standard domestic bank lending terms. A firm representative interviewed for this study articulated this structural problem as follows:

> *'It has not only been with availability of funds, but it's also the tenure...the payback period for renewables is not akin to the typical funding needs that we currently have'.*

International development finance focuses on large-scale asset deployment rather than manufacturing investment, reflecting a global pattern among development finance institutions that prioritises revenue generation assets over higher-risk industrial investments (IFC, 2021). Except for the SUNREF programme, channeled through CalBank, a national Ghanaian bank, to provide concessional credit lines for small and medium enterprises, international finance vehicles in Ghana have not been structured to support manufacturing or assembly. This gap in domestic industrial financing instruments limits how much international capital can be leveraged for manufacturing investment. Targeted blended finance facilities could address this gap.

The implications for decent work and gender equity are direct. The lack of manufacturing finance reinforces the sector's reliance on downstream deployment activities, which generate precarious, project-based employment. For women, who already face barriers to formal finance due to gender-discriminatory lending practices and collateral requirements, the financing gap compounds their exclusion from ownership and entrepreneurship in the sector's higher-value activities.

5.7 Trade Unions and Workers

Labour representation within Ghana's solar PV sector remains underdeveloped. Evidence from this study found no union dedicated specifically to solar workers, while stakeholder engagements and the firm-level survey indicate relatively limited unionisation within Ghana's renewable energy sector. This pattern is consistent with broader energy-transition literature documenting comparatively weaker union representation and collective-bargaining protections in many segments of the renewable energy economy (Newell and Mulvaney, 2013; ILO, 2018; Pollin, 2015). Semi-structured interviews with labour union representatives confirmed that labour organisations are often poorly integrated into discussions of Ghana's renewable energy transition. Although workers can theoretically access broader union structures, actual union coverage among solar installation workers remains limited. The firm-level

survey of 16 licensed solar PV companies found that eight (50%) consider union representation important, while six (37.5%) believe companies can operate effectively without it.

The sector's project-based employment structure makes organising inherently difficult. Workers are employed for the duration of individual contracts and released upon completion, severing the ongoing employment relationship that typically enables collective bargaining. In solar sectors dominated by installation rather than integrated manufacturing ecosystems, employment tends to be project-based and cyclical, limiting the sector's capacity to absorb trained workers sustainably (Edze, 2025; Strietska-Ilina et al., 2019). This structural feature means the absence of union coverage is not simply a reflection of worker preference but a consequence of the market dynamics driving project-based contracting. The semi-structured interviews with labour union representatives and workers confirmed this. The International Trade Union Congress representative observed that

> *'Trade unions are really essential to the whole discussions. But then oftentimes they are not really at the table in these discussions'.*

The role of worker representation should not be understood solely as expanding conventional union coverage. Evidence from this study shows that labour representation can bring gender-specific workplace concerns into just-transition debates. For example, in an interview, a labour union representative emphasised maternity protection and the conditions needed for women's retention and dignity at work. At the same time, labour representation within Ghana's renewable-energy sector remains relatively limited, yet appears to be evolving. The data therefore does not establish whether worker voice in the solar sector will develop primarily through stronger trade-union coverage, professional associations, or other forms of representation.

When workers do not enjoy collective bargaining power and formal employment protections, households must absorb the risks of insecure employment and modest wages, redistributing the social costs of the energy transition across families and communities rather than sharing them through institutional labour protections (ILO, 2018). The implications for localisation are that the project-based nature of solar employment gives workers limited incentive to invest in sector-specific skills that may not be used continuously, reinforcing the skills accumulation deficit that constrains localisation. In this way, the failure to localise is itself a barrier to decent work and worker voice.

5.8 Communities

Community actors have demonstrated the capacity to shape resource governance and accountability in Ghana's extractive and agricultural sectors. CBOs in the Ashanti Region facilitate access to information, education, training, and resource mobilisation to support agricultural livelihoods (Asenso, 2020). CBOs have also mobilised communities around natural resource governance more broadly. In the Upper West Region, for example, organised community structures have protected the livelihoods of forest-dependent communities (Baddianaah and Baaweh, 2021). At the national level, well-organised civil society coalitions have shaped energy governance through advocacy, research,

and direct dialogue with government. The Ghana Anti-Corruption Coalition has mobilised citizens around natural resource management issues, including raising awareness of inefficiencies in oil revenue allocation and advocating for reforms in resource management (Ghana News Agency, 2023). In addition, the Alliance of Civil Society Organisations for Clean Energy Access coordinates its members toward clean energy objectives in Ghana and across Africa (Energypedia, 2025).

Despite this demonstrated capacity, direct community engagement with Ghana's solar PV production network remains limited. The literature reviewed for this study gives limited attention to direct community–civil society engagement in Ghana's solar PV sector. Prominent Ghana-focused studies instead examine knowledge transfer, local content and skills development, and workforce preparation (Kuada and Mensah, 2020; Edze, 2025; Lijfering and van der Veen, 2024). Evidence from this study indicates that community–firm interactions are largely mediated through philanthropic CSR rather than formal community benefit agreements or participatory mechanisms. Broader Ghanaian energy-sector research similarly examines CSR as an important dimension of firm–community relations (Jnr, Kukah and Akotia, 2021). When CSR interventions are perceived as tokenistic or externally imposed, they can generate mistrust, although the evidence cited here comes from Ghana's oil and gas sector (Mohammed et al., 2022). The social legitimacy of solar firms may therefore depend on responsiveness to local expectations and meaningful participatory practices. From a gender-equity perspective, the available evidence does not establish systematic mechanisms for women's participation in community-level solar deployment decisions.

6. CONCLUSION

Three overarching trends emerge from the analysis. First, Ghana's solar PV sector is structurally locked into the lowest-margin activities of the GPN. Domestic firms are concentrated in installation, distribution, and systems integration, while foreign firms dominate manufacturing and higher-value production. Chinese companies, in particular, benefit from Chinese government financing, vertical integration, and economies of scale that create competitive advantages Ghanaian firms cannot currently match. This structural position is reflected in imports recorded under HS Code 854140, which nearly doubled from about US$7.8 million in 2018 to US$15.9 million in 2023 (UNSD, n.d.), directing value outward rather than building domestic industrial capability.

Second, the employment this downstream position generates is predominantly project-based, contract-driven, and poorly protected. This creates income volatility that workers and their households absorb informally in the absence of adequate social protection. The decent work deficit is not incidental to Ghana's industrial position; rather, it is a direct structural consequence of that position.
Third, gender exclusion is embedded in the sector's recruitment practices, occupational norms, and policy frameworks, and deployment growth alone will not correct it. Women's underrepresentation in technical and managerial roles, disproportionate unpaid care burdens, and the absence of enforceable gender equity instruments in sector regulation mean that the energy transition, as currently structured, risks reinforcing rather than transforming existing inequalities. Future research should therefore examine how continued solar PV deployment affects women's recruitment, occupational roles, retention, advancement, and unpaid care constraints, using sector-specific, gender-disaggregated data (Ofori et al., 2025).

Taken together, these three trends point to a single conclusion: Ghana's renewable energy transition will not automatically lead to inclusive industrial development. The structured challenges, opportunities, and recommendations that follow are intended to address this gap.

6.1 Key Challenges

The following challenges are the principal constraints on Ghana's ability to achieve localisation, decent work, and gender equity through the solar PV sector:

01 **Cost competitiveness:** Chinese solar modules, produced at scale with state-backed financing and vertically integrated supply chains, are priced below what locally assembled alternatives can match. This is a not a temporary market condition, rather a structural competitive advantage that is reinforced by deliberate industrial policy (IEA, 2022).

02 **Policy implementation gap:** Ghana's policy framework sets formally ambitious local content targets, yet thirteen (81.25%) surveyed firms report policy as ineffective or unknown. Local content targets for 2025 have not been tracked, communicated, or enforced (Ofori et al., 2025).

03 **Financing misalignment:** The payback periods for manufacturing investment are incompatible with the short-tenor, high-cost domestic credit market. Development finance has been directed toward deployment assets rather than manufacturing (Sackey et al., 2020).

04 **Skills and workforce development deficit:** TVET systems have not been updated to reflect the requirements of the solar sector. No surveyed firm reported targeted investment in formal workforce reskilling. The training disincentive stemming from staff retention concerns remains unaddressed.
Absence of technology transfer obligations: No formal bilateral mechanism requires foreign firms operating in Ghana's solar market to transfer technology, develop local supply chains, or contribute to skills development. The two Chinese firms with PPAs operate without such obligations.

05 **Decent work deficit:** Employment in the solar energy sector is predominantly project-based and contract-driven, leaving workers without formal social protection. Labour standards are unevenly enforced, particularly for subcontracted and informal workers.

06 **Gender exclusion:** Women make up only 21% of energy sector employment (African Development Bank, 2022), are largely absent from technical and managerial roles, face structural barriers stemming from informal and gendered recruitment practices, and are disproportionately burdened by unpaid care work that limits their capacity to participate in field-based or technically demanding roles.

6.2 Key Opportunities

The following opportunities provide realistic, high-impact pathways for Ghana to advance localisation, decent work, and gender equity in its emerging solar PV industry:

01 **Local module assembly and BOS component manufacturing:** Ghana's industrial base, including an aluminum smelter in Tema, cable manufacturers, and silicon deposits, already provides inputs directly relevant to solar PV manufacturing. Existing assembly initiatives demonstrate technical feasibility. The commercial and industrial solar market's projected 39.24% annual growth rate through 2031 (Mordor Intelligence, 2026) creates a growing demand base that structured local content requirements could direct toward domestic suppliers.

02 **Public procurement as an industrial policy instrument:** Public procurement for solar deployment, including public facility electrification and rural access programmes, can be used strategically to advance localisation. Procurement conditions requiring local participation and linking eligibility to labour standards and gender equity could direct public demand towards domestic suppliers, improve demand predictability, and strengthen the conditions for manufacturing investment.

03 **Long-term operations and maintenance services:** Ghanaian firms have developed genuine competencies in system design, technical problem-solving, and project delivery. Structured training investments that extend beyond installation to include quality assurance, production processes and standards compliance could help bridge current downstream capabilities and future participation in manufacturing (IRENA, 2017). Long-term operations and maintenance activities could also support more stable and sustained employment than reliance on project-based installation alone (IRENA and ILO, 2022); Strietska-Ilina *et al.*, 2019).

04 **Solar PV recycling and AfCFTA regional market access:** As Ghana's installed capacity grows, decommissioning, recycling, and material recovery could become an additional source of local economic activity and skilled technical employment. End-of-life solar panels contain recoverable materials, including silver, copper, aluminium, and silicon, and formal recycling infrastructure could reduce environmental hazards while supporting circular-economy activity. This opportunity requires early institutional attention, because delayed development of formal recycling infrastructure could shift solar PV waste into informal waste streams where handling may fall outside regulated safety, environmental, and labour standards. Recycling and material-recovery systems should therefore be formal, regulated, and subject to appropriate safety and labour standards so that emerging employment contributes to decent work and local value creation. AfCFTA rules of origin create additional export potential for assembled BOS components in regional markets (IEA-PVPS, 2024; Ndzibah, Pinilla-De La Cruz and Shamsuzzoha., 2022; Boakye and Ofori, 2022).

05 **Technology transfer as a condition of market access:** Ghana can leverage its growing solar market to establish formal quid pro quo arrangements with major foreign manufacturers, requiring measurable technology transfer, joint ventures, and supplier development as conditions for PPA awards, procurement positioning, or access to concessional, state-backed financing.

06 **Gender-targeted procurement and training:** Linking procurement eligibility to gender policy requirements and developing TVET pathways that actively recruit women into technical solar careers are practical, immediately actionable interventions that could significantly expand women's participation in the sector's higher-value activities.

6.3 Recommendations

The recommendations below are organised around five strategic objectives, and each recommendation identifies the challenges (from Section 6.1) it addresses and the opportunities (from Section 6.2) it helps unlock.

Table 3: Recommendations, Challenges, and Opportunities unlocked.

Objective	Recommendation	Challenge Addressed	Opportunity Unlocked
A. Shaping Demand	A1. Require local content across all government-financed solar projects, specifying minimum local sourcing thresholds and linking procurement eligibility to labour standards and gender equity practices	Policy implementation gap, decent work deficit, and gender exclusion	Government procurement as an anchor market
	A2. Redesign import duty structures to favour component imports used in domestic assembly while removing exemptions for finished solar products where local assembly alternatives exist	Cost competitiveness	Local module assembly and BOS component manufacturing
B. Trade, Investment, and Regional Market Development	B1. Leverage AfCFTA rules of origin to develop an export strategy for assembled BOS components and locally produced materials for West African markets	Cost competitiveness	Solar PV recycling and AfCFTA regional market access
	B2. Negotiate explicit technology transfer terms in all future PPAs and large-scale solar contracts, establishing a formal *quid pro quo* for market access	Absence of technology transfer obligations	Technology transfer as a condition of market access

Objective	Recommendation	Challenge Addressed	Opportunity Unlocked
C. Supporting Business Upgrading	C1. Develop government-backed credit guarantees, blended finance facilities, and working capital instruments calibrated to manufacturing investment cycles, building on and expanding the SUNREF programme	Financing misalignment	• Local module assembly and BOS component manufacturing • Solar PV recycling and AfCFTA regional market access
	C2. Revise TVET curricula to incorporate manufacturing competencies including quality assurance, production management, and recycling technology; develop structured industry-education partnerships with gender-targeted pathways	• Skills and workforce development deficit • Gender exclusion	• Long-term operations and maintenance services • Solar PV recycling and AfCFTA regional market access • Gender-targeted procurement and training
D. Driving Decent Work and Inclusivity	D1. Embed measurable gender equity targets in licensing conditions, procurement eligibility, and financing requirements, and implement systematic gender-disaggregated data collection to ensure accountability	Gender exclusion	Gender-targeted procurement and training
	B2. Negotiate explicit technology transfer terms in all future PPAs and large-scale solar contracts, establishing a formal *quid pro quo* for market access	Decent work deficit	• Government procurement as an anchor market • Long-term operations and maintenance services

Objective	Recommendation	Challenge Addressed	Opportunity Unlocked
E. Government Effectiveness	E1. Establish a cross-ministerial coordination mechanism with binding authority to integrate objectives for localisation, SMME development, and gender inclusion within a single industrial policy framework	Policy implementation gap	• Local module assembly and BOS component manufacturing • Government procurement as an anchor market
	E2. Set time-bound, measurable, and publicly tracked local content targets, replacing aspirational statements with enforceable obligations communicated directly to all licensed sector firms	• Policy implementation gap • Absence of technology transfer obligations	• Local module assembly and BOS component manufacturing • Technology transfer as a condition of market access

Ghana's solar transition is not only a question of how much capacity is installed, but also of who creates, captures, and benefits from the value it generates. The analysis identifies concrete levers across procurement, finance, skills development, technology transfer, labour protection, and gender inclusion. The priority now is to translate these recommendations into coordinated, measurable, and enforceable action so that solar expansion strengthens domestic capabilities, decent work, and more equitable participation.

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APPENDICES

Appendix A: Methodology

This study employed a mixed-methods design that integrated quantitative survey data, qualitative stakeholder interviews, and comprehensive desk research. The solar PV sub-sector was chosen as the primary analytical focus because of its growing importance in Ghana's national deployment plans, its higher labour intensity relative to other renewable technologies (SolarPower Europe, 2023), and its strategic potential for industrial upgrading and localisation. Solar PV panel production is estimated to require approximately 1,970 full-time equivalent jobs per gigawatt of production capacity, compared with 360 FTE jobs per gigawatt for inverter production (SolarPower Europe, 2023). Battery production is reported separately at approximately 100 FTE jobs per gigawatt-hour of production capacity (Aslesen, Vennerød and Erraia, 2022). These employment intensities reinforce the relevance of solar PV manufacturing for an analysis focused on employment creation and localisation. This characteristic makes the sub-sector particularly relevant for analyses focused on employment and localisation.

The firm-level survey focused on companies operating under two of the Energy Commission's licencing categories: importation and installation and maintenance licences. These categories constitute the dominant segments of Ghana's solar PV market. The Energy Commission's directory, which lists approximately 54 licensed firms in these categories, served as the sampling frame. Structured survey were administered to collect data on firm characteristics, operational activities, investment behaviour, supply chain linkages, technology partnerships, workforce development, policy awareness, and gender inclusion practices. 16 firms submitted complete responses. Although this response rate limits the statistical generalisability of the findings, qualitative follow-up engagements with participating firms provided substantive contextual depth that complements the observed quantitative patterns. A summary of the survey results is provided in Appendix B.

The qualitative interview component comprised in-depth, semi-structured interviews with a purposively selected group of stakeholders representing a range of institutional roles and perspectives. Participants included government ministries and regulatory agencies responsible for energy, industry, and gender; parliamentary oversight bodies such as the parliamentary energy committee; industry associations for solar firms and the broader manufacturing sector; renewable energy entrepreneurs and technical experts; labour union representatives; civil society organisations involved in clean energy advocacy and community development; and academic experts in energy, industrial development, and gender studies. Interviews followed a common thematic guide covering Ghana's participation in solar PV value chains, barriers to localisation and technology transfer, employment conditions and skills development, gender dynamics, household-level impacts, and the influence of policy instruments. Data analysis used iterative thematic coding, focusing on both convergent patterns and divergent perspectives across stakeholder groups. An overview of the coding scheme is provided in Appendix C.

Desk research supplemented the primary data and included Ghana's published renewable energy and industrial policy documents; reports from international organisations, including IRENA, IEA, ILO,

the African Development Bank, and IFC; peer-reviewed academic literature on renewable energy value chains, GPN theory, decent work, and gender in the energy transition; and statistical sources such as UN Comtrade trade data, Ghana Statistical Service, and sector-specific market assessments. Several limitations are acknowledged. The firm-level survey's response rate limits the statistical representativeness of the quantitative findings, and some survey categories overlap because firms perform multiple functions. The qualitative component, although analytically rich, does not provide statistical representativeness. Comprehensive firm-level employment data and detailed cost structures for the sector are not publicly available in Ghana, which restricts the precise quantification of employment quality. However, triangulating primary survey data, qualitative stakeholder perspectives, published policy analysis, and existing secondary literature establishes a robust empirical foundation for the case study's analytical conclusions.

Appendix B: Summary of Key Quantitative Findings from the Firm-Level Survey

This appendix presents summary statistics from a structured survey of 16 licenced solar PV companies in Ghana, conducted from January to March 2026 as part of the primary research for this case study. Because some survey questions allowed multiple responses, the total percentages may exceed 100%. Figures marked (~) are approximate estimates, derived by back-calculation from the survey data.

Table B1: Firm Characteristics

Variable	Number of Firms	Percentage of Firms
Operational Orientation		
Solar Energy Solution Providers and Systems Integrators	10	62.5%
Solar Product Suppliers, Distributors, and Logistics Firms	4	25.0%
Assembly, Installation, and Technical Service Firms	5	31.3%
Emerging Component Assembly or Manufacturing Activities	2	12.5%
Firm Size (employees)		
1–10 employees	8	50.0%
11–49 employees	7	43.8%
50–100 employees	1	6.3%
Ownership Structure		
100% locally owned	10	62.5%
Majority foreign-owned	4	25.0%

Table B2: Localisation and Supply Chain Linkages

Variable	Number of Firms	Percentage of Firms
Portion of Solar PV Inputs Sourced Locally		
Less than 25% of key inputs sourced domestically	7	46%
25% to 50% of key inputs sourced domestically	1	7%
51% to 75% of key inputs sourced domestically	4	27%
More than 75% of key inputs sourced domestically	3	20%
SMME Participation in Solar PV Component Manufacturing and/or Assembly		
Local SMMEs not involved in component manufacturing at all	6	46.0%
SMME participation limited to low-skill assembly and supply of basic materials.	4	31.0%
SMMEs participate in design, research, and development activities.	2	15.4%
SMMEs involved in the manufacture and assembly of final products	1	6.3%

Table B3: Foreign Firm Relationships and Distribution of Benefits

Variable	Number of Firms	Percentage of Firms
Nature of Relationship with Foreign Firms		
Informal or occasional supply arrangements with foreign firms	~6	~40%
Formal long-term supplier relationships with foreign firms	~3	20%
Joint ventures or close collaborative partnerships with foreign firms	~3	20%
No significant relationships with foreign firms	~2	~13.3%
Distribution of Benefits within Partnerships		
Pre-arranged profit-sharing arrangement with foreign partner	8	~50.0%
Paid a fixed fee while foreign partner retains remaining profits	5	~31.3%
Not applicable (no partnership with foreign firms)	3	~18.8%

Table B4: Investment, Partnerships, and Capability Development

Variable	Number of Firms	Percentage of Firms
Areas of Recent Firm Investment		
Non-production activities: design, marketing, logistics, and research	8	53.3%
Improving the efficiency of the production process	3	20%
Improving the quality or sophistication of existing products	3	20%
Developing completely new and different products	1	6.7%
No financial investments	3	20%
Firm Coping and Adaptive Strategies		
Investment in workforce training	~13	86.7%
Seeking financing from banks and investors	~10	66.7%
Forming partnerships or joint ventures with foreign firms	~10	66.7%
Collaborating with other local firms	~8	53.3%
Diversifying customer base	~6	40%
Investing in machinery and technologies to improve efficiency	~4	26.7%
Developing new and higher-value products	~2	13.3%
No improvement efforts undertaken	0	0%
Training Practices		
Training provided on an ad hoc basis only	~15	93%
Formal, structured training programmes in place	~7	46.7%
Technology Transfer Perceptions		
Foreign firms perceived as supportive of technology transfer to local SMMEs	~8	53.3%
Foreign firms perceived as generally uninterested in transferring technological skills	~6	40%
Support from foreign firms perceived as varying across firms and partnerships	~1	~6.7%

Table B5: Policy Perceptions and Firm-Level Barriers

Variable	Number of Firms	Percentage of Firms
Awareness of Policies to Support Manufacturers		
Not aware of any specific supporting policies	2	13%
Policies exist but are not effectively implemented	11	69%
Policies exist and are effective in supporting business	2	13%
Awareness of policies to support SMME growth in renewable energy technologies		
I do not know of any policy or legislation	3	19%
Policies and legislation exist and are effective in supporting local firms	2	13%
Policies and legislation exist but are ineffective in supporting local firms	10	63%
Key Firm-Level Barriers ($\frac{Percentage\ of\ Firms}{100} \times 16 = n,\ Number\ of\ Firms$)		
Inconsistent government policies	14	87.5%
Competition from larger or foreign firms	13	81%
Difficulty in accessing finance	12	75%
High cost or scarcity of raw materials	4	25%
Low profit margin	3	19%
High cost of labour	2	12.5%
Shortage of skilled workers	0	0%

Table B6: Decent Work and Gender Inclusion

Variable	Number of Firms	Percentage of Firms
Educational Profile of Workforce		
Firms employing degree-qualified workers	16	100%
Firms employing postgraduate-qualified workers	12	75%
Firms employing vocationally trained workers	6	37.5%
Firms employing workers with secondary-level education	8	50%

Variable	Number of Firms	Percentage of Firms
Firms employing workers without secondary-level education	1	6.3%
Employment Stability		
Firms with relatively stable employment levels	~15	93.3%
Firms reporting employment fluctuations due to project cycles	~8	53.3%
Trade Union Perceptions		
Trade unions considered important for firm operations	~8	47%
Firms can function effectively without union representation	~6	40%
Firms that expressed more neutral views	~2	13%
Women's Workforce Representation		
Women constitute less than 50% of total workforce	~14	88%
All female workforce	1	~6.3%
Zero female workforce	1	~6.3%
Gender Policy Status at Firm Level		
No gender policy; none under consideration	~8	47%
Gender policy currently being developed	~4	26.7%
Formal gender policy in place	~2	13%

Appendix C: Semi-Structured Interview Research: Stakeholder Categories and Thematic Analysis

The semi-structured interview component engaged a purposively selected group of stakeholders representing seven categories. Interview transcripts were analysed using thematic analysis, with iterative coding applied throughout the process. Table C1 identifies the seven stakeholder categories and the organisations or institutional affiliations represented within each category. Table C2 summarises the six thematic areas explored during the interviews and the principal sub-topics and questions addressed under each theme.

Table C1: Stakeholder Categories Consulted

Stakeholder Category	Organisation(s)
Government Ministries and Regulatory Agencies	• The Ministry of Energy and Green Transition • The Ghana Energy Commission
Parliamentary Oversight Bodies	• Committee on Energy (often referred to as the Select Committee on Energy)
Industry Associations and Business Membership Organisations	• Association of Ghana Solar Industries (AGSI) • Association of Ghana Industries (AGI) • Ghana Electrical Contractors Association • General Agric Workers Union Ghana Chamber of Young Entrepreneurs
Renewable Energy Firms and Entrepreneurs	• Jensah Electricals and Engineering Company • 3ESL Company Limited • AB Solar Africa Limited • Agic Energy Technology Global Africa Limited • AIS Energy Company Limited • Akopack Technologies Enterprise • Dahai New Energy Technology Limited Company • Daystar Power Group Limited • Deng Limited • Dutch & Co Limited • Mpower Solar Solutions Ghana Limited • Naiko Engineering • Renpower Systems Limited • Rife Energy Ghana Limited • Righthause Energy Limited • Solar Light Company Limited • Starsight Energy Ghana Limited • Tino Solutions Limited
Labour Unions	• Trades Union Congress Ghana • Public Utility Workers' Union • International Trade Union Confederation
Civil Society Organisations	• Strategic Youth Network for Development • Green Africa Youth Organization • Natural Resource Governance Institute • Open Society Foundation

Stakeholder Category	Organisation(s)
Academic and Technical Experts' Institutions or Affiliations	• The Energy Center of the Kwame Nkrumah University of Science and Technology • Department of Construction Technology and Management at the Kwame Nkrumah University of Science and Technology

Table C2: Key Thematic Areas Explored in Interviews

Theme	Sub-topics and Questions Covered
Localisation and Structural Transformation	Ghana's current solar PV value chain position; barriers and enablers of domestic industrial development; feasible entry points for localisation; technology transfer mechanisms; and the role and behaviour of foreign firms
Policy and Institutional Environment	National energy and industrial policy landscape; implementation gaps; coordination challenges across ministries; the role of procurement; and local content regulation design and enforcement
Decent Work and Employment Quality	Employment patterns and contractual arrangements; labour standards enforcement; occupational health and safety standards; skills development requirements; social protection coverage; and mechanisms for worker voice and union representation
Gender Equity at Work	Women's participation in technical and non-technical solar roles; barriers to entry and advancement; recruitment practices; employer gender policies; and social norms around gender and technical work
Social Reproduction and Household Context	Unpaid care burdens; energy access as a gender issue; the intersection of household roles and labour market participation; and community-level impacts of solar deployment strategies
Global Production Network Dynamics	Lead firm relationships and governance; global competitive pressures from Chinese manufacturers; and international standards requirements and their implications for market access

Appendix D: Global Solar PV Trade, Labour Intensity, and Industry Data

The tables in this appendix present key trade, labour-intensity, and industry data compiled for this case study from international databases, sector studies, and global industry assessments. Table D1 reports import values for four solar PV-related product lines in Ghana from 2018 to 2023. No import values are reported for 2020 because the relevant source data were unavailable. The category "Static converters (Inverter)" falls under the broad Harmonised System Code 850440, which includes power-electronics products beyond inverters. Table D2 presents the labour intensity of solar PV panels, static converters, and batteries. Labour intensity is measured as full-time equivalent jobs per gigawatt or gigawatt-hour of production capacity, reflecting the employment associated with each unit of production capacity. Table D3 ranks 13 leading global solar PV module manufacturers in 2024 using a maximum score of 100. The scoring methodology evaluates ten weighted criteria: capacity utilisation (15%), technology maturity (15%), ESG/CSR adherence (10%), third-party certification (10%), financial conditions (10%), production experience (10%), supply chain resilience (10%), vertical integration (10%), years of manufacturing experience (5%), and research and development investment (5%). Sources for each table are provided directly below the respective table.

Table D1: Import Values of Key Solar PV System Components into Ghana in USD, from 2018–2023

Year	Solar PV Panel (HS 854140) (US$)	Charge Controller (US$)	Batteries (US$)	Static Converters/ Inverter (US$)
2018	7,798,911	9,551,066	1,202,786	17,692,637
2019	6,475,621	7,232,683	1,498,641	28,012,276
2020	(no data)	(no data)	(no data)	(no data)
2021	9,480,974	6,897,313	826,372	29,960,864
2022	16,739,904	8,061,617	2,598,334	22,847,433
2023	15,901,165	4,949,499	1,893,368	18,015,477

Source: UN Comtrade international trade statistics database (2025).

Table D2: Labour Intensity of Key Solar PV System Components

Component	Labour Intensity	Unit
Solar PV Panel	1,970	Full-time equivalent per gigawatt of production capacity
Static Converter (Inverter)	360	Full-time equivalent per gigawatt of production capacity
Batteries	100	Full-time equavilent per gigawatt-hour of production capacity

Source: SolarPower Europe (2023), and Aslesen, S., Vennerød, Ø., and Erraia, J. (2022)[4].

Table D3: Leading 13 Global Solar PV Module Manufacturers Ranked by Quality Score, in 2024

Rank	Manufacturer	Country/Headquarters	Score (out of 100)
1	Jinko Solar	China	90.6
2	JA Solar	China	89.8
3	LONGi	China	86.5
4	Canadian Solar	Canada/China	84.0
5	Trina Solar	China	83.7
6	DMEGC Solar	China	83.0
7	Astronergy	China	78.2
8	Boviet Solar	Vietnam	76.3
9	Risen Energy	China	74.2
10	Qcells	South Korea	73.9
11	Adani Solar	India	72.8
12	TCL Solar	China	70.8
13	Tongwei	China	70.7

Source: WoodMac (2025).

[4] Menon Economics (2022). Outlook for jobs creation in European battery industryhttps://menon.no/uploads/images/2022-71-Outlook-for-jobs-creation-in-European-battery-industry.pdf?utm_source=chatgpt.com

Appendix E: Summary of Policy Data from the Ghana Renewable Energy Policy Review

Table E1: Gender Considerations in Ghana's National Energy Policy and Associated Policy Directions

Issue Identified	Policy Directions
Low participation of women in managerial positions in the energy sector	• Enhance the capacity development of women in the energy sector through science, technology, engineering and mathematics education, skills training, and internship opportunities • Promote the involvement of women in leadership and decision-making processes in the energy sector
Low participation of women in the private sector throughout the energy production network	• Promote and support women-owned businesses in the energy sector • Create awareness campaigns to address cultural beliefs and practices that hinder gender equality in the energy production network
Low awareness of gender issues in the energy sector among policymakers and the public	• Build the gender sensitivity of decision-makers and technical officers in all energy sector institutions to facilitate gender mainstreaming into energy-related interventions • Institute a gender focal unit in all energy sector institutions.
Inadequate gender-disaggregated energy data, which creates difficulty for proper planning of gender issues in the energy sector	• Enhance gender-disaggregated energy data collection, management, and publication • Conduct regular participatory gender audits of the energy sector • Establish a measurement, reporting and verification system to monitor gender mainstreaming in the energy policy

Source: Ghana Policy Scan (Ofori *et al.*, 2025: 15).

Table E2: Milestone Goals by Target Year in Ghana's National Energy Transition Framework (NETF)

Year	Milestone Goals
2030	• New sales of household electrical appliances are best in class • More than 95% of households are electrified • Internal combustion engines and trains fuelled by Compressed Natural Gas are introduced • More than 60% of cooling appliances and systems are best in class • 10% of electricity generation capacity is from renewable energy • A 10% ethanol blend in major petroleum products is introduced
2040	• Nuclear power in the electricity generation mix upscaled • Carbon Capture, Utilisation, and Storage for electricity generation, Oil & Gas and Industries • Sustainable aviation fuel (biofuel for aviation kerosene) introduced • Off-road fossil-fuelled internal combustion engines phased out • Fossil liquid fuel for electricity generation phased out
2050	• More than 50% of water heating systems are solar-powered • More than 50% of metro-urban households use electric stoves • More than 90% of household electrical appliances are best in class • More than 70% of road vehicles are electricity- or hydrogen-fuelled
2070	• More than 70% of rural households use liquified petroleum gas for cooking • More than 98% of all appliances and cooling systems are best in class • All road and rail mobilities are electricity- or hydrogen-fuelled • Net zero emission in electricity generation by the mid-2060s • 20% of electricity generation capacity is from renewable energy

Source: Ghana Policy Scan (Ofori *et al*., 2025: 20), reproduced from the NETF (Ministry of Energy, Ghana, 2022).

Table E3: National Green Jobs Strategy – Objective 3: Strategy to Intensify and Encourage Renewable Energy Investments

Objective 3 of the National Green Jobs Strategy, which seeks to intensify and encourage renewable energy investments, covered the 2021–2025 implementation period. Lead agencies were the Ghana Investment Promotion Center, Ministry of Finance, and Ministry of Energy. Implementation also involved several collaborating institutions, including relevant sector ministries, the Department of Co-operatives, Metropolitan, Municipal and District Assemblies, the private sector, and development partners.

Activity	Expected Outputs	Indicators	Means of Verification
Develop collaboration, partnerships and cooperatives in the renewable energy sector	Collaborations, partnerships and cooperatives in renewable energy developed	Number of collaborations, partnerships and cooperatives in renewable energy	Reports, pictures, and videos
Sign memoranda of understanding (MOUs) and agreements for the development of renewable energy projects	MOUs and agreements in renewable energy signed	Number of renewable energy MOUs and agreements signed	List of MOUs and agreements in renewable energy
Facilitate the operationalisation of MOUs and agreements signed	MOUs and agreements implemented	Number of MOUs and agreements implemented	Status Reports
Implement attractive packages that encourage investment in renewable energy and support local employment	Attractive packages for renewable energy investments for local employment benefits implemented	Number of attractive packages implemented	List of attractive employment-oriented renewable energy packages

Source: Ghana Policy Scan (Ofori et al., 2025: 28).