



# **Closing the Green Skills Gap in EMDEs: Policy Pathways and Implementation Models**

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## 1.0 Executive summary

As emerging and developing economies (EMDEs) accelerate efforts to expand renewable energy, improve energy efficiency, and strengthen climate resilience, workforce readiness is increasingly recognised as a critical enabling factor for effective implementation. While global investment in low-carbon technologies continues to grow, the availability of workers with relevant technical, vocational, and institutional competencies remains uneven across regions. Evidence suggests that gaps in applied technical skills, industry-aligned certification systems, and work-based learning pathways may limit the ability of EMDEs to translate climate ambition into employment outcomes and infrastructure delivery.

Addressing these constraints requires more than expanding training capacity alone. Effective green workforce development depends on coordinated systems that link skills formation with labour market demand, strengthen technical and vocational education and training (TVET) institutions, and support continuous learning through modular credentials and workplace-based training models. Country experiences demonstrate that targeted programmes can improve workforce readiness when training pathways are aligned with sectoral investment and supported by credible policy frameworks.

This article examines policy-relevant approaches to strengthening green skills systems in EMDEs, drawing on evidence from selected country programmes in Nigeria, India, and Brazil. These cases illustrate how institutional capacity building, demand-linked training models, mentorship structures, and modular learning pathways can support workforce transitions across renewable energy, energy efficiency, and related sectors. The analysis highlights the importance of integrating skills development into broader transition strategies, ensuring that workforce preparedness evolves alongside investment flows and technology deployment. By identifying practical mechanisms that connect training systems with employment opportunities, this paper contributes to ongoing discussions on how EMDEs can build resilient and inclusive green workforce ecosystems capable of supporting long-term structural transformation.

## 2.0 Country case studies using official programme evidence

Based on the analytical framework of this study, Nigeria, India, and Brazil are examined as representative EMDEs across Africa, Asia, and Latin America respectively.

### Nigeria: transition ambition and institutional capacity challenges

Nigeria's Energy Transition Plan highlights the employment potential associated with a low-carbon development pathway. Official projections indicate the possibility of creating approximately **340,000 jobs by 2030** and up to **840,000 jobs by 2060**, with major contributions expected from the power, clean cooking, and transport sectors (Energy Transition Office, 2024). These projections are significant because they explicitly link decarbonisation pathways to labour market outcomes.

Investment frameworks associated with the transition also emphasise technology transfer and skills development. Policy documentation identifies an estimated investment opportunity of approximately **USD 23 billion**, alongside objectives that include local manufacturing and assembly of transition technologies and targeted technical assistance to support knowledge transfer in electric mobility and carbon market development (Energy Transition Office, 2022).

Nigeria also provides an example of large-scale institutional capacity building through the SPESSE programme, which is designed to strengthen professional competencies in procurement and environmental and social safeguards (World Bank, 2025). By late 2025, programme data indicated that **3,429 candidates** had completed professional certification examinations, while **40,914 participants** had completed training across various programme levels, including short courses, postgraduate diplomas, and degree programmes (World Bank, 2025). Financing arrangements included an IDA credit of approximately **USD 80 million**, with an additional **USD 65 million** approved but not yet fully operational at the time of reporting (World Bank, 2025).

These findings suggest that skills gaps in Nigeria extend beyond technical occupations to include institutional capabilities related to procurement systems, regulatory compliance, and safeguards that enable project implementation and investment flows.

### India: scaling solar workforce development while addressing job quality concerns

India's rapid expansion in renewable energy capacity implies substantial and growing demand for technical skills. IRENA estimates that solar PV employment in India reached approximately **304,340 jobs in 2024**, including around **127,230 rooftop positions** and **177,110 utility-scale roles**, with additional employment in off-grid applications (IRENA & ILO, 2026).

India's national solar workforce training architecture provides one of the most documented examples among EMDEs. The Suryamitra programme, implemented through the National Institute of Solar Energy, focuses on training technicians in solar PV installation, operation, and maintenance (NISE, n.d.). Government reporting indicates that by June 2022, **51,331 individuals** had completed training under the programme, with **26,967 trainees securing employment** (Press Information Bureau, 2022).

However, programme effectiveness is influenced by labour market conditions and job quality. Independent evaluation evidence suggests that placement rates averaged approximately **51% between FY2016 and FY2020**, declining to about **31% in FY2021** (CEEW, 2021) [10]. Many trainees were employed on contractual terms, with average monthly earnings of approximately **INR 9,700**, and about **70% earning less than INR 10,000 per month** (CEEW, 2021).

These findings suggest that large-scale training programmes can expand skills supply, but long-term effectiveness depends on wage structures, employment stability, and the availability of career progression pathways.

### **Brazil: diversified renewable employment and institutionalised training systems.**

Brazil demonstrates how diversified renewable energy sectors can support a large and varied green workforce. IRENA estimates that renewable energy employment in Brazil reached approximately 1.39 million jobs in 2024, with significant contributions from biofuels, hydropower, and solar PV. Solar PV employment alone is estimated at approximately 323,800 jobs, including around 120,330 direct positions (IRENA & ILO, 2026).

Public programmes can also stimulate demand for skills by creating large-scale deployment opportunities. Brazil's Ministry of Mines and Energy reports that the "Clean Energy in My House, My Life" initiative aims to install approximately 500,000 solar connections by 2028, supported by an investment of around R\$3 billion intended to reduce energy costs and address energy poverty (Ministério de Minas e Energia, 2025). Such initiatives generate demand for installers, electricians, and maintenance professionals, thereby functioning as catalysts for skill development through practical experience.

Brazil's vocational training system, including institutions such as SENAI, has been widely studied. Evaluation evidence indicates positive labour market outcomes associated with participation in these training programmes. One study reports an estimated 14.9% earnings premium for certain groups of trained youth and finds that programme participants were more likely to be employed in occupations aligned with their training (Attanasio et al., 2015/2016).

Brazil's experience illustrates how established training institutions can support workforce transitions associated with structural change, although distributional considerations such as access for lower-income groups and gender equity remain important factors influencing overall impact.

## 2.0 Country case studies using official programme evidence

### Cross-country comparison

Table 4. Nigeria, India, Brazil, program levers and evidence (selected)

| Country | Transition demand signals                                                                                | Core skills programs cited                                                 | Evidence strength                                                             | Main binding constraints (skills lens)                                                        |
|---------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Nigeria | ETP projects job creation to 2030/2060 (Energy Transition Office, 2024).                                 | SPESSSE professional certification and training tracks (World Bank, 2025). | High (official WB ISR; official ETP portal)                                   | Delivery capacity at scale; linking training to private-sector demand; formalization pathways |
| India   | Large solar additions; solar PV jobs estimated for 2024 (IRENA & ILO, 2026).                             | Suryamitra (MNRE/NISE); Skill Council ecosystem (PIB, 2022; NISE, n.d.).   | High + mixed (official counts; independent evaluation shows retention issues) | Job quality/attrition; contract labor; wage/career progression                                |
| Brazil  | Large renewable workforce; solar expansion; social PV program investment (IRENA & ILO, 2026; MME, 2025). | Public deployment programs; vocational training ecosystem (S-system)       | Moderate–high (official sector data; evaluation evidence for training)        | Inclusion (women/low-income access); aligning training with fast-changing tech standards      |

## 3.0 Best-practice interventions, policy recommendations, and implementation roadmap

Evidence from both energy-sector studies and labour market research suggests that addressing green skills shortages requires coordinated policy packages rather than isolated interventions. Effective responses typically combine expansion of training capacity, improvements in job quality, stronger certification and standardisation frameworks, and clearer linkages between training systems and employment opportunities. Pilot initiatives implemented in isolation often struggle to scale when labour demand signals are uncertain or when job-matching mechanisms are weak.

### 3.1 Evidence-informed interventions

#### 3.1 Align training systems with labour demand (demand-linked skills development)

Research indicates that linking training programmes directly to employment pipelines can significantly reduce skill mismatches. The IEA reports that many employers currently respond to skill shortages by providing internal training or recruiting workers from adjacent industries; however, in many EMDE contexts, limited availability of structured training pathways leads firms to rely on external recruitment rather than investing in domestic workforce development (IEA, 2025). Programmes designed to integrate training with hiring needs can therefore improve alignment between supply and demand. India's Suryamitra programme provides an example of this approach, reporting both high training participation and substantial numbers of trainees transitioning into employment, suggesting that demand-linked training structures can facilitate workforce placement at scale (Government of India, 2022).

### 3.2 Strengthen technical and vocational education and training (TVET) capacity in priority occupations

Targeted investment in high-impact occupations can improve both labour market outcomes and energy transition performance. In the buildings sector, the IEA identifies priority occupations including insulation technicians, energy auditors and inspectors, HVAC/R specialists, and glazing professionals as critical for improving building energy performance. Analysis suggests that the buildings sector alone could contribute approximately 1.3 million additional energy efficiency jobs over a six-year period under net-zero transition pathways, indicating that prioritising training in occupations associated with major energy savings can maximise impact in resource-constrained EMDE contexts (IEA, 2024b).

### 3.3 Adopt modular credential systems and multi-channel learning pathways

Flexible training systems are particularly important in labour markets characterised by high levels of informality. The IEA highlights the growing adoption of multi-channel strategies in EMDEs that combine formal education, short modular courses, and industry partnerships, alongside certification frameworks capable of recognising informally acquired competencies (IEA, 2025). Modular credential structures allow workers to accumulate competencies progressively and improve accessibility for individuals unable to commit to long-term full-time study programmes.

### 3.4 Promote inclusion, mentorship, and work-based learning approaches

Expanding the pool of green talent requires addressing barriers that limit access to training and employment opportunities. The International Finance Corporation highlights the importance of mentorship programmes and work-based learning arrangements in improving labour market entry for underrepresented groups, including examples from Nigeria where structured mentorship and practical training pathways support workforce inclusion (IFC, 2026). Such approaches are particularly relevant in EMDEs, where financial constraints, mobility limitations, and social norms may restrict participation in formal training systems.

### 3.5 Strengthen enabling institutional skills to support project delivery

Skills related to procurement systems, environmental and social safeguards, and project compliance are increasingly recognised as critical components of green transition capacity. Nigeria's SPESSE programme illustrates the importance of strengthening institutional competencies that enable project implementation, reduce risk, and accelerate investment flows (World Bank, 2025). These governance-related capabilities can be considered part of the enabling infrastructure required to support effective deployment of green technologies.

### Intervention matrix with evidence and cost anchors

Table 5. Recommended interventions for EMDEs: evidence signals, costs, and implementation notes (IEA, 2025; IEA, 2024b; ILO, 2018; Government of India, 2022; Federal Government of Nigeria, 2022; International Renewable Energy Agency & ILO, 2026; World Bank, 2025; IFC, 2026; LinkedIn Economic Graph, 2024).

**Table 5. Nigeria, India, Brazil, program levers and evidence (selected)**

| Intervention                                                                           | Evidence of impact<br>(what is measurable)                                                                         | Cost evidence or<br>anchor                                                            | Practical EMDE design<br>considerations                                               |
|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Demand-linked training<br>(train-to-hire; auction/PPP requirements for local training) | Placement outcomes reported in India's solar technician pipeline; employer surveys show training used to fill gaps | Cost often not reported publicly; can be embedded in project CAPEX/OPEX               | Tie to procurement/auctions; require reporting (graduates, placement, wages)          |
| TVET upgrades for priority occupations (buildings, electrical, HVAC/R)                 | IEA prioritizes a small set of occupations with high system impact                                                 | Global-scale training expansion estimate: ~USD 2.6bn/year (energy graduates pipeline) | Focus on instructor training, labs, standards; align building codes with skills       |
| Micro-credentials + modular skilling                                                   | Enables upskilling without long program duration                                                                   | Often low unit cost; cost data varies widely and is context-specific                  | Stackable credentials; recognition by employers; pathway from informal to formal      |
| Apprenticeships and dual training models                                               | Reduces mismatch and improves job readiness; common employer preference to retain sector know-how                  | Requires wage support or employer incentives; cost data often program-specific        | Use wage subsidies for SMEs; protect apprentices; certification recognized nationally |
| Mentorship platforms and work-based rotations                                          | IFC highlights mentorship and rotations as pathway builder for                                                     | Cost is relatively low vs labs; often bundled into HR budgets                         | Pair mentorship with credential outcomes; track retention and progression             |

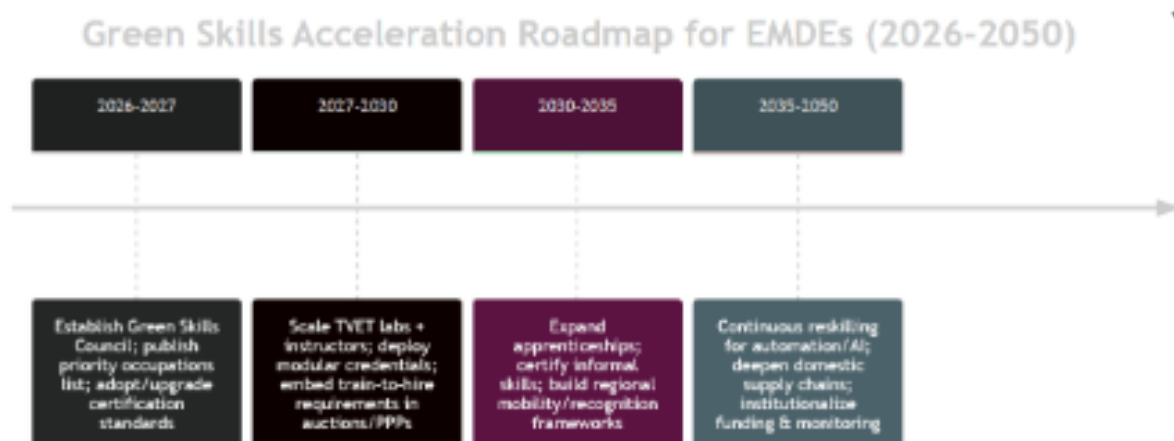
|                                                                           |                                                              |                                                                       |                                                                                  |
|---------------------------------------------------------------------------|--------------------------------------------------------------|-----------------------------------------------------------------------|----------------------------------------------------------------------------------|
|                                                                           | underrepresented talent                                      |                                                                       |                                                                                  |
| “Enabling skills” accelerators (procurement, safeguards, ESG, permitting) | Nigeria SPESSE targets certified experts and system capacity | SPESSE additional financing cited at USD 65m; savings potential cited | Treat as project throughput; integrate into public investment management systems |
| Circular economy skills formalization (OHS + process skills)              | ILO estimates 6m jobs potential by 2030 from circular shift  | Cost data sparse; municipal investments + donor finance possible      | Formalization pathways, safety equipment, municipal PPPs, aggregation models     |

## 4.0 Regional perspectives with quantitative anchors

A structured and phased roadmap is necessary to prevent two common transition risks:

1. Skills development occurring without corresponding employment opportunities,
2. Project pipelines expanding without an adequately prepared workforce.

The framework outlined below is intended to guide stakeholders in EMDE contexts, including government ministries, development agencies, training institutions, and industry platforms, in coordinating workforce development with investment and project implementation timelines.



(IEA, 2025; IEA, 2024b; ILO, 2018; International Renewable Energy Agency, 2023).

## 5.0 Policy recommendations tailored to EMDE constraints

### 1) Establish a coordinated “Green Skills and Jobs Compact” linking transition deployment to workforce development

One of the most effective governance mechanisms is to formally integrate workforce planning into national transition strategies. Aligning policies on renewable energy expansion, building efficiency, transport electrification, and circular economy development with a jointly managed skills pipeline and monitoring framework can improve policy coherence and reduce mismatches between labour supply and demand. Such an approach reflects the ILO's emphasis on coordinated transition planning and responds to evidence showing that skills shortages can coexist with unemployment where labour market signals are poorly aligned (ILO, 2011; IEA, 2025).

### 2) Focus training investments on occupations with the greatest system-level impact

Resource constraints in many EMDEs require prioritisation of training investments in occupations that represent critical bottlenecks for project delivery. Evidence from the buildings sector identifies priority occupations such as insulation technicians, energy auditors and inspectors, HVAC/R specialists, and glazing professionals as having high potential impact on energy performance outcomes. Similarly, in renewable energy sectors, occupations including electricians, solar PV installers, operations and maintenance technicians, and grid interconnection specialists represent key constraints on deployment capacity. Concentrating training resources in these areas can improve system efficiency and accelerate implementation timelines (IEA, 2024b; International Renewable Energy Agency & ILO, 2026).

### 3) Treat skills development as an enabling investment within climate finance strategies

Although workforce development is essential to the success of green transition policies, the required investment is relatively modest compared with overall infrastructure financing needs. Estimates suggest that approximately USD 2.6 billion annually would be sufficient to expand global training capacity to a level capable of preventing worsening skills shortages by 2030. This indicates that skills development should be considered a strategic enabling investment and integrated into national climate finance frameworks and public investment planning processes (IEA, 2025; Federal Government of Nigeria, 2022).

#### **4) Link certification systems to safety, quality standards, and job formalisation**

Expanding workforce supply without establishing consistent certification and regulatory standards may create risks related to safety, quality assurance, and sector credibility. This is particularly relevant in labour markets characterised by high levels of informality. Policy responses should therefore include licensing frameworks, occupational safety certification systems, and recognition of prior learning mechanisms that allow informally acquired competencies to be formally accredited. This approach is especially important in sectors such as electric mobility, battery systems, and HVAC refrigerants, where safety standards are critical (IEA, 2025).

#### **5) Recognise enabling institutional capabilities as part of the green skills ecosystem**

Green transitions require not only technical expertise but also institutional competencies that facilitate project implementation. Skills related to procurement processes, environmental and social safeguards, and regulatory compliance play a key role in enabling investment execution and reducing project risk. Nigeria's SPESSE programme provides an example of a structured approach to strengthening these governance-related skills as part of broader transition capacity development (World Bank, 2025).

## **6.0 Data gaps and assumptions requiring transparent acknowledgement**

Several methodological limitations should be recognised when interpreting available evidence on green skills gaps in EMDEs.

First, there is no single global dataset that provides consistent estimates of green skills shortages across all emerging and developing economies. Current understanding relies on triangulation across multiple data sources, including employment tracking data from organisations such as the IEA, IRENA, and ILO, scenario modelling studies, and labour market proxies such as platform-based skills indicators (IEA, 2025; International Renewable Energy Agency & ILO, 2026; ILO, 2018; LinkedIn Economic Graph, 2024).

Second, platform-based indicators, including LinkedIn skills metrics, depend on classification frameworks and coverage of digitally mediated labour markets. These datasets should therefore be interpreted as directional indicators of trends rather than comprehensive measures of labour force structure (LinkedIn Economic Graph, 2024).

Third, renewable energy employment statistics do not capture the full range of activities included within the broader green economy. Some categories, such as heat pump deployment or waste-to-energy systems, may overlap with classifications used in energy efficiency or circular economy frameworks. Combining datasets without harmonisation may therefore lead to double counting or inconsistencies in aggregate estimates (International Renewable Energy Agency & ILO, 2026; IEA, 2025).

Finally, country case study analysis in this report focuses on Nigeria, India, and Brazil as representative EMDEs across Africa, Asia, and Latin America respectively. However, significant subnational variation exists within each country, including differences between regions, states, and urban versus rural labour markets. In many cases, skills bottlenecks are most pronounced at these subnational levels rather than at national scale (Federal Government of Nigeria, 2022; Government of India, 2022; International Renewable Energy Agency & ILO, 2026).

## 7.0 Conclusion

Findings from the country's case studies and policy analysis indicate that closing the green skills gap in emerging and developing economies requires coordinated institutional responses rather than isolated training initiatives. Evidence from Nigeria, India, and Brazil demonstrates that workforce readiness improves when skills development systems are directly linked to sectoral investment pathways, supported by structured certification frameworks, and complemented by work-based learning opportunities. Programmes such as Nigeria's SPESSE capacity-building initiative, India's Suryamitra solar training pathway, and Brazil's vocational training ecosystem illustrate how targeted interventions can strengthen both technical competencies and enabling institutional capabilities required for effective transition implementation.

The analysis further shows that technical and vocational education and training (TVET), modular credential systems, mentorship structures, and apprenticeship pathways play a critical role in expanding access to green employment opportunities, particularly within middle-skill occupations that form the operational backbone of renewable energy deployment, energy efficiency improvements, and low-carbon infrastructure development. At the same time, evidence highlights that training effectiveness depends on complementary labour market conditions, including job quality, stable demand signals, and policy environments that incentivise private-sector participation in workforce development.

A central implication emerging from this study is that green skills development should be treated as an enabling investment within broader climate and industrial policy frameworks. Aligning workforce development strategies with national transition plans, procurement mechanisms, and sectoral growth trajectories can improve labour market matching and support inclusive employment outcomes. While data limitations remain and context-specific factors influence implementation pathways, the evidence suggests that integrating training systems, certification structures, and institutional capacity development into transition planning can strengthen the ability of EMDEs to capture both economic and environmental benefits associated with the green transition.

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