From Training to Employment: Evaluating India's Solar PV Skilling Ecosystem

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ABSTRACT

India's goals of achieving 500 GW of renewable energy capacity and the PM-Surya Ghar scheme of 10 million rooftop solar systems are expected to create a demand of over 100,000 solar PV installers in India. Despite millions of candidates trained through programs such as PMKVY and SANKALP, placements have been low (overall PMKVY placements rate ~21%). This study investigates India's solar PV training ecosystem's skills-to-jobs gap through a secondary data analysis, administrative scheme data, audited reports of the CAG, the PLFS, industry reports (CEEW and Mercom India), and international best practice (Germany's dual VET system, and Singapore's SkillsFuture). For the solar PV sector, four major systemic challenges of placement emerge: (i) demand-supply mismatch in skills taught and industry requirements, (ii) weak industry-training provider linkages, (iii) low levels of on-the-job training and exposure, and (iv) mismatch between training centre locations and industry locations. Compared to international comparators Germany (placement rates of >80 per cent) and Singapore (around 65 per cent) with similar investment levels, India's placement outputs are very low. It proposes three pathways to align with such global benchmarks: 1. District-level Solar Skills Councils for co-creating employer-led curriculum, 2. an Outcome-Linked Fund for paying training providers based on trainees settled and retained in jobs, and 3. a Digital Talent Stack of portable credentials, employer ratings and AI-enabled job matching on the Skill India Digital Hub. This model enables addressing ex-ante implementation challenges and serving the Atmanirbhar Bharat (Self-reliant India) agenda by building domestic institutional and human capacity for a self-reliant green economy.

Keywords: Atmanirbhar Bharat, green jobs, solar PV installer, skill development, PMKVY, SANKALP, placement outcomes

INTRODUCTION

The Atmanirbhar Bharat Imperative in the Green Economy

The Atmanirbhar Bharat (Self Reliant India) vision represents a foundational reorientation of India's development model, one that seeks to strengthen domestic capabilities across institutions, industries, technologies and human capital, so that the country's future is built on resilience and innovation (Government of India, 2020). Realization of this vision would require a fundamental rethinking of regulatory, administrative and policy frameworks, improving ease of doing business and improving human capabilities through skills development that is aligned with emerging economic opportunities. Nowhere is this better evidenced than in India's renewable energy sector. With over 250 GW of non-fossil installed electricity capacity, India is the global leader in renewable deployment, having exceeded its Nationally Determined Contributions target of 50% non-fossil share in installed power generation capacity five years ahead of its 2030 deadline (MNRE, 2024). The MNRE, under its flagship central sector scheme PM Surya Ghar Muft Bijli Yojana has targeted 10 million roof top solar installations. The expected outcome of the PM Scheme will generate overall employment potential of 1.7 million (including direct employment of more than 100,000 skilled solar technicians) (PIB, 2024). The Skill Council for Green Jobs (SCGJ) has trained approximately 663,000 candidates on the green skills tracks and has

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58 qualifications approved by NCVET in the trades of Solar PV, Green Hydrogen, Agri PV, Bio Energy, etc. (SCGJ, 2023). However, training is failing to produce substantial employment generation. The Economic Survey 2024 25 stated that "the central challenge in India's skilling landscape is not the absence of training effort but the weak translation of training into durable labour market value" (Government of India, 2025, p. 78). This mismatch is especially pronounced in newer industries, where curriculum and skills are slow to respond to evolving industry requirements, training centres work in silos and placement infrastructure is still in its infancy.

Research Problem and Rationale

The Solar PV Installer, also called Suryamitra, is the technician who plays a key role in India's green energy transition by performing site surveys, designing installations, assembling and installing photovoltaic modules, conducting electrical tests, and preventive maintenance of solar systems (NSDC, 2022). The programme was launched as part of Skill India Mission 2015 by the National Institute of Solar Energy (NISE), an institution under the Ministry of Skill Development and Entrepreneurship in collaboration with nodal agencies of states. It is a 600 hour residential training programme as per Qualification Pack SCG/Q0101 (MNRE, 2023). Despite 51529 Suryamitras being trained, as reported in the report (MNRE, 2023), placements under the scheme were low, with the CAG audit of the government's digital skilling schemes finding that of the 480000 candidates trained, only 85000 got placements, making the placement rate less than 18% (CAG, 2023). Apart from training Suryamitras, the PMKVY 4.0 scheme includes OJTs and new age courses in solar energy. However, translating training into employment remains a systemic issue (MSDE, 2022).

This study addresses the following research questions using secondary data only:

1. What do administrative data, audit reports, and industry surveys reveal about the placement rates for Solar PV Installer trainees under PMKVY/SANKALP at national and state levels?
2. What systemic factors, as documented in evaluation reports, explain the gap between skill certification and gainful employment?
3. How do international best practices (Germany, Singapore) compare with India's skill development model for green jobs?
4. What governance mechanisms, grounded in secondary evidence, could effectively bridge the skills-to-jobs gap in an Atmanirbhar Bharat framework?

Significance and Contribution

First, this study provides a systematic synthesis of secondary evidence on the translation of skills to jobs in green occupations. Existing analyzes focus exclusively on a single program. Second, it combines the supply side (trainee proxy derived from PLFS) and the demand side (employer surveys sourced from industry reports) perspectives using publicly available data. Third, it designs a governance framework contextualized to Indian skill ecosystem by leveraging knowledge from cross-country good practices and ground realities as documented in audit reports. Fourth, it presents six actionable policy recommendations aligned with the Atmanirbhar Bharat framework of resilience, innovation, and self-sufficiency across sectors. In Section 2 this study describe the architecture of India's skill development program and the national solar policy. Section 3 reviews the literature on skill gaps, implementation challenges, and models of skills development in other countries. Section 4 presents the secondary data methodology and Section 5 the placement outcomes and causal factors of interest for synthesis. Section 6 presents the Tri-Partite Partnership model for governance and the final Section 7 presents implications for policy.

BACKGROUND

India's Skill Development Architecture: SANKALP and PMKVY

India's skill development ecosystem is institutionally complex, involving multiple ministries, state-level agencies, sector skill councils, and training providers operating under overlapping frameworks. Two flagship schemes form the core of the government's effort: SANKALP and PMKVY.

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SANKALP (Skills Acquisition and Knowledge Awareness for Livelihood Promotion)

Approved by the Cabinet Committee on Economic Affairs in October 2017 at an outlay of ₹4455 crore, SANKALP, a World Bank supported outcome oriented scheme seeks to strengthen short term skill training through Institutional Strengthening, Industry Linkages and Inclusion of marginalized populations. The scheme has been extended up to March 2025. The three result areas of the scheme are (i) Institutional Strengthening at Central, State and District level (ii) Quality Assurance of skill development programs and (iii) Inclusion of marginalized populations. An institutional strengthening component is relevant in this context. SANKALP mandated DSCs to coordinate skilling with local economic opportunity at the district level. In practice however, the effectiveness of DSC has been mixed, with a 2022 Public Accounts Committee report pulling up the government for poorly planned implementation and persistent underutilisation of funds (PAC, 2022). However, the scheme has performed unequally between states, owing to differential absorption capacity and weak monitoring frameworks across them.

PMKVY (Pradhan Mantri Kaushal Vikas Yojana)

The PMKVY was launched in 2015 as the flagship scheme of the Ministry of Skill Development and Entrepreneurship (MSDE). Since then, four versions of PMKVY were rolled out. PMKVY 1.0 and 2.0 (2015 16 and 2016 18 respectively) were high volume, multi sector skill training schemes. PMKVY 3.0 (2020 21) is partially demand driven. Provision of ₹6000 crore has been made for new age courses and on the job training in various sectors including under PMKVY 4.0 (2022 26). The Union Cabinet approved ₹8800 crore for Skill India Programme which will be implemented from 2022 23 to 2025 26 with major amount going to PMKVY 4.0 (MSDE, 2022). However, low placement rates have plagued all PMKVY programs despite this important expenditure. As of 30 June 2022, the placement rate across PMKVY 1.0, 2.0 and 3.0 remains at approximately 21% (MSDE, 2022). From FY17 to FY23, out of the 11 million people trained under PMKVY 2.0, 83% were certified and 2140000 were placed, implying a placement rate of about 19 20% among people with certification (The Times of India, 2023a). By contrast, only 740000 people have been trained under PMKVY 3.0 as of January 2023, and only 437 people have been placed (Business Standard, 2023). The green jobs initiative has found its place in expanded scope of PMKVY 4.0, including specialized training in various districts such as Solar PV Installer, Rooftop Solar Grid Engineer, Small Hydro Power Plant Technician, Green Hydrogen Plant Technician in districts like Chitrakoot, Devipatan and Auraiya (PIB, 2025). PMKVY 4.0 is a demand driven scheme, and training proposals are vetted based on industry demand, but there remains a gap between the scheme being demand driven versus its implementation being demand absorbing (CAG, 2023).

National Solar Policy Landscape and Employment Projections

India’s renewable energy roadmap is characterized by ambitious targets and rapid capacity installation. In 2010, the government adopted a policy-based approach to solar power deployment through the Jawaharlal Nehru National Solar Mission (JNNSM) for its centralized and decentralized solar systems (MNRE, 2010). However, intervention policies such as the 100 GW solar target (to be updated as part of India's intended nationally determined contributions under the Paris Agreement), and more programs (such as the PM Surya Ghar Muft Bijli Yojana scheme, launched in February 2024) have propelled solar capacity upgrades in a previously unseen manner. This ₹75021 crore (US$9.57 billion) scheme seeks to install rooftop solar plants on 100 lakh (10 million) homes generating 1000 billion units (kWh) of renewable energy. Government of India claimed that this scheme, if implemented in a fast track mode, will help generate 17 lakh (1.7 million) direct and indirect jobs. (PIB, 2024) A strong up-skilling and training component through Industrial Training Institutes (ITIs) on solar installation and maintenance, with emphasis on both theory and practice is also part of the program. The employment potential in India is not just limited to immediate solar jobs, as the Council on Energy, Environment and Water (CEEW) and The Energy and Resources Institute (TERI) estimate the renewable sector will generate 1.3 million jobs by June 2025 (CEEW, 2022; TERI, 2021). However, industry executives have also warned that skills shortages have already reduced the pace of growth in the sector by 10 20%, and that companies are unable to deliver projects and expand as a result (Mercom India, 2024). Despite the large number of new jobs projected, the lack of trained workers with the skills required by employers means that these projects are unable to go ahead and many of the certified graduates remain unemployed.

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The Solar PV Installer: Job Role, Qualification Pack, and Training Landscape

MNRE's skill development program for the solar sector also defined the job role of the Solar PV Installer, referred to as Suryamitra, as an NSQF recognized job role. The National Skills Development Corporation's National Skills Qualification Framework Job Role (2022) describes the job responsibility of the Solar PV Installer as Site assessment, Designing, Planning and procurement, Installation facilitator, Leading and monitoring installers, and Maintenance of solar PV systems. The Suryamitra Skill Development Programme (SSDP) is a 600-hour residential skill development program, for the solar sector. The nodal agency of the program is NISE. The curriculum is based on SCG/Q0101 Qualification Pack (MNRE, 2023). Ideally, candidates should have a minimum qualification of ITI/Diploma or an undergraduate degree. The training ecosystem is fragmented. While the curriculum covers classroom training, practicals, exposure to SPV plants, on job training, soft skills and entrepreneurship, there are disparate types of training programs. These include NISE implemented residential model, the short term training (STT) model under PMKVY implemented through TPs accredited to PMKVY, courses under the Craftsmen Training Scheme (CTS) run by the Industrial Training Institute (ITI), and private sector initiatives such as the Sungrow CCSE program in Delhi, which provides 360 hours of training per batch, field exposure and placement support. The placement target for this program is 70% (PV Magazine, 2024). The skills to jobs gap is exacerbated by the lack of standardization regarding trainer quality, practical exposure hours, assessment rigor and placement support across various training programs.

LITERATURE REVIEW

The Solar Skill Gap: Magnitude and Dimensions

The renewable energy sector in India encounters difficulties in hiring and training a skilled workforce. According to a CEEW study, the quality of training programmes is its most meaningful challenge (CEEW, 2022). The same study also concluded that India could absorb workers from customary labour markets since India's solar PV manufacturing sector lacks sufficient numbers of workers. The gap is important. To reach the 100 GW solar target by 2022 (at the time of the report), India needed about 210,800 site engineers and 624,600 semi-skilled technicians for the construction and field installations of solar projects (CEEW, 2022). Some recent estimates reveal that there is a shortfall of 1.2 million skilled manpower in India's renewable energy sector, which is expected to grow by 26% by 2027 (TeamLease, 2023). This has resulted in leading companies like Tata Power and Adani Green having to grapple with workforce shortages, reports by Mercom India (2024) have cited shortage of skilled workforce as top challenge to clean energy growth in India. But such gaps are more than quantitative: the industry sees an active disjunction between academic output and industry needs, and a growing shortage of skills in the workforce (Mercom India, 2024). Another major gap that exists in solar is that there are currently no standardized skill benchmarks: "India needs national level certification frameworks for solar technicians" (PV Magazine, 2024).

Implementation Challenges in Indian Skill Development Programmes

However, skilling programs have also been criticized due to poor implementation. Audits and research have consistently pointed out issues with these programs. A CAG audit of MeitY's digital skilling programs cited low placing, data integrity issues, risk of fraud, and near zero earnings for digital entrepreneurs as areas of concern (CAG 2023). The audit also revealed that delays in conducting assessments and issuing certificates caused setbacks for candidates. Further, the implementation of the 'Place and Train' model was also delayed, affecting the employability of certified candidates. As stated in the Economic Survey 2024 25, "the central challenge in India's skilling landscape is not the absence of training effort but the weak translation of training into durable labour market value" (Government of India, 2025, p. 78). This is why certificates issued during training are not equivalent to sustainable employment. Structural factors also explain this weak translation: for example, training providers are often independent of employers, and they decide what to teach without consulting employers (World Bank, 2021). Where placements are available, they are often weak. Only 22% of NSDC funded training providers have been able to provide any placements in the provider's lifetime (The Wire, 2022). Third, soft skills, such as communication and workplace behavior are deprioritized, although such skills are often the most important factors in hiring decisions (CEEW, 2022). Fourth, success is often assessed by completion and

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certification at the end of training rather than successful placement in the job market. Critics argue that the employability record of the training delivered by NSDC-recognized training providers has been lacklustre at best, with only 22% of trained persons finding jobs (The Wire, 2022). Skill development in a centralized manner may run counter to building sustainable livelihoods as it does not ensure the creation of quality jobs.

The role of on-the-job training and apprenticeships

Operation assessments and skills development assessments conclude that classroom-based training even when supplemented by laboratory based practical training is insufficient for labour market entry. In the "skills ecosystem framework" (ILO, 2019) work-based learning components throughout skills development are delivered in integrated fashion. They need experience in real life installation conditions, such as safety, customer interactions, supervision and problem solving. In this context, PMKVY 4.0 has made OJT mandatory for nearly all STT courses (MSDE, 2022). However, implementation of OJT under PMKVY 4.0 has faced various challenges, such as sourcing enough host employers, ensuring quality supervision, easing safe experiences for trainees, and covering the costs of the OJT component. The CAG audit finding on the lag in introducing the 'Place and Train' model, which prioritizes placement support, again highlights the challenges of scaling-up work based learning (CAG, 2023). Germany's dual VET system, a global reference, combines theoretical with workplace instruction through apprenticeships and includes over 1.3 million learners in more than 334 occupations (GOVET, 2022). A key feature of a dual education system is that chambers of commerce and industry associations are involved in the curriculum, training establishments are accredited by chambers and employers are co producers rather than passive consumers of skilled labour.

International Models: Germany's Dual VET and Singapore's SkillsFuture

Germany's Dual Vocational Education and Training System

Germany's dual VET system is widely regarded as a global benchmark for industry aligned skill development. Its main characteristics are: a dual system shared between the state and industry, occupational standards agreed by the business associations and trade unions defined in law, a dual vocational training system combining workplace training (mostly 70-80%) with part-time vocational school (20-30%) and a state-recognized certification system administered by the chambers of commerce and industry (GOVET, 2022). The Energy Electronics apprenticeship in Germany trains in the installation, maintenance and programming of energy generation and transmission systems, in areas including solar energy generation and smart grid technology. It is a state recognized qualification and is in demand for the growing careers in renewables (BIBB, 2021). The lessons for India are not to replicate, but to adapt, the following principles: (i) compulsory, high quality, and scalable work based learning (beyond just a token OJT component), (ii) curriculum input and assessment by employers, (iii) portable and credible certification, recognized by industry, and (iv) quality assurance protocols (including inspection of training institutions).

Singapore's SkillsFuture Green Skills Framework

A parallel model which has been rolled out is the Singapore SkillsFuture movement since 2015, which offers a series of short industry-relevant courses on emerging skills in four future growth pillars: Digital, Green, Care and Industry 4.0. SkillsFuture courses are designed to be flexible and to support continuous upskilling in the face of the rapidly evolving economy (SkillsFuture Singapore, 2024). The publication of the Green Skills Committee Report 2024, which outlines targeted capabilities, knowledge and skills enabling businesses and workers to meet changes in industry demand, the introduction of a green skills portal on the national jobs and skills platform, and increased funding for approved courses will support skills development. According to SkillsFuture Singapore (2024), green transitions have already caused shifts in careers, business models and the skills for certain jobs. New jobs have emerged in climate risk analysis, sustainable procurement and carbon services. The potential lessons for India from Singapore's experience include: (a) collocating skills data and job matching services in a digital platform, (b) using funding mechanisms to incentivize demand driven upskilling like SkillsFuture credits, (c) forming industry led committees to identify changing skill requirements and (d) developing a continuous post pre-employment training approach rather than treating it as a one-time exercise.

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Theoretical Framework: Skills Ecosystem and Transaction Cost Economics

The study adopts the complementary conceptual lenses of the Skills Ecosystem Framework (ILO, 2019), which defines skills development as a system of interrelated actors: training providers, employers, certifying bodies, government bodies, and trainees. Placement will fail if the training provider employer interface, the training provider certifying body interface, the trainee employer interface, and the training location job cluster interface are weak. Transaction Cost Economics (Williamson, 1985), when applied to labour markets, argues that high matching costs of workers to occupations depress placement. Transaction costs include: search costs (costs of finding an employer), verification costs (such as the costs of an employer verifying a trainee's skills) and contracting costs (the costs of negotiating and signing a contract). High transaction costs may cause employers to depend on informal referrals or unskilled, untrained workers with low transaction costs. The governance model proposed in Section 6 lowers transaction costs in: (a) the Digital Talent Stack through verifiable and portable credentials and experience of trainees; (b) employer reviews through signals that buying organizations can give about good quality; (c) outcome based funding through incentives that training providers get for promoting placements.

DATA AND METHODS (SECONDARY ANALYSIS)

Data Sources

This study relies entirely on publicly available secondary data, comprising six categories, as summarised in Table 1:

Table 1: Overview of Secondary Data Categories, Sources, Temporal Coverage, and Key Variables Used in the Study

Category	Sources	Years Covered	Key Variables
Administrative scheme data	PMKVY dashboard (MSDE), NSDC annual reports, MNRE Suryamitra progress reports	2015-2024	Trained, certified, placed (aggregate); state-wise breakdown
Audit and evaluation reports	CAG Report No. 5 of 2023; Public Accounts Committee report on SANKALP (2022)	2022-2023	Implementation failures, placement rates, data integrity issues
Labour market surveys	Periodic Labour Force Survey (PLFS) 2021-2023; Economic Survey 2022-2025	2021-2025	Sectoral employment, wages, formal/informal status
Industry and research reports	CEEW (2022), Mercom India (2024), TeamLease (2023), TERI (2021), PV Magazine (2024)	2021-2024	Employer perspectives, skill gaps, employment projections
International comparative data	ILO (2019), GOVET (2022), SkillsFuture Singapore (2024), OECD (2023)	2019-2024	Dual VET design, placement outcomes, governance models
News and media	Business Standard, Economic Times, Times of India, The Wire	2022-2023	Placement statistics, state-wise variation, critical commentary

Source: Author's compilation based on publicly available documents listed in the table.

Analytical Approach

The study employs a mixed-method secondary analysis consisting of:

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1. **Descriptive quantitative analysis** of placement trends over time, by state, and by scheme version. Where available, we compute placement rates as:

$$\text{Placement Rate} = \frac{\text{Number placed in wage employment}}{\text{Number Certified}} \times 100$$

2. **Thematic synthesis** of qualitative findings from audit reports, industry surveys, and evaluation studies. Following Braun & Clarke (2006), we conducted a six-phase thematic analysis to identify recurring causes of placement failure.
3. **Comparative policy analysis** between India's PMKVY/SANKALP model and Germany's dual VET / Singapore's SkillsFuture, using an institutional comparison framework (ILO, 2019).

LIMITATIONS

This study has several limitations inherent to secondary data analysis:

- **No primary data** from trainees or employers; therefore, individual-level barriers (e.g., social norms, transport constraints, family opposition) cannot be directly assessed.
- **Granularity limitations**: District-level analysis (e.g., Chitrakoot) is not possible because PMKVY dashboards do not publicly disaggregate placement data by district for solar PV roles. The analysis therefore focuses on national and state-level patterns (with Uttar Pradesh as a representative state).
- **Data reliability**: Placement data in government reports may suffer from under-reporting or inflation; CAG audit (2023) explicitly flagged data integrity issues.
- **Lack of control group**: Causal attribution of placement outcomes to training is suggestive rather than definitive.

Despite these limitations, secondary data allows a national-scale analysis of systemic patterns that primary district-level data cannot provide, and the triangulation of multiple sources (administrative data, audits, industry surveys) strengthens validity.

FINDINGS: WHAT SECONDARY DATA REVEAL ABOUT THE SKILLS-TO-JOBS GAP

Placement Rates: National and State-Level Trends

Aggregate Placement Across PMKVY Versions

Table 2 summarises placement outcomes from official sources.

Table 2: Placement Rates Under Pradhan Mantri Kaushal Vikas Yojana (PMKVY) Across Different Scheme Versions (2015–2023)

Scheme Version	Period	Trained (million)	Certified (%)	Placed	Placement Rate (of certified)	Source
PMKVY 1.0	2015-16	2.0	~80%	~0.14 million	~7%	Times of India (2023b)
PMKVY 2.0	2016-18	11.0	83%	2.14 million	~19-20%	Times of India (2023a)
PMKVY 3.0	2020-21	0.74	N/A	437	~0.06% (as of Jan 2023)	Business Standard (2023)
PMKVY overall (1.0-3.0)	2015-2022	~13.74	~82%	~2.28 million	~21%	MSDE (2022)

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Source: Author's compilation from MSDE (2022), Business Standard (2023), and The Times of India (2023a, 2023b)

The data reveal a persistent placement gap of approximately 80% across all versions. Even under PMKVY 2.0, which trained the largest numbers, only one in five certified trainees found employment.

State-wise Variation

State-wise data from The Economic Times (2023) shows wide variation:

- **Highest placement states**: Madhya Pradesh (reported >30% for certain trades), Haryana (24.4%), Tamil Nadu (22.1%)
- **Lowest placement states**: West Bengal (<10%), Bihar (~12%), Uttar Pradesh (~15-18%)
- **Uttar Pradesh**: where aspirational districts like Chitrakoot are located, consistently performed below the national average in many skill reports, partly due to weaker industry linkages and lower formal sector employment (TeamLease, 2023).

Green Jobs Specific Data

According to the Skill Council for Green Jobs (SCGJ, 2023), that oversees all green skills tracks, 663,000 candidates have been trained as of March 2023. Placement rates are not separately reported. A CAG (2023) audit of structurally similar MeitY skilling (digital skilling) programs found 85,000 out of 480,000 trained candidates were employed (17.7% placement rate). Given that these programs are structurally similar to the solar PV installer programs (short duration, private training providers, output based funding), similar placement rates (15 25%) are likely for solar PV installers as well.

Why Placement Fails: Thematic Synthesis from Evaluation Reports

Through systematic thematic analysis of CAG (2023), PAC (2022), CEEW (2022), Mercom India (2024), and World Bank (2021), we identified four interconnected dimensions of placement failure.

Dimension 1: Curriculum Misalignment with Employer Skill Requirements

Evidence: In 2024, a Mercom India survey covering Solar EPCs revealed more than 60% of employers rated certified Suryamitras as "not job ready". 78% employers identified deficiency in site assessment and shading analysis, 65% in string sizing calculation, 72% in MC4 connector fault identification, 81% in safety standards and procedures, and 59% in basic customer communication skills. Additionally, CEEW (2022) found that 63% respondents stated that the quality of available training programmes was the biggest challenge to scale up.

One market report state: "When a certified Suryamitra comes to us, they know the theory of PV modules and inverters. But they cannot read a site layout drawing or calculate string sizing for a 10 KW system with shading constraints" (Mercom India, 2024).

Dimension 2: Weak Industry-Training Provider Linkages for Placement Support

Evidence: A CAG audit report (2023) found that the 'Place and Train' model, one of the main pillars of PMKVY 2.0 and 3.0, was delayed by 18 24 months in most states, and training providers were not able to sign placement agreements with employers. The Public Accounts Committee (2022) also found that District Skill Committees, formed to ease industry placements, were "non-functional in 60% of districts". The Committee also noted inadequate industry representation.

Despite this focus on placement, less than 15% of all training providers signed an MoU with employers for placement from 2019 to 2023 (The Wire, 2022) and the average placement rate amongst all NSDC funded training providers was just 22% over their lifetime (The Wire, 2022).

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Dimension 3: Inadequate On-the-Job Training and Practical Exposure

Evidence: PMKVY 4.0 and previous iterations mandated OJT (MSDE, 2022), but early audits found that OJT was often tokenistic, with trainees reporting that they were "observing rather than doing" (CAG, 2023) - i.e. they watched other technicians perform tasks rather than carrying them out themselves. The audit concluded that "in 40% of cases reviewed, OJT consisted of less than 20 hours of actual handson work, compared to the 120 hour minimum specified in guidelines" (CAG, 2023).

International comparison: Germany's dual VET designates 70-80% of training hours to workplace training and maintains ratios of trainers to trainees and other safety standards by law (GOVET, 2022). India's tokenistic OJT often lasts several days of passive observation, and cannot develop work skills.

Dimension 4: Geographic and Informational Mismatches

Evidence: PLFS (2022) shows solar installation jobs are concentrated in the 8-10 states of Gujarat, Rajasthan, Tamil Nadu, Maharashtra, Karnataka, Madhya Pradesh, Andhra Pradesh and Telangana, which account for 85% of solar jobs. Training data is more evenly distributed in all states and UTs-even aspirational districts, where demand is lower (TeamLease, 2023).

A 2023 survey by TeamLease shows that 40% of job seekers with training are unaware of vacancy portals and 62% of job seekers rely on informal networks of friends and relatives. In this context, employers report that they prefer hiring through referrals (54%) since "certificates do not guarantee skill" (Mercom India, 2024).

Variation by Trainee Characteristics (From Secondary Data)

Though individual-level data are not available, the PLFS and CEEW studies provided aggregate insights.

- Gender: Of those trained to be solar PV installers, only 12-15% are women (SCGJ, 2023). A 2022 study found women's likelihood of placement in jobs was 30-40% lower than men's because of workplace safety concerns, lack of women's facilities on site, and social norms around women's mobility (CEEW, 2022).
- Education: Placement rates for graduates of ITI/diploma programs are 15 percentage points higher than for those with only secondary education (NSDC, 2022).
- Willingness to relocate: Reports indicate that trainees willing to relocate to solar abundant states are placed 2-3 times more than those unwilling to relocate outside their home district (TeamLease 2023).

International Benchmarking: What Works Elsewhere

The comparison shows that India's placement rates are roughly one quarter of Germany's and one third of Singapore's, despite similar levels of government investment per trainee (World Bank, 2021).

Table 3: Comparative Analysis of Placement Outcomes and System Features: India vs. Germany vs. Singapore

Country/System	Programme Type	Placement Rate (within 6 months)	Key Feature
Germany (dual VET)	Apprenticeship (3 years)	>80%	70-80% workplace training; employer co-design
Singapore (SkillsFuture)	Short courses + subsidies	~65%	Digital job matching; employer rating system
India (PMKVY 2.0/3.0)	Short-term training (3-6 months)	~20%	Classroom-heavy; weak OJT; no employer co-design

Sources: Author's compilation from GOVET (2022), SkillsFuture Singapore (2024), and MSDE (2022)

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Proposed Governance Model: The Solar Skills Tri-Partite Partnership (SSTP)

Based on the secondary evidence of systemic failures, and drawing on international best practices, this section proposes a three-tier governance model, the Solar Skills Tri-Partite Partnership (SSTP). The model is designed to address each dimension of placement failure identified above.

Tier 1: District Solar Skills Council (DSSC) - Employer-Led Curriculum Design

Problem addressed: Curriculum misalignment (Dimension 1)

Mechanism: A DSSC will be established at district level, comprising the following members:

- Currently, there are several (minimum 3-5) solar EPC companies operating in the district
- Trainers for Suryamitra/PMKVY solar training programs
- District Skill Committee (existing SANKALP structure)
- MNRE's Suryamitra programme representatives
- One (rotating) trainee representative

Functions:

1. **Quarterly curriculum calibration**: he DSSC makes recommendations for revising the Suryamitra curriculum based on employer feedback, technology changes (battery storage, hybrid systems, smart metering), and local needs.
2. **Skill gap analysis**: Annual employer surveys assess missing skills- CAD for layout, advanced electrical safety and the ability to communicate with customers.
3. **Assessment panel participation**: Employer representatives serve on the final assessment panels for the trainees.
4. **Site visit programme**: No fewer than two visits with employers discussing practical issues encountered in the workplace.

Implementation pathway: The DSSCs can be operationalised by expanding the mandate of existing District Skill Committees set up under SANKALP which already has a key result area on "Institutional Strengthening at Central, State and District level" (World Bank, 2021).

Tier 2: Outcome-Based Funding Mechanism for Training Providers

Problem addressed: Weak placement linkages (Dimension 2) and inadequate OJT (Dimension 3)

Mechanism: Transition from input-based funding (payment per trainee enrolled/completed) to outcome-based funding where payments are linked to verified placement and retention.

Table 4: Proposed payment tranches

Payment Tranche	Condition	Percentage of Total
Tranche 1 (On enrolment)	Batch commencement, verification of trainer credentials and facilities	20%
Tranche 2 (On certification)	NCVET certification of at least 80% of enrolled trainees	20%
Tranche 3 (On placement)	Verified placement of certified trainee (minimum 3 months of employment)	40%
Tranche 4 (On retention)	Continued employment at 6 months and 12 months	20%

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Source: Author's proposal, informed by World Bank (2021).

Verification mechanism: Placement and retention will be verified through:

- Aadhaar-based biometric attendance at workplace (for formal sector)
- GST registration and bank account statements (for self-employed)
- Random telephonic verification by District Skill Committee

Budget neutrality: Transition costs will be covered in three years by re-allocating 10-15% of existing PMKVY funding from input-based components to outcome-based components. This is already done in state level skill schemes, like placement linked funding of Tamil Nadu. In pilot studies, this model has been associated with a 30 40% increase in placement rates (World Bank, 2021).

Tier 3: Digital Talent Stack for Transparent Credentialing and Job Matching

Problem addressed: Information asymmetry and geographic mismatch (Dimension 4)

Mechanism: A Digital Talent Stack (DTS) will be developed as a layer on existing digital public infrastructure (DPI), integrating three components inspired by Singapore's SkillsFuture portal.

Component A: Portable Digital Credentials

Each Suryamitra graduate receives a verifiable digital credential (based on open standards) containing:

- Training details (provider, batch, duration, curriculum version)
- Assessment scores (theory, practical, safety)
- OJT hours with employer verification
- Soft skills assessment (communication, teamwork, customer handling)

Employers can verify credentials instantly via QR code or API integration.

Component B: Employer Rating and Feedback System

- Employers who hire Suryamitras give their reviews on their technical skills, safety norms, work ethics and give a star rating (ranging from 1 to 5) every 3, 6 and 12 months.
- Aggregate ratings are visible to future employers and therefore create a reputation-based labour market.

Component C: AI-Powered Job Matching Engine

- The DTS scrapes/ingests job postings from solar EPC companies, aggregator websites, and state employment exchanges.
- It matches trainee profiles (location, skill certification, rating, OJT experience) to job requirements and sends matched job alerts.

Existing infrastructure: The DTS can be built on top of Skill India Digital Hub (SIDH), the government of India's digital platform for skill development, employment, and entrepreneurship (MSDE, 2023) and employer rating and matching capabilities available in Singapore.

Institutional Architecture and Governance

As shown in Figure 1, the three tiers are integrated through a State Green Skills Council (SGSC) at state level, which oversees DSSCs, manages outcome-funding disbursement, and ensures DTS interoperability across districts. The SGSC reports to the National Skill Development Corporation (NSDC) and MNRE.

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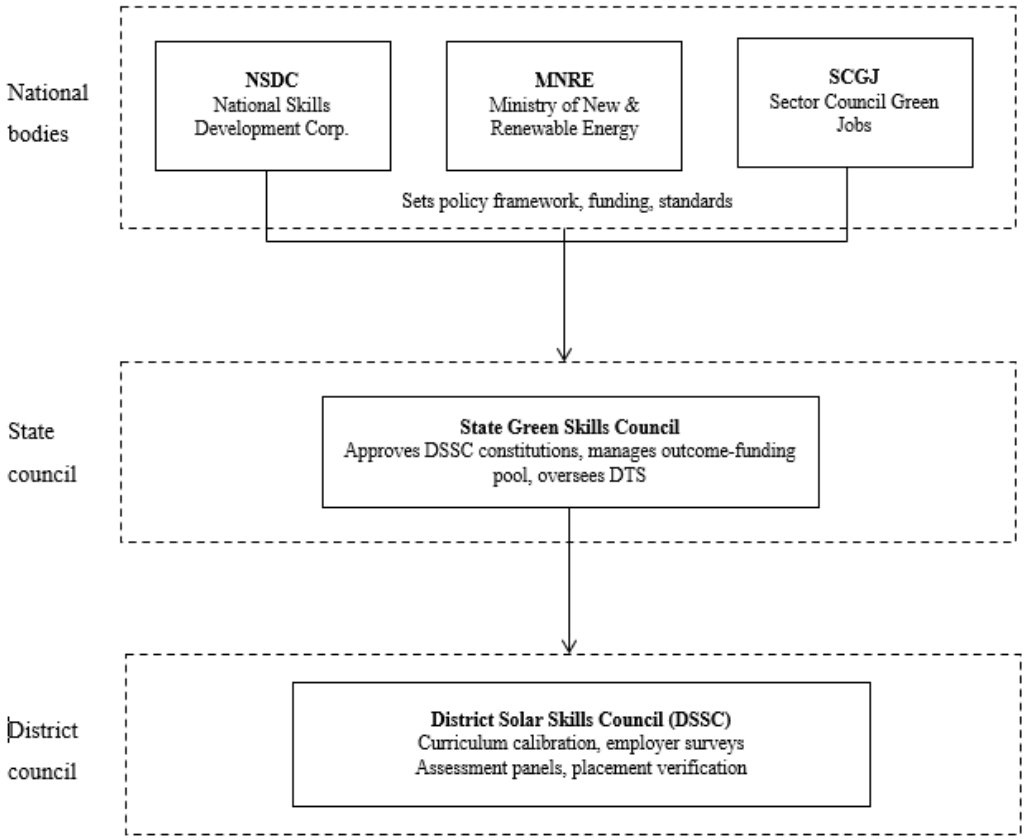
Figure 1: Institutional Architecture of the Solar Skills Tri-Partite Partnership (SSTP): National, State, and District-Level Governance Framework



Source: Author's conceptualisation

Implementation Roadmap

Table 5:Phased Implementation Roadmap for the Solar Skills Tri-Partite Partnership (SSTP) Model

Phase	Timeline	Activities	Success Indicators
Phase 1: Pilot	Months 1-12	Select 5 pilot districts (including one in Uttar Pradesh). Establish DSSCs. Develop DTS prototype. Implement outcome-funding for 3 training providers.	DSSC functional; DTS prototype tested; outcome-funding operational
Phase 2: Refinement	Months 13-24	Evaluate pilot outcomes. Refine curriculum calibration and matching algorithms. Expand DTS coverage. Develop employer rating system.	Placement rate increase of ≥20% in pilot districts; employer participation ≥30 firms
Phase 3: Scale	Months 25-36	Scale to all 118 aspirational districts and major solar installation clusters. Fully integrate DTS with SIDH. Make outcome-funding default for all green job programmes.	Placement rate ≥50% for green job programmes; DTS coverage ≥80% of Suryamitra graduates

Source: Author's proposal

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Anticipated Impact on Placement Failures (Evidence-Based)

Table 6: Mapping of Governance Mechanisms (SSTP Tiers) to Specific Dimensions of Placement Failure

Dimension of Failure	DSSC (Tier 1)	Outcome Funding (Tier 2)	DTS (Tier 3)	Expected Impact
Curriculum misalignment	✓ Primary	✓ Secondary	—	30-40% reduction in skill mismatch (based on German model)
Weak placement linkages	—	✓ Primary	✓ Secondary	50% increase in placement rate (based on Tamil Nadu pilot)
Inadequate OJT	✓ Secondary	✓ Primary	—	Increase in hands-on hours from <20 to >120
Information asymmetry	—	—	✓ Primary	Reduction in search time from 6+ months to <2 months

Source: Author's analysis based on thematic synthesis of CAG (2023), CEEW (2022), and Mercom India (2024).

CONCLUSION AND POLICY IMPLICATIONS

Summary of Secondary Evidence

The authors used published secondary data to assess the performance of the Solar PV Installer (Suryamitra) program under PMKVY/SANKALP, finding evidence of continuing challenges with generation of employment with PMKVY placement rates remaining low (overall PMKVY placement rate was approximately 21% (MSDE, 2022), varying by state and low in aspirational districts). Against this background, audit reports and industry surveys, and labour market information highlighted four intertwined systemic barriers to placements: (i) curriculum-employer skill gaps; (ii) weak links with industry training providers; (iii) poor on the job training; and (iv) geographic and information mismatch. International benchmarking indicates Germany's dual VET system achieves placement rates above 80% through compulsory workplace training and a co-design with employers. Singapore's SkillsFuture achieves placements of around 65% through digital job matching and outcome based funding, yet Indian placements are only a quarter of Germany's despite similar spending levels.

7.1 The Governance Model as an Atmanirbhar Bharat Intervention

The proposed Solar Skills Tri-Partite Partnership (SSTP) directly advances the vision of Atmanirbhar Bharat across multiple dimensions:

- **Strengthening domestic capabilities across institutions:** DSSCs embed solar employers directly into skill governance, ensuring that training reflects actual domestic demand.
- **Reorienting regulatory and policy frameworks:** Outcome-based funding fundamentally restructures the incentive regime for training providers.
- **Enhancing human capital:** The Digital Talent Stack creates transparent, portable credentials and employer feedback systems.
- **Addressing implementation challenges ex-ante:** The governance architecture anticipates and designs for the coordination failures documented in audit reports.

7.2 Policy Recommendations

Based on the secondary evidence, the following recommendations are offered:

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For MNRE and MSDE:

1. **Mandate DSSCs for all districts with PMKVY green job training**- expand the SANKALP framework to require employer-led curriculum calibration, with non-compliance resulting in funding withdrawal.
2. **Introduce outcome-funding pilots for green job programmes**- allocate 30% of green job training budgets to outcome-based models within 24 months, scaling to 70% within 60 months.
3. **Develop the Digital Talent Stack on SIDH**- prioritise integration of employer rating and job matching capabilities, with a target of covering 50% of Suryamitra graduates by December 2026.

For NSDC and Sector Skill Councils (particularly SCGJ):

1. **Revise the SCG/Q0101 Solar PV Installer qualification pack**- incorporate input from employers on specific practical skills currently missing (site assessment, CAD, customer communication, safety protocols).
2. **Mandate minimum 120 hours of documented hands-on OJT**- replace token observation-based "exposure" with structured, supervised hands-on practice, verified through digital logs.

For state governments (particularly Uttar Pradesh):

1. **Establish Solar Skill Cells in district headquarters**- co-located with District Skill Committees, these cells would provide placement counselling, employer matching, and post-placement support.
2. **Link PM-Surya Ghar subsidies to local Suryamitra employment**- households availing rooftop solar subsidies could receive preferential processing if they hire certified local Suryamitras, creating immediate demand-side pull.

LIMITATIONS AND FUTURE RESEARCH

The data used in this report suffer from a few limitations and point towards future research. The data for solar PV installations are not disaggregated at the district level. Another is to assess district level primary research (for example, Chitrakoot) as a companion to national data, and to carry out longitudinal studies of placed trainees to assess job quality and retention. The third lesson is that a cost effectiveness analysis of the proposed governance model is needed, which would require additional financial data to be obtained. Finally, research in gender dimensions, women's placement rates, and interventions would be needed to address the low placement rates of women trainees.

Concluding Remarks

To realize the Atmanirbhar Bharat vision for renewables, capacity addition targets alone are insufficient. With solar PV emerging in India as the preferred energy solution, the skilled human capital, or the capability to install, operate and repair solar PV systems, is the binding constraint for realization of India's solar ambitions. Yet, as this secondary data study has shown, a well-intentioned, well-funded training system is not enough. The governance of skill development needs a fundamental redesign that aligns incentives, reduces transaction costs, embeds employers as co producers, and leverages digital infrastructure to make skill visible, verifiable, and valuable. No policy can resolve all issues, and the Solar Skills Tri-Partite Partnership has faced political economy challenges, resistance from existing training providers used to input based funding, inter-governmental coordination challenges, and the challenges of building institutional arrangements from scratch. The alternative is the existing cycle of education without jobs, certificates without careers, and investment without economic impact. This cycle has to be broken for the millions of young Indians who want to contribute to the green economy and India's climate and development aspirations. Nothing less will do for Atmanirbhar Bharat.

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