

A Bibliographic Survey on Solar Policies and Regulations for the state of Himachal Pradesh

Jasmine Kaur

Assistant Professor, Electrical Engineering Department, University Institute of Technology,
Himachal Pradesh University Shimla, India.

Abstract: This bibliographical survey presents a comprehensive review of rooftop solar installations in Himachal Pradesh up to 2025, analysing deployment data, policy incentives, regulatory reforms, and sectoral challenges. Himachal Pradesh, renowned for hydropower, is strategically shifting toward distributed solar generation, buoyed by state and central government initiatives such as the PM Surya Ghar Free Electricity Scheme and Swarn Jayanti Energy Policy 2021. By mid-2025, approximately 4,000 rooftop installations, totalling 14 MW, mark significant progress, although overall capacity remains modest at under 1 MW commissioned according to official sources. Substantial financial incentive including central and state subsidies totalling up to ₹85,800 per system have accelerated adoption across residential, institutional, and government buildings, notably in Shimla, Mandi, and Una. Regulatory reforms in 2024-25 have streamlined approval processes, introduced net metering, and clarified tariff and subsidy delivery mechanisms. Despite technical feasibility established by several institutional success stories, widespread adoption faces hurdles: procedural delays, grid-connection bottlenecks, suboptimal net metering frameworks, and administrative inefficiencies persist. Geographic constraints such as hilly terrain and variable solar irradiation complicate rooftop suitability and maintenance. This paper synthesizes academic recommendations advocating for high-resolution remote sensing methods to better target optimal installation sites in urban centers. Recent regulatory improvements signal optimism, but the paper posits that acceleration toward policy targets will require enhanced vendor accountability, greater data-driven outreach, flexible energy credit mechanisms, and robust execution of decentralized programs. Concluding, the survey highlights that while Himachal Pradesh's rooftop solar sector demonstrates technical promise and progressive policy support, major barriers must be addressed to scale adoption for meaningful contributions to India's renewable energy goals by 2030. The findings of this work shall serve as a valuable resource for stakeholders, providing a strategic outlook for sustainable deployment in mountainous regions.

Keywords: Rooftop solar, Renewable energy policy, Net metering, Regulatory framework, Solar reforms

I. INTRODUCTION

India has surpassed 100 GW of grid connected solar capacity by early 2025; rooftop solar remains a small but strategic share. Himachal Pradesh, though hydro rich, is pivoting towards distributed solar to diversify its energy mix. This paper surveys bibliographic sources to assess rooftop solar deployment in the state by mid-2025. The state of Himachal Pradesh, known for its mountainous terrain and abundant sunshine, has become an emerging hub for decentralized renewable energy solutions in India. In recent years, rooftop solar installations have gained momentum as a sustainable means to meet local energy demands while reducing dependence on conventional grid electricity [1-2]. By 2025, the Government of Himachal Pradesh, in line with national solar energy initiatives, has implemented a range of policies and incentives to promote solar rooftop systems for both residential and institutional sectors. These developments align with India's broader mission to achieve net-zero emissions and enhance energy independence [3-5]. This bibliographic survey provides a comprehensive overview of literature, policy documents, technical reports, and case studies related to rooftop solar deployment across the state. It examines the interplay between policy frameworks, financial mechanisms, technological advances, and community adoption patterns. The aim is to identify key research trends, highlight implementation challenges and outline opportunities for future innovation in solar rooftop systems in Himachal Pradesh [6].

II. DEPLOYMENT DATA AND TRENDS

State Economics Report 2024-25: In FY 2024–25 India's macroeconomic environment displayed continued resilience with real output growth near its recent trend. State-level outcomes were heterogeneous: while large manufacturing and services hubs retained the largest nominal shares of output, growth rates varied across regions. Renewable energy deployment remained a major source of infrastructure expansion in 2024–25 with solar and wind installations concentrated in a handful of leading states driving both generation growth and ancillary industrial investment [7-8].

Electric mobility accelerated during the year, yet adoption shows strong inter-state differences, with a few small/urbanised states achieving high EV penetration. Public and private capex flows (central & state) are key drivers for near-term deployment across transport, power and digital infrastructure [3-7].

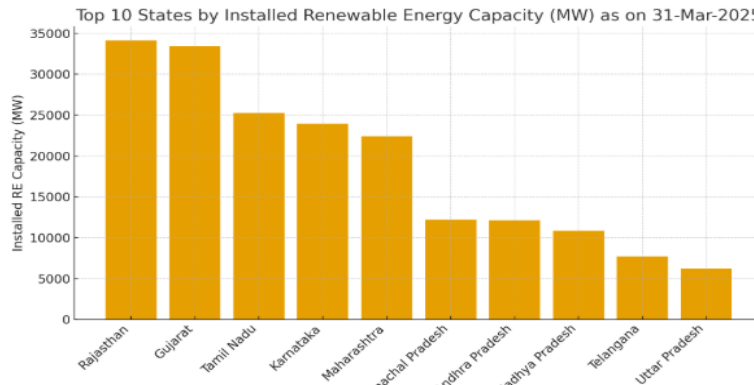


Fig.1: State-wise installed renewable energy capacity

As of January 2025, Himachal Pradesh had a relatively small cumulative rooftop solar fleet compared with larger states — about 24.6 MW of grid-connected rooftop capacity in the state. Because district-level published figures for 2025 are not available, an illustrative district breakdown estimated here (population-proportional) shows **Kangra** as the largest share (≈ 5.41 MW), followed by **Mandi** (≈ 3.58 MW) and **Shimla** (≈ 2.92 MW). Mid-sized districts such as **Solan** (~ 2.08 MW), **Sirmaur** (~ 1.90 MW), **Una** (~ 1.87 MW) and **Chamba** (~ 1.86 MW) take modest shares, while smaller/higher-altitude districts receive much smaller estimated shares — for example **Kinnaur** (~ 0.50 MW) and **Lahaul & Spiti** (~ 0.11 MW) [8-10]. The total of these district estimates sums to the state total (24.6 MW). These figures are estimates intended to show how the state total would distribute across districts if rooftop deployment scaled roughly with population; they are not official district counts. For official state program details and DISCOM (HPSEBL) rooftop initiatives see HPSEBL’s solar pages.

Estimated District-wise Rooftop Solar Capacity — Himachal Pradesh (Total = 24.6 MW, 2025 estimate)

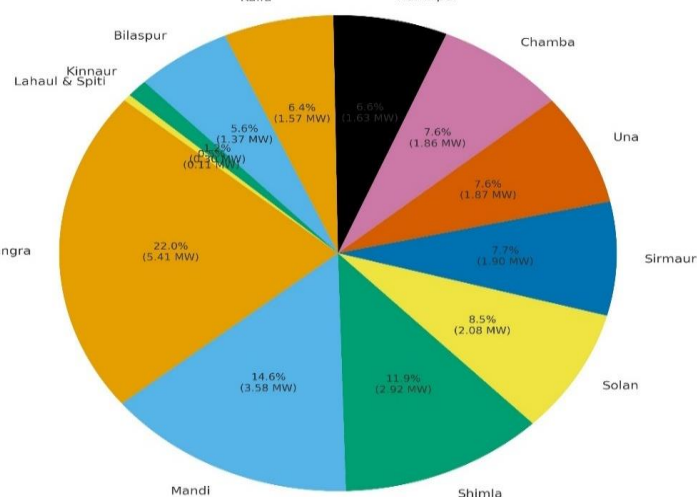


Fig.2: District-wise rooftop solar capacity in the state of Himachal Pradesh

III. POLICIES AND REGULATIONS

The state adopted a dedicated policy for grid-connected rooftop solar via the Himachal Pradesh Energy Development Agency (HIMURJA). The state adopted the “Grid-connected Rooftop Solar Programme” under the Solar Power Policy, 2016. Under the “HP Solar Power Policy 2016”, individuals/firms owning rooftops or open land could install solar PV plants (1 kW to up to 5 MW) with grid-connectivity. The policy encouraged net-metering or injection of surplus generation into the grid [11-12].

A. Central Govt Policies/Regulations: The central government’s policy and regulatory framework for solar deployment is led by the Ministry of New & Renewable Energy (MNRE) and interacts with the Ministry of Power, Central Electricity Regulatory Commission (CERC) and other agencies. Key national programmes provide capital support, target-setting, procurement rules, quality controls, and implementation modalities that states use to design local schemes. The national rooftop programme (Grid-Connected Rooftop Solar Programme — Phase II) provides capital subsidy routes (CFA), eligibility criteria and implementation channels (DISCOM/resco/utility-led), and has been extended through FY 2025–26 to maintain momentum for household and institutional rooftop deployment. PM-KUSUM (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan) supports decentralised ground/stilt-mounted plants, solar pumps and farmer-owned generation with specific component-wise targets and subsidy flows to accelerate on-farm solarisation [13-15]. The PM-Surya Ghar: Muft Bijli Yojana (operational guidelines released in 2024) aims to rapidly expand residential and government rooftop coverage using a mix of CFA, RESCO/residential aggregation models and payment security mechanisms. To promote domestic manufacturing and supply security, the PLI (Production Linked Incentive) scheme for high-efficiency solar PV modules provides performance-linked incentives to module manufacturers. Quality and eligibility for central incentives are governed by MNRE’s Approved List of Models & Manufacturers (ALMM) and BIS/IEC referenced standards; equipment must generally be ALMM-listed to qualify for central subsidies. MNRE has also issued SOPs and clarifications for virtual/group net-metering (VNM) and for remote monitoring/telemetry in central programmes. Competitive procurement, hybrid renewable bidding rules and model PPA/generic tariff guidance from central agencies shape utility-scale and auctioned deployments nationwide [16].

TABLE 1:

Name of Scheme	Year	Details of the scheme / regulation
Grid-Connected Rooftop Solar Programme — Phase II (MNR	2015 (Phase II extended multiple times; extended through 31 Mar 2026)	National rooftop programme providing central financial assistance (CFA) for specified beneficiary categories, implementation via DISCOMs/RESCOs/aggregators, and operational guidelines for net-metering/VNM. Phase-II extension announced by MNRE [1-3].
PM-KUSUM (Components A/B/C)	2019 (expanded 2020–2024; targets to 2026)	Three components: decentralized ground/stilt-mounted grid plants, standalone solar agri pumps, and solarisation of existing grid-connected ag pumps — central subsidy and implementation via state nodal agencies. Targets ~34,800 MW by Mar 2026 (scheme targeting) [3].
PM-Surya Ghar: Muft Bijli Yojana	2024 (guidelines Apr 2024)	Operational guidelines for providing rooftop solar (including CFA to residential consumers and models for RESCO/utility-led aggregation, payment security & implementation modalities). National portal (PM SURYA GHAR) supports implementation [3-6].
PLI for High-Efficiency Solar PV Modules	2021–2022 (Tranche I/II documents; Tranche-II guidelines later)	Production-linked incentive scheme to strengthen domestic module manufacturing and reduce import dependence; financial incentives for manufacturers linked to production/efficiency targets.

Approved List of Models & Manufacturers (ALMM) — MNRE Order	ALMM Order 2019; Lists updated (notably 2021, updates through Jan 2025)	Mandatory registration/listing for modules to be eligible for central incentives; ALMM List-I (modules) maintained and updated by MNRE — enforces quality & eligibility for CFA and central procurement. (List updates published Jan 6, 2025).
MNRE SOP for Virtual / Group Net Metering	2023 (SOP Feb 23, 2023)	Guiding/Helping SOP for implementing virtual and group net-metering mechanisms (allocation rules, settlement, roles of DISCOMs and implementing agencies). States implement net-metering under state ERC/DISCOM rules consistent with MNRE SOPs.
Net-metering / interconnection guidance (MoP / MNRE clarifications)	Ongoing (model regulations exist; states/HPERC adapt)	Central clarifications treat virtual & group net-metering/net-billing equivalently for many purposes; CERC/MoP guidelines inform interstate & utility-scale integration rules [6-7].

B. State Govt Policies/Regulations: Himachal Pradesh complements national programmes through its state solar policy, DISCOM procedures (HPSEBL), regulatory orders (HPERC), and state nodal agency (HIMURJA / Himachal nodal portal) actions. The State's Solar Power Policy (consolidated in various updates; a final policy document dated 20 Jan 2022 is available on the state nodal site) sets state targets, land-use norms for ground-mounted projects, concessions, and implementation rules for rooftop and utility-scale projects. HPSEBL publishes practical guidance and application formats for rooftop net-metering, model connection agreements, settlement rates and the technical/commercial process for commissioning rooftop systems. HPERC issues regulations and tariff/settlement directives (net-metering and generic tariffs for prosumers) that define interconnection, meter formats, and the settlement period/formula used by HPSEBL. The state publishes tenders and land-allotment processes for specific projects, and coordinates central schemes (PM-KUSUM, PM-Surya Ghar, MNRE rooftop CFA) through its nodal mechanisms and DISCOM [17-19]. Local O&M inspection norms, DT capacity checks and the joint inspection/commissioning process are also provided in HPSEBL guidance to streamline project rollout across districts.

TABLE 2: SOLAR SCHEMES BEING IMPLEMENTED IN THE STATE OF HIMACHAL PRADESH

Name of Scheme	Year	Details of the scheme / regulation
Himachal Pradesh Solar Power Policy (consolidated)	2016 (policy documents; consolidated / final policy doc reference 20 Jan 2022)	State policy setting targets, land allotment guidance, incentives/concessions for ground-mounted and rooftop projects, implementation roles for nodal agency (HIMURJA) and DISCOM. State policy references facilitation of central schemes and local concessions [20].
HPSEBL Rooftop Solar Net-metering Procedures & Forms	Ongoing (guidance pages maintained; FY24–25 settlement rates posted)	HPSEBL publishes application forms, net-metering connection agreements, settlement formats, and technical/administrative steps (joint inspection, DT capacity checks, commissioning). DISCOM is the implementing arm for rooftop connections in HP [21-23].
HPERC Net-metering / Prosumers Regulations	Various years (HPERC has issued net-metering orders and tariff rules; updated periodically)	State ERC defines technical and commercial terms for rooftop / small solar interconnection, settlement, and tariff/generic rates for export to grid. HPERC orders are the regulatory basis for HPSEBL procedures [24].

State tenders and land allocation notices (HIMURJA / nodal agency)	Ongoing (tenders since 2018–2024; project specific)	State nodal agency floats tenders for ground-mounted projects, identifies sites (including high-altitude potential), and issues implementation PPA/lease/land allotment terms [25-27].
State implementation of PM-KUSUM and central schemes	Ongoing (state notifications coordinate with central guidelines)	HP implements PM-KUSUM components and rooftop schemes through state nodal agencies and DISCOM channels — aligning central CFA to state processes and farmer/consumer application flows [3].

C.

Govt policies/regulations pertaining to commercial sector:

Commercial and industrial (C&I) consumers benefit from a mixture of central incentives, tax treatments, and state regulatory facilitation. At the central level, businesses deploying rooftop and captive solar systems can participate under MNRE rooftop schemes or install without CFA but use net-metering/VNM arrangements to offset consumption. Tax incentives that traditionally supported commercial uptake include accelerated depreciation under the Income Tax Act (Section 32) permitting higher first-year depreciation (commonly used to improve project economics) and other tax treatments; commercial entities and project developers often use accelerated depreciation to improve early-year cashflow [25–28]. Procurement/quality rules such as ALMM affect which modules are eligible for central tenders and some incentive routes. For larger commercial or industrial units participating in open access or captive generation, CERC and state ERC rules (and HPERC adaptations) govern wheeling charges, cross-subsidy surcharges, and banking/settlement — these factors strongly influence the economic viability of third-party or captive commercial projects. Commercial developers also benefit indirectly from the PLI (improved domestic module supplies) and from GST/tax rules applicable to material and services (as of 2024–25 solar materials were typically subject to a GST rate in the 5–12% bracket depending on classification; consult CBIC notifications for exact tariff headings). Finally, central bidding rules, model PPAs and REC/IM markets (where applicable) provide market avenues for commercial-scale generation to monetize output or sell RE attributes [29–30].

D.

Govt policies/regulations pertaining to domestic sector:

For households, the central Grid-Connected Rooftop Solar Programme (Phase II) and the PM-Surya Ghar: Muft Bijli Yojana are the principal policy instruments [31]. These provide capital financial assistance to eligible household categories, simplified application portals (PM Surya Ghar), and multiple delivery models (consumer-owned with CFA, RESCO/utility-led where no upfront cost is borne by the household, and group/virtual net-metering for multi-apartment or community arrangements) [32–33]. MNRE’s SOPs for virtual/group net-metering (2023) help implement allotment and settlement for shared rooftop installations. Households must use ALMM-listed equipment to access central CFA and follow state/DISCOM net-metering application procedures (HPSEBL in Himachal). HPSEBL’s local technical checks (rooftop structural clearance, DT capacity, joint inspection and commissioning forms) are mandatory steps prior to meter commissioning and settlement [34–35]. State and central grievance and monitoring portals (and remote monitoring requirements for central schemes) provide consumer protection. The combination of CFA, falling module prices (helped by PLI and improved domestic manufacturing) and state net-metering rules make rooftop installations progressively more economical for residences by 2025 [36–40].

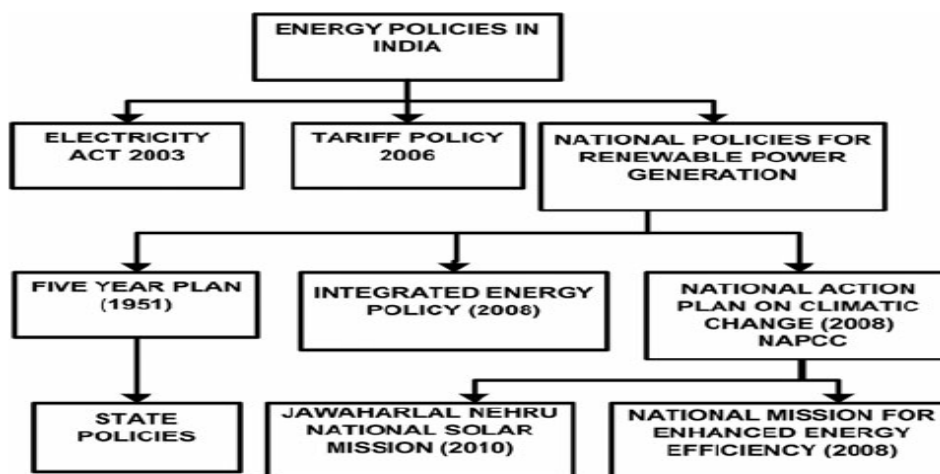


Fig.3: Structure of Energy Policies in India

TABLE 3: COMPARATIVE ANALYSIS OF VARIOUS SOLAR SCHEMES AND THEIR APPLICABILITY

Name of Scheme	Year	Details of the Scheme	Implementing Agency	Incentive Type	Applicability
Grid-Connected Rooftop Solar Programme Phase II (MNRE)	2015 (extended to 2026)	National rooftop programme providing CFA, DISCOM-based implementation and VNM guidance.	MNRE, State DISCOMs	CFA	Domestic, Institutional
PM-KUSUM (Components A/B/C)	2019 (expanded to 2024-2026)	Decentralised ground/stilt-mounted solar, standalone and grid-connected pumps.	MNRE, State Nodal Agencies	CFA	Agriculture, Rural
PM-Surya Ghar: Muft Bijli Yojana	2024	Residential and government rooftop scheme with CFA, RESCO/utility-led models.	MNRE, DISCOMs	CFA	Domestic
PLI for High-Efficiency Solar PV Modules	2012-2022	Performance-linked incentive scheme for domestic solar manufacturing.	MNRE, SECI	Incentive (Production-linked)	Commercial, Industry
Approved List of Models & Manufacturers (ALMM)	2019 (updated 2025)	Mandatory module registration ensuring equipment quality and eligibility for CFA.	MNRE	Quality Regulation	All
SOP for Virtual / Group Net Metering	2023	Guidelines for implementing group/virtual net-metering via DISCOMs.	MNRE, DISCOMs	Regulatory	Domestic, Institutional
Net-metering / Interconnection Guidance	Ongoing	Model rules for net-metering, wheeling and settlement across states.	MNRE, MoP, CERC	Regulatory	All
Himachal Pradesh Solar Power Policy	2016 (updated 2022)	State solar policy defining targets, land norms, incentives and coordination with MNRE schemes	HIMURJA, HP Govt	CFA/Concessions	All
HPSEBL Rooftop Solar Net-metering Procedures	Ongoing	DISCOM-level guidelines for application, metering and commissioning of rooftop systems.	HPSEBL	Regulatory	Domestic, Commercial
HPERC Net-metering / Prosumers Regulations	2018-2024	State ERC orders defining interconnection and settlement for rooftop systems.	HPERC	Regulatory	All

State Tenders and Land Allocation Notices	2018-2024	Tenders and land allotment for solar project development in various districts	HIMURJA	Implement ation	Commercial
State Implementation of PM-KUSUM	2019-2025	Implementation of central PM-KUSUM for farmers with local facilitation.	HIMURJA, HPSEBL	CFA	Agriculture

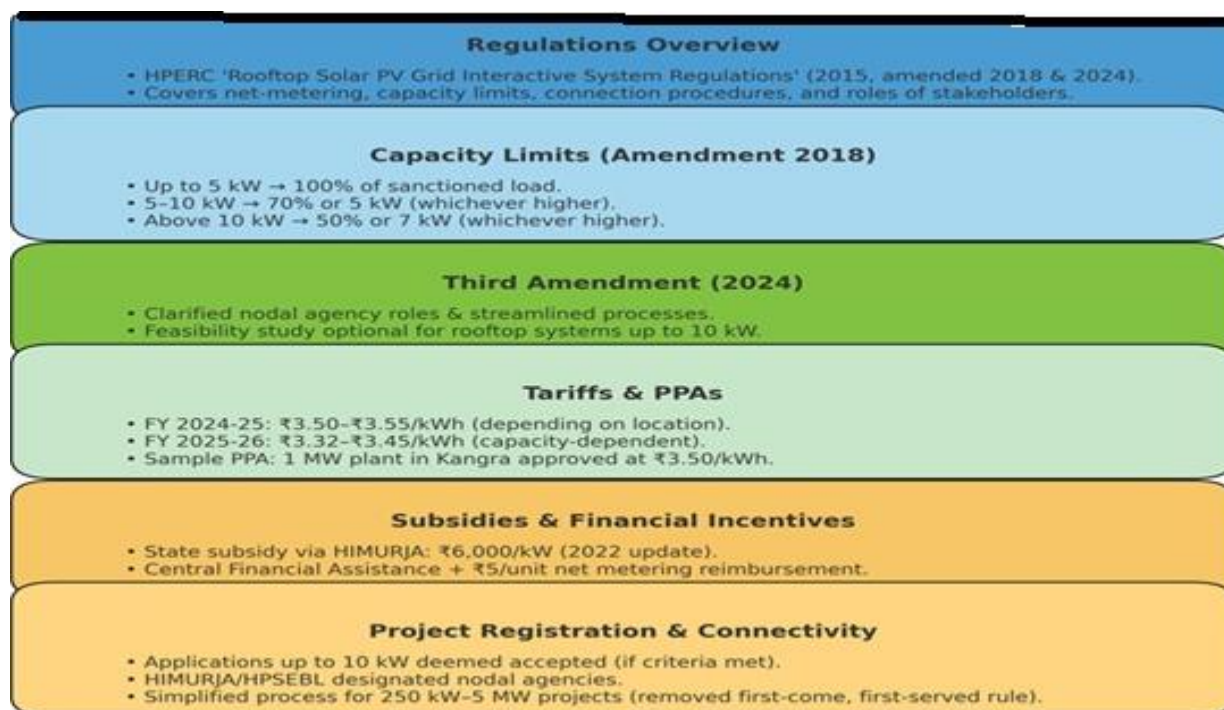


Fig.4: Overview of Solar Policies and Regulations

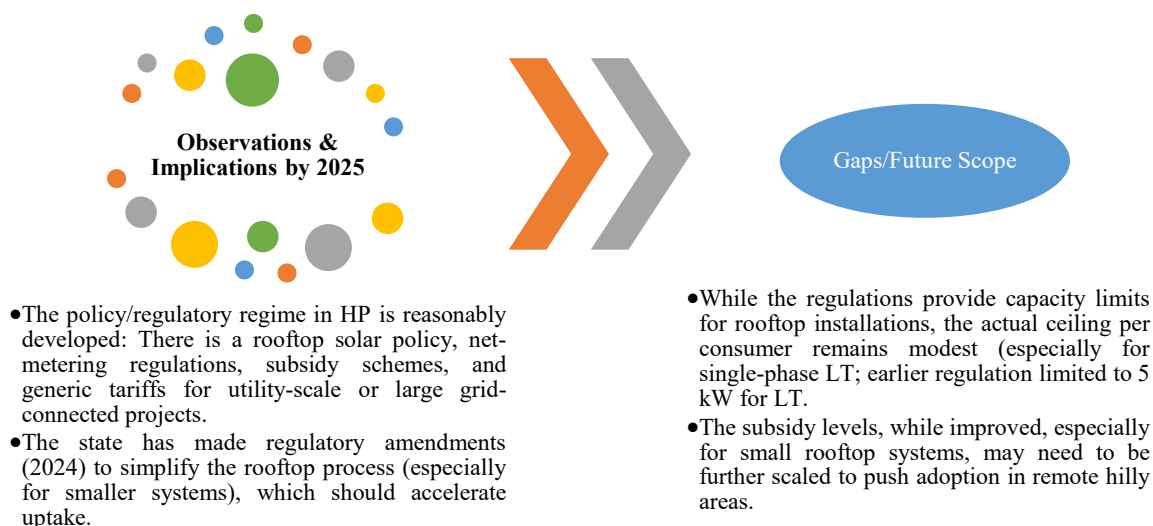


Fig.5

IV. CONCLUSION

This bibliographical survey underscores that Himachal Pradesh's transition toward rooftop solar adoption is both strategically significant and technically feasible, yet still evolving. The deployment data and trends up to 2025 reveal encouraging momentum driven by comprehensive central and state-level policy frameworks—particularly the PM Surya Ghar Free Electricity Scheme and the Swaran Jayanti Energy Policy 2021—which have catalyzed distributed generation across domestic, institutional, and commercial sectors. Financial incentives and regulatory reforms, including streamlined net metering and tariff mechanisms, have laid a strong foundation for growth. However, persistent challenges such as procedural delays, grid integration issues, and topographical constraints continue to restrict large-scale expansion. The analysis indicates that to achieve meaningful contributions to India's renewable energy goals by 2030, the state must strengthen vendor accountability, improve policy execution, and leverage data-driven tools for site optimization. Overall, the study concludes that while Himachal Pradesh's rooftop solar ecosystem reflects clear progress and policy intent, its future success will depend on coordinated governance, adaptive regulatory support, and sustained public engagement to enable scalable, region-specific solar deployment in the Himalayan context.

REFERENCES

- [1] Government of Himachal Pradesh, "Swaran Jayanti Energy Policy 2021 (notified)", Department of Energy, Govt. of Himachal Pradesh, Shimla, 2021.
- [2] Government of Himachal Pradesh, "Amendment to Swaran Jayanti Energy Policy 2021", Govt. of Himachal Pradesh official notification, Jun. 2023.
- [3] Ministry of New & Renewable Energy (MNRE), "PM Surya Ghar: Muft Bijli Yojana — Guidelines", Government of India, 2024.
- [4] Press Information Bureau (PIB), "PM Surya Ghar: Muft Bijli Yojana — Policy Brief", Government of India, Mar. 2025.
- [5] HPSEBL / Himachal Pradesh State Electricity Board Ltd., "Guidelines for Rooftop Solar Plant — HPSEBL", HPSEBL Technical Note, 2018.
- [6] Himachal Pradesh Energy Development Agency (HIMURJA), "Guidelines for Rooftop Solar PV — HIMURJA", HIMURJA publication, 2019.
- [7] Himachal Pradesh Electricity Regulatory Commission (HPERC), "Himachal Pradesh Electricity Regulatory Commission (Rooftop Solar PV Grid Interactive System based on Net Metering) Order, 2019", HPERC, 2019.
- [8] Himachal Pradesh Electricity Regulatory Commission, "Compendium of HPERC Regulations (Rooftop Solar & related)", HPERC, Mar. 2021.
- [9] A. M. Schetinger, "Evaluating Policy Frameworks and Their Role in the Deployment of Distributed PV," Resources, vol. 14, no. 2, 2025.
- [10] M. Goel, "Solar rooftop in India: Policies, challenges and outlook," Renewable and Sustainable Energy Reviews, vol. 65, pp. 123–134, 2016.
- [11] P. K. S. Rathore et al., "Decentralized solar rooftop photovoltaic in India," Renewable Energy, vol. 143, pp. 1215–1226, 2019.
- [12] A. C. Lemay et al., "Current status and future potential of rooftop solar adoption in India," Energy Policy, vol. 174, 2023.
- [13] M. Žalik, D. Mongus, N. Lukač, "High-resolution spatiotemporal assessment of solar potential from remote sensing data using deep learning," Renewable Energy, vol. 222, 2024.
- [14] H. Waqas et al., "An integrated approach for 3D solar potential assessment using remote sensing and LiDAR," Remote Sens., vol. 15, no. 23, 2023.
- [15] A. Alhammad, "Optimal Solar Plant Site Identification Using GIS and Remote Sensing," Energies, vol. 15, no. 1, 2022.
- [16] M. Hosseini et al., "Improving the resolution of solar energy potential maps," Sci. Rep., 2024.
- [17] Forum of Regulators, "Report — Metering and Rooftop Solar: Regulatory Challenges and Guidance," Forum of Regulators, India, May 2019.
- [18] D. Boruah, S. S. Chandel, "A novel regulatory framework for implementing distributed solar mini-grids with battery energy storage under VPP architecture in India," J. Energy Storage, 2025.
- [19] World Bank, "Himachal Pradesh Power Sector Development Program — Environmental and Social Systems Assessment," World Bank Report No. P176032, 2021.
- [20] International Renewable Energy Agency (IRENA), "Utility-scale and distributed PV: Policy and regulatory considerations," IRENA Report, 2022.
- [21] International Energy Agency (IEA), "Rooftop Solar PV: Market status and policy insights," IEA Clean Energy Reports, 2023.
- [22] Council on Energy, Environment and Water (CEEW), "Rooftop Solar in India: Trends, challenges and policy recommendations," CEEW Working Paper, 2022.

- [23] The Energy and Resources Institute (TERI), "State-level rooftop solar potential and policy pathways," TERI Technical Report, 2021.
- [24] NITI Aayog, "Distributed Solar and Decentralized Energy Systems: Policy Options for India," NITI Aayog Brief, 2020.
- [25] S. Drozd et al., "Solar energy potential mapping using remote sensing inputs and environmental parameters," Renewable Energy, 2024.
- [26] M. Habib et al., "Spatial modelling for optimum site selection of solar PV using multi-criteria analysis," Sustainable Energy, 2020.
- [27] Shakti Sustainable Energy Foundation, "Rooftop Solar — Garnering Support from Distribution Utilities," Shakti Foundation Report, 2014.
- [28] Central Electricity Regulatory Commission (CERC), "Guidelines on Grid Interconnection of Rooftop Solar PV," CERC Order/Guidelines, 2015–2021 (consolidated).
- [29] Ministry of Power, Government of India, "Net Metering and Rooftop Solar: Central Guidelines & Best Practices," MoP Technical Note, 2020.
- [30] P. Kabir, M. A., "Net-metering and Feed-in-Tariff policies for the optimum integration of rooftop PV: Comparative analysis," Energy Reports, 2023.
- [31] R. Joshi et al., "Mapping rooftop potential at national scale: Methods and case studies," World Bank / ESMAP working paper, 2020.
- [32] Himachal Pradesh Government Press Release, "Swaran Jayanti Policy: Targets and Implementation Plan," Govt. of Himachal press release, 2022.
- [33] Himachal Pradesh Directorate of Energy, "Implementation agreement and supplementary documents for SJEP 2021," Directorate of Energy, HP, 2022–2024.
- [34] M. Sujikannan, "Sizing of rooftop PV arrays and community-run battery storage for hilly regions," DGA Energy Journal, 2022.
- [35] D. Gawley et al., "Investigating GIS and remotely-sensed inputs for rooftop suitability assessment," Renew. Sustain. Energy Rev., 2022.
- [36] H. Farnaz et al., "Evaluating site selection for optimal photovoltaic installations," Sci. Rep., 2025.
- [37] Chris Heinrich et al., "Roof age determination for automated site-selection of rooftop solar," arXiv:2001.04227, 2020.
- [38] M. Mehla, "Solar Photovoltaic Pumping Systems: Site selection using remote sensing/GIS," Biotica Publications, 2020.
- [39] R. Kabir et al., "Policy instruments and subsidy design for rooftop solar in India: Lessons and outcomes," Energy Policy Journal, 2018.
- [40] City Gap Fund / World Bank, "Rooftop Solar Energy Potential in Low-and Middle-Income Countries — assessment and policy brief," 2025.
- [41] H. Celik, "Present status of photovoltaic energy: Life cycle techno-economic analysis of grid-connected households," Renew. Sustain. Energy Rev., 2006.
- [42] IRJET / IRJ publications, "Economic assessment of small-scale grid-connected rooftop systems in Himachal Pradesh — case studies," IRJET, 2024.
- [43] Loop Solar / Industry Note, "Net-metering application processes and forms — Himachal Pradesh," Industry Technical Note, 2023.
- [44] Freyr Energy, "Practical guide: PM Surya Ghar portal — vendor registration and application workflow," Industry Guide, 2025.
- [45] S. Mittal et al., "Rooftop Solar Panel Detection from Satellite Imagery Using Deep Learning," IEEE Conference Proc., 2025.
- [46] M. Žalik, "Deep learning for spatiotemporal solar potential mapping," Renewable Energy Workshop Proceedings, 2024.
- [47] Renewable Energy Policy Network for the 21st Century (REN21), "Global Status Report — Distributed PV and policy trends," REN21 Report, 2024.
- [48] TERI / CEEW collaborative study, "State readiness for rooftop solar scale-up: Institutional and regulatory bottlenecks," Joint Report, 2022.
- [49] S. Chandel et al., "Rooftop solar mini-grids and VPP: Regulatory pathways for mountainous regions," Journal of Energy Storage, 2024.
- [50] IEA / IRENA joint brief, "Scaling rooftop PV in challenging geographies: policy, finance and technical solutions," International Policy Brief, 2023