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Mapping the Value Chain of an Electric Vehicle – Skill Gaps, Training, Gender & Just Transition

Himachal Pradesh

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Disclaimer
This document includes preliminary recommendations and way forward, based on the interactions, fieldwork and background research conducted in the ten cities/island and may require detailing as per the dedicated studies.

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Executive Summary

Transition to electric mobility in Himachal Pradesh offers the chance to decarbonize transport and facilitate sustainable economic development. With the state looking to align with India's vision for cleaner mobility, transportation electrification becomes the necessity, with rising pollution, fuel prices, and the imperative for energy-efficient transport solutions making the case compelling.

Despite efforts at the state and central level such as FAME-II and PLI schemes, electric vehicle (EV) adoption in Himachal Pradesh is constrained by a number of factors. These range from limited charging points, high initial costs and lack of skills in the workforce. Moreover, the state's topography-related challenges in the form of extreme weather conditions and hilly terrain require customized EV solutions, more so for the public transport segment, last-mile connectivity, and freight transport.

A value chain analysis done by this study reveals where the policy support and investments are the need of the hour. At the upstream level, India is over-dependent on imports from abroad for such critical raw material as lithium and cobalt and therefore requires investments in the battery recycling space on a long-term basis and access to domestic material resources. At the midstream level, there is a growing need for localized production of EVs, assembly, and powertrains, along with skill development interventions for technicians, mechanics, and service providers. At the downstream requires extensive expansion of charging points at length, particularly fast-charging corridors along priority tourist circuits such as Shimla-Manali and Dharamshala-Pathankot.

There needs to be a framework of a just transition to facilitate reskilling of the workforce in legacy ICE-based sectors, particularly mechanics, fuel pump attendants, and transport drivers, to perform new work in EV maintenance and charging station management. The transition also provides the possibility of improving gender equality in the automotive industry by offering specially developed women-centric training modules and economic incentives to women-owned EV businesses.

This report outlines a set of strategic interventions to facilitate the accelerated deployment of EVs in Himachal Pradesh, including:

- Electrification of government and commercial fleets of vehicles, with a focus on public buses, taxis, and last-mile delivery vans
- State-level EV charging infrastructure development, with hydropower-powered smart grids allowing environmentally friendly consumption of power
- Financial incentives and subsidies to consumers purchasing EVs, businesses, and MSMEs producing and servicing EVs
- Streamlining policy recommendations to make new residential and commercial complexes EV-ready
- Institutionalizing reskilling workforce programs through vocational training schools and industry academic collaboration to develop an EV-skilled workforce

1. Introduction

The world transition towards electric mobility is revolutionizing the transport industry, offering a cleaner, more energy-efficient alternative to traditional fossil fuel-based transport. India, with one of the world's fastest-growing economies, has aggressive targets to reduce carbon emissions and electric vehicle (EV) penetration to 30% by 2030. Himachal Pradesh, with its vast renewable energy resources and unique geographical limitations, is well set to be at the vanguard of India's e-mobility revolution. But for the transition of EVs in the state's transport industry to take off, there is a need for a strategic plan—a one that spans areas of infrastructure development, skill upgradation, change in workforce, and gender balance.

This report attempts to give an integrated roadmap for the transition of Himachal Pradesh to EVs with value chain integration, policy support, and development of the workforce, highlighting necessary interventions that have to be scaled up for adoption of EVs and ensuring a fair and equitable transition of workers and communities affected by the transition from internal combustion engine (ICE) vehicles to electric mobility solutions.

1.1 Background of the Project and Its Relevance to the EV Industry

Himachal Pradesh has been on a sustainable transport trajectory, the Himachal Pradesh Electric Vehicle Policy 2022 aiming ambitious EV adoption goals. The state's reliance on hydropower as a primary energy source offers an opportunity to build a 100% renewable-powered EV ecosystem, reducing transport sector emissions by a big margin. But the shift towards such a system needs to deal with key challenges in the form of a lack of EV charging infrastructure, high cost of purchasing EVs, and lack of skilled manpower to perform vehicle maintenance and battery management.

At the national level, the Government of India has introduced several policy initiatives, including the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME-II) scheme, to drive EV adoption. State and city governments, however, remain essential to facilitating effective implementation of policies at the local level. The geography and climate of Himachal Pradesh pose special challenges to EV efficiency, battery life, and charging infrastructure installation. The current study evaluates how policy responses at the local level, financial incentives, and capacity-building schemes can overcome these challenges and bring long-term economic benefits to the state.

Based on a comprehensive value chain analysis, this report analyzes the upstream (battery and raw material procurement), midstream (assembly of vehicles, including components manufacturing), and downstream (charging infrastructure, sales, and servicing) of the EV industry. It also captures best practices from global EV transitions, providing insights into how Himachal Pradesh can become a green mobility and sustainable tourism leader.

1.2 Importance of Skill Gaps, Training, Gender Inclusion, and Just Transition in E-Mobility

Mitigating Skill Gaps and Workforce Readiness

One of the major challenges in the transition to electric mobility is the alignment of existing workforce skills with the demands of the EV industry. Traditional automotive workers, including mechanics, service technicians, and fuel station attendants, need to be reskilled to meet EV-specific repair requirements, high-voltage battery maintenance, and charging infrastructure management. An effective skill development program can bridge this gap, ensuring the workforce remains competitive and employment opportunities are retained.

Gender Inclusion in the EV Industry

The transport industry and automobile sector have been male-dominated, with women holding less than 10% of the workforce and employed in administrative or non-technical positions. The EVs boom provides the opportunity to re-order the involvement of the workforce in a more gender-symmetric manner in battery manufacturing, charging station management, and software diagnostics. The government policies must have gender-based training programs, women entrepreneur promotion, and women support systems in the workplace like child care facilities and flexible work schedules to enhance the involvement of women in the sector.

Just Transition: Workforce Transformation with Equitable Impact

Just transition planning ensures that the transition from ICE-based transport to EVs does not disproportionately affect workers and vulnerable sections. Mechanics, service station staff, and small-scale automobile part manufacturers stand to lose their livelihoods unless pro-active reskilling is implemented. Public-private partnerships must be leveraged to create organized reskilling programs, funding support to small and medium enterprises for conversion to EV-focused industries, and job protection in new green jobs like battery recycling, vehicle diagnostics, and EV charging station operation.

1.3 Role of ICLEI and IIM Sirmaur

ICLEI – Local Governments for Sustainability, South Asia, has played a key role in facilitating Indian states and cities to transition towards sustainable mobility. Through the "Support Indian Cities in Taking Leadership on Electric Vehicles (EVs)" program, ICLEI facilitated stakeholder interaction, policy support, and pilot intervention in cities like Shimla. Their expertise in urban management, infrastructure planning, and capacity building facilitates support to local governments in formulating customized solutions to EV adoption in accordance with national policy objectives. IIM Sirmaur, as a flagship management school of Himachal Pradesh, provides policy research, economic analysis, and strategic frameworks to the state's transition to EVs. Their support involves financial viability analysis, consumer behavior analysis, and business model innovation to facilitate the transition to EVs on economically viable and inclusive terms. Coordination between ICLEI, IIM Sirmaur, government agencies, and private sector participants is critical in formulating a scalable and implementable EV roadmap to the state. The report synthesizes government policy perspectives, industry best practices, and stakeholder consultations to formulate an overall strategy for Himachal Pradesh's transition to electric mobility. With the overcoming of critical challenges in infrastructure, policy, skill development, and equitable workforce transition, the state can become a leader in sustainable and inclusive transport.

2. Approach and Methodology

A rigorous research approach was employed to attain a deep understanding of the challenges, opportunities, and interventions for electric vehicle (EV) adoption in Himachal Pradesh. The study employed a mixed-method approach by combining primary research through stakeholder interaction and field visits with secondary research from published literature, policy documents, and industry reports. The objective was to create a realistic, data-driven roadmap for electric mobility transition within the state.

2.1 Approach to the Study

The study was designed to offer a ground-level report on Himachal Pradesh's EV ecosystem following the country and international best practices. The approach involved field research, expert discussions, policy analysis, and secondary data analysis to engage with critical themes such as charging infrastructure, workforce readiness, policy interventions, and value chain integration.

Primary Research

To capture on-ground challenges and views, one-on-one in-depth interviews and field interactions were conducted with primary stakeholders along the EV value chain. These interactions offered firsthand inputs on market readiness, workforce concerns, and infrastructure constraints. The stakeholders were:

- Automobile dealers and EV distributors – To gauge consumer interest, demand trends, and prevailing barriers to EV adoption.
- Vehicle technicians and service center operators – To gauge workforce readiness for EV servicing, maintenance concerns, and skill gaps.
- Petrol pump managers and workers – To gauge the probable impact of the transition to EVs on fuel station operations and employment.
- Local transport operators and fleet managers – To analyze the feasibility of electrifying public and commercial transport fleets.
- General consumers in the region – To assess awareness, perception, and willingness to adopt EVs.

The qualitative insights from these interviews helped identify the most significant challenges for EV adoption and informed the development of focused recommendations.

Secondary Research

A thorough review of literature, policy reports, and market reports was conducted to validate primary research findings and offer a wider context to EV adoption. The secondary research sources were:

- Government Policies & Reports – Himachal Pradesh EV Policy 2022, FAME-II Scheme, and state transport department reports were examined to comprehend existing regulatory initiatives and policy support.
- Industry Publications – NITI Aayog reports, Automotive Skills Development Council (ASDC) reports, ICLEI reports, and reports by international agencies such as the International Energy Agency (IEA) and World Resources Institute (WRI) were examined for market trends and global best practices.
- Research Papers & Academic Studies – EV technology, infrastructure deployment, and workforce transition studies from leading institutions and journals were referenced.
- Online Data & News Articles – Data from automobile industry websites, government websites, and media publications were utilized to incorporate recent trends in the EV industry.

This two-tiered approach—ground-level qualitative research supplemented by secondary data analysis—enabled a thorough and evidence-based analysis of Himachal Pradesh's e-mobility transition.

2.2 Methods Used to Identify Stakeholders and Analyze Skill Gaps

A structured stakeholder mapping framework was used to identify the key stakeholders driving and impacted by the EV transition in Himachal Pradesh in a systematic manner. This framework enabled all significant viewpoints—government, industry, workforce, and consumers—to be addressed in the study.

Stakeholder Mapping Framework

The key stakeholders were categorized based on their role in the EV ecosystem, influence level, and impact on mobility transformation:

- Government & Policy Makers – State transport departments, energy regulators, municipal corporations, and urban planning authorities for policy implementation and infrastructure development.
- Industry Players & Infrastructure Developers – EV manufacturers, auto dealers, fleet operators, and charging infrastructure companies for vehicle production and service expansion.

- Workforce & Small Business Owners – Mechanics, petrol pump attendants, auto-repair technicians, and small transport operators who need reskilling and business transformation.
- Consumers & General Public – Private car owners, commercial fleet owners, tourism industry players, and local communities, whose EV adoption will drive market growth.

This model of stakeholder mapping helped us to sequence interventions and craft policy recommendations addressing the needs of each category.

Skill Gap Assessment

Transition to EVs poses a massive challenge for workers traditionally engaged in ICE vehicle repair, fuel station operations, and traditional auto production. Drawing from stakeholder interviews and secondary research, the following key skill gaps were revealed:

- Lack of training in EV-focused maintenance, including high-voltage system management and battery diagnostics.
- Limited exposure to charging infrastructure management, including installation, diagnostics, and integration with the grid.
- Lack of exposure to software-based vehicle diagnostics, which are necessary to repair advanced vehicles.
- Resistance of workforce to transition due to lack of formalized reskilling programs and financial insecurity.

To bridge these gaps, the report proposes state-sponsored vocational training programs, reskilling partnerships with industry, and formal transition strategies for mechanics and fuel station employees.

2.3 Data Sources, Tools, and Techniques Used

A combination of field research, qualitative data collection, and secondary data analysis was used to ensure accuracy and completeness of the study:

Primary Data Collection Techniques

- In-Depth Interviews – Carried out with EV dealers, service mechanics, petrol pump attendants, and transport operators to reflect real-world perspectives on challenges and opportunities.
- Field Observations – Evaluated the scope of charging infrastructure, road quality, and fleet electrification milestones at varied locations.
- Consumer Interactions – Measured public awareness, perception, and adoption hurdles through informal conversations.

Secondary Data Collection and Analysis

- Policy & Market Reports Review – Evaluated state and national EV policies, industry reports, and market trend studies to establish a regulatory and economic context.
- Comparative Case Studies – Evaluated best practices from path-finding EV markets (Norway, California, and India's leading EV-adopting states such as Delhi and Maharashtra) to draw relevant lessons.
- Infrastructure Gap Analysis – Evaluated charging station deployment data, electrical grid integration, and policy preparedness to identify gaps and areas for improvement.

By combining direct stakeholder input with policy and market research, this methodology ensures a pragmatic, data-driven, and locally-relevant approach to the development of Himachal Pradesh's EV roadmap. The conclusions from this study act as a guide for policy makers, industry players, and workforce planners, with realistic, actionable steps to spur EV adoption while ensuring a just and inclusive transition.

3. Value Chain Mapping of Electric Vehicle Industry

3.1 Detailed Mapping of EV value chain

A value chain is the entire life cycle of a product or service, ranging from raw material procurement to final delivery to the customer and after-sales. For the electric vehicle (EV) industry, this includes upstream, midstream, and downstream operations that collectively drive production, distribution, consumption, and recycling. A good value chain model thus helps organizations optimize efficiency, minimize costs, and optimize value for stakeholders.

Upstream Phase: Procurement of the Building Blocks

The upstream process involves procurement and processing of raw materials for use in EV components. It involves mining, refining, and supplying material needed for manufacturing batteries, motors, electronics, and vehicle bodies. Batteries, particularly lithium-ion batteries, are the mainstay of EV technology, and lithium is sourced predominantly from Australia, Chile, and Argentina. Cobalt used for battery stabilization comes mainly from the Democratic Republic of Congo (DRC), whereas nickel, graphite, and manganese come from various global markets.

In addition to batteries, electric motors and automotive bodies also rely on the such as rare earth elements such as neodymium and dysprosium, which are under the majority control of China. Light metals such as aluminum and steel are being imported from significant producers such as China and Canada. Copper, an essential material utilized in electrical wiring and windings of motors, is primarily being imported from Chile, Peru, and the United States.

Despite the critical significance of these materials, the upstream sector is faced with various challenges including environmental concerns as a result of over-mining, geopolitical risks of reliance on a limited number of supplier nations, and economic pressures from fluctuating raw material prices. These issues must be met by strategic interventions such as domestic prospecting of resources, investment in recycling batteries, and government-supported sustainability initiatives under programs such as India's FAME-II scheme. Himachal Pradesh, being endowed with abundant renewable energy resources, can leverage these programs to create a localized and sustainable supply chain appropriate to its geographical and economic requirements.

The table below outlines the relevance and potential benefits of these initiatives for Himachal Pradesh.

FAME II Initiative	Why is it Relevant to Himachal Pradesh	How it can benefit Himachal Pradesh
Support for Charging Infrastructure	Under FAME II, the government has earmarked ₹1,000 crore to develop charging infrastructure across the country. It includes grants for public and private entities to install charging stations, especially in urban areas and highways. With its hilly terrain, long-distance travel routes, and tourism-driven economy, Himachal Pradesh faces range anxiety as a big barrier to EV adoption.	Establishing strategically placed charging stations along highways and tourist spots can encourage EV adoption among locals and tourists, reducing dependence on fossil fuels. Enhanced access to charging will also promote smoother intercity travel and benefit the local economy.
Incentives for Domestic Manufacturing	FAME II offers subsidies and tax incentives for EV components manufacturers, such as batteries, motors, and controllers. This will be relevant to Himachal Pradesh in the sense that it can attract industries to set up manufacturing units that will source resources locally and thus create jobs.	Encouraging domestic manufacturing will increase industrial development in the state, create jobs for local residents, and reduce costs around importing components.
Boosting Electric Public Transportation	The scheme provides incentives to state governments to purchase electric buses and related infrastructure; it has subsidy support of up to ₹45 lakh per bus for public transport. Himachal Pradesh, which relies heavily on buses for public transportation, stands to benefit greatly.	Replacing diesel buses with e-buses will reduce air pollution and noise pollution in ecologically fragile zones, improve the travel experience, and lower fuel costs for the government in the long term.

Battery Manufacturing Ecosystem	FAME II supports the creation of a sustainable battery ecosystem by incentivizing recycling and reuse. Grants are given for the setting up of recycling units, and research is encouraged into advanced battery technologies like lithium-ion and solid-state batteries, which is important for Himachal Pradesh in view of its ecologically sensitive landscape.	Setting up battery recycling units in the state will reduce environmental risks associated with used batteries. It will also help local industries by allowing the reuse of useful materials, supporting a circular economy.
Collaboration for Capacity Building	The initiative promotes partnerships between the government, private sector, and educational institutions for the delivery of skill development programs in EV technology. This will be particularly important for Himachal Pradesh because the lack of local expertise in EV maintenance and operations will hinder the adoption of this technology.	Training programs for technicians and entrepreneurs will generate employment opportunities and empower the workforce to support EV infrastructure, ensuring smoother implementation and maintenance of EV systems.
Support for Renewable Energy Integration	FAME II promotes the integration of renewable energy with EV charging stations, encouraging solar and hydroelectric-powered infrastructure. Himachal Pradesh, with its rich hydroelectric resources, can ride on this initiative to create a sustainable EV ecosystem.	Renewable-powered charging stations can significantly reduce energy costs and carbon footprints, aligning with Himachal Pradesh's green energy initiatives and promoting eco-tourism.

Table 1 – Relevance and potential benefits of initiatives

Midstream Phase: Manufacturing and Assembly

The midstream phase involves transforming raw materials into functional EV components and fully assembled vehicles. The phase involves building battery packs, integration with Battery Management Systems (BMS) for performance enhancement, and powertrain production comprising electric motors, inverters, and controllers. Dominant OEMs such as Tata Motors, Mahindra Electric, and Ola Electric are the leading manufacturers of India's EV, producing an extensive range of vehicles from two-wheelers to four-wheelers and electric buses.

Localization efforts within EV component manufacturing have accelerated as companies have invested in research and development to lead the low-cost battery technology and energy-saving technology innovations. Vertical integration, with producers taking ownership of their own supply chain, is serving to keep import dependency-related risks in check. However, challenges persist in certain sectors of advanced component production, bottlenecks within the supply chain, and state level infrastructure constraint in states such as Himachal Pradesh, where topographical limitations hinder the installation of heavy industrial installations. Additionally, unfavorable climatic conditions and winter snow cover render functioning challenge to control through standardized manufacturing and logistic planning. Government initiatives like the Production Linked Incentive (PLI) scheme are inducing local manufacturing of sophisticated auto components, providing incentives to companies to set up production facilities locally. By creating a culture of localized production and technological improvements, India can enhance its position in the global market of EVs.

Source – EVTechnician

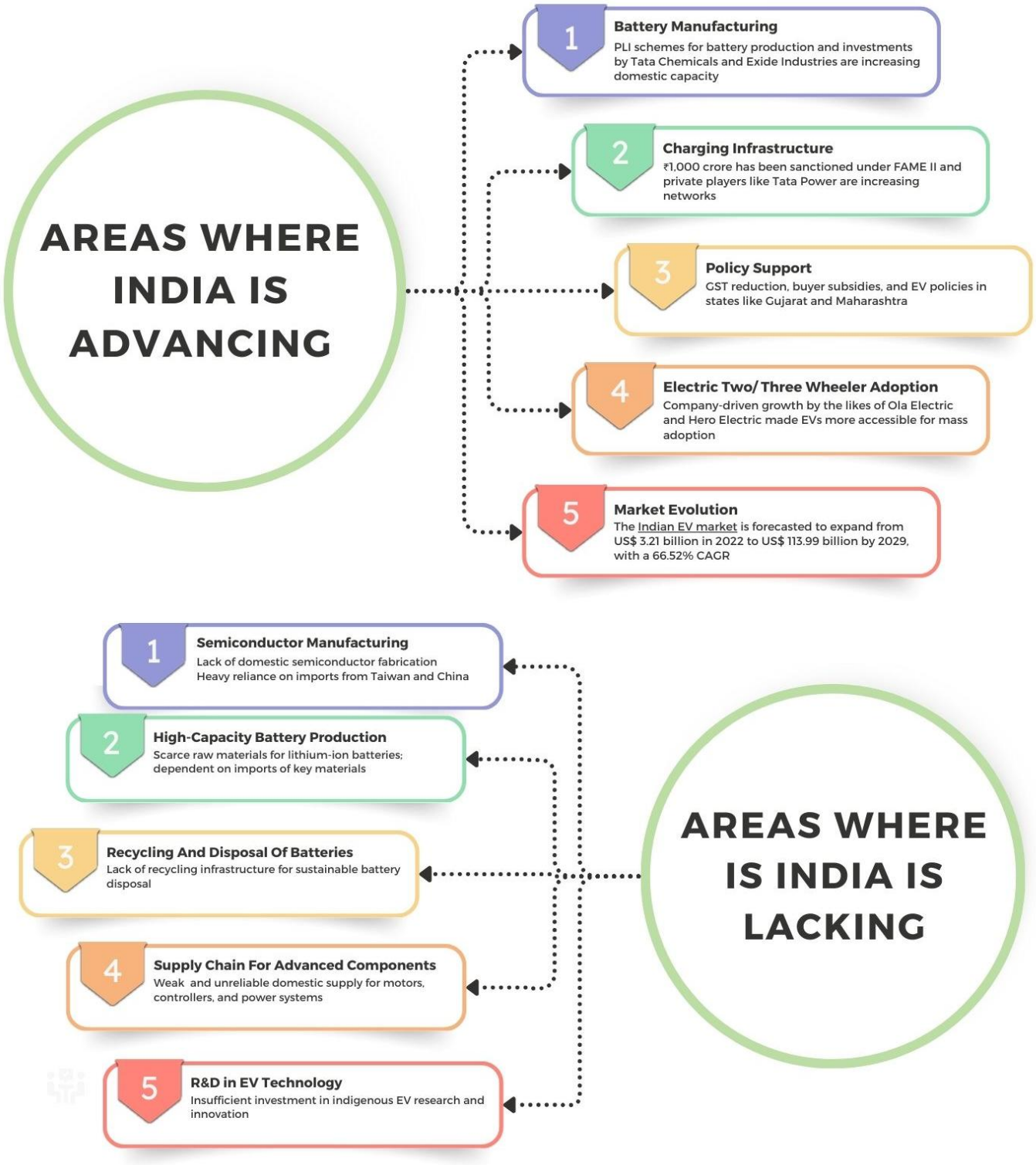


Figure 1 – Areas where India is advancing and lacking

Downstream Phase: Providing Value to Consumers

The downstream value chain of EV is concerned with the availability and sustainability of EV adoption through having strong distribution networks, charging stations, and after-sales support. Distribution models are traditional dealership networks and direct-to-consumer sales models, which have been implemented by top international brands such as Tesla.

The growth of charging infrastructure is a key component of downstream development and over the last five years, India has invested over ₹3,700 crore in public charging networks and battery-swapping models.

Service and maintenance are central to establishing consumer trust in EV technology. With diagnostics of batteries, software updates, and repairs at the core of after-sales support, OEMs are increasingly teaming up with third-party service providers to further improve access to maintenance networks. While there is improvement, gaps in infrastructure remain a major concern, especially in rural and off-grid locations where EV uptake remains in its early stages.

Policy incentives like taxation benefits, subsidy under FAME-II, and state support have helped ease transition to electric mobility. Consumer perception and awareness still are areas of concern. Meeting range anxiety issues, educating long-term cost saving to users, and making financial affordability more accessible via incentives and financings will become essential in faster mass adoption.

Comparative Analysis: India vs. Global EV Value Chain

In comparison to top global markets, India shows significant advancement in EV policy support, manufacturing growth, and charging infrastructure development. India has made considerable progress in domestic battery production, driven by PLI schemes and investments from key industry players like Tata Chemicals and Exide Industries. Nevertheless, the industry continues to face major challenges such as limited domestic semiconductor production, reliance on imported lithium-ion cells, and shortcomings in sustainable battery disposal and recycling systems.

Countries such as Norway, Netherlands, and U.S. have put in place wide-scale EV adoption policies, coupled with dense networks of charging infrastructure and stringent ICE vehicle phase-out plans. India, on the other hand, continues to work on its long-term high-capacity battery manufacturing road map and R&D investments in next-generation EV technologies like solid-state batteries.

3.2 Key Stakeholders, Their Roles, and Challenges

Stakeholder	Role	Challenges
Automobile Manufacturers (OEMs)	Design and assemble EVs.	Transitioning from ICE production, skill gaps in EV technology, reliance on imports, and green manufacturing adaptation.
Auto Component Manufacturers (ACMs)	Supply essential EV components such as batteries and motors.	Obsolescence of ICE-specific parts, financial constraints among MSMEs, and technological barriers.
Raw Material Suppliers	Provide critical elements like lithium, cobalt, and rare earths.	Limited domestic reserves, environmental concerns, and supply chain vulnerabilities.
Workforce in Manufacturing	Adapt to new EV technologies in production lines.	Job displacement, skill adaptation, safety risks, and job security concerns in MSMEs.
Service and Repair Technicians	Maintain and repair EVs, including battery diagnostics and software updates.	Need for high-voltage safety training, specialized repair knowledge, and EV infrastructure servicing expertise.
Charging Infrastructure Developers	Establish EV charging stations and networks.	High capital costs, standardization issues, grid reliability concerns, and renewable energy integration.
Policymakers and Regulators	Frame and implement EV policies, subsidies, and industry regulations.	Balancing industry growth with environmental concerns, subsidy allocation, and evolving EV technologies.
Consumers and Drivers	End users of EVs who drive adoption rates.	Range anxiety, high initial costs, and limited affordable EV options.
EV Dealers	Facilitate EV sales and educate customers.	Addressing consumer scepticism and dependency on charging infrastructure availability.
Financial Institutions and Insurers	Provide financing and insurance for EVs.	Managing high financing costs, structuring EV insurance products, handling uncertainties in residual values.

Table 2 - Key Stakeholders, Their Roles, and Challenges

4. Just Transition for EVs in Himachal Pradesh

4.1 What is it and its importance

Himachal Pradesh is part of India's national EV program in line with India's climate and energy goals. Transitioning to EVs is not a technological shift—it is a socio-economic shift with industries, workers, and communities. A Just Transition ensures an equitable transition to a sustainable economy with focus on reducing disruption and reskilling workers, creating opportunities so that no one is left behind. Himachal Pradesh had approximately 3000 EVs registered, from a single two-wheeler registered in 2018. These are buses, taxis, autos, and two- and three-wheelers. The Ministry of Skill Development and Entrepreneurship estimates that the electric vehicle industry will create an additional 5 crore indirect jobs in India with the expansion of the industry.

Skill Gaps and Reskilling Needs

There are enormous capability gaps in terms of EVs among existing workers. The automotive industry has witnessed a 40% increase in workers with at least one EV-related skill over the last five years. However, specialized training in new technologies being implemented in EVs is significantly inadequate among most workers.

Given that 89% of Himachal Pradesh's population resides in rural areas, rural workers need to be included in reskilling. This demographic fact requires the creation of customized training programs considering local economic activities and mobility requirements of these workers. The Annual Area Employment Market Report reports that there are about 3,547 unskilled workers in Himachal Pradesh, with a marginal increase of 0.85% compared to earlier years (as of 2014-2015 report). These workers are largely employed in jobs such as helpers, cleaners, and manual labor, which are essential to the traditional automobile sector.

Current Employment in the ICE Sector:

The automobile industry is a major contributor to India's economy, accounting for about 7% of the nation's GDP and employing about 30.7 million individuals. Both direct employment (13.7%) and indirect employment (86.3%), which comprise jobs such as car mechanics, garage staff, informal manufacturing workers, and auto part dealers, are part of this number.

The introduction of electric vehicle (EV) technology is likely to revolutionize existing employment trends in the automobile sector. A research shows that 45% to 84% of the parts utilized in internal combustion engine (ICE) vehicles—especially powertrain parts—will be rendered obsolete due to EVs' penetration. This shift is a significant threat to the livelihood of the production and maintenance workers of these parts.

The Indian EV sector is also confronted with a shortage of several important skills in the value chain. This shortage emphasizes the need for targeted reskilling initiatives to equip unskilled workers with the required skills in EV manufacturing, battery technology, and maintenance of charging infrastructure. (Source : WRI India)

To effectively address this transition, there is a need to implement holistic reskilling initiatives that are specific to the needs of rural workers in Himachal Pradesh. By concentrating on the acquisition of relevant skills for new technologies, stakeholders can ensure sustainable employment for this segment while promoting economic growth in the region.

Job Generation in the EV Sector:

The electric vehicle (EV) sector is likely to transform India's employment map in a drastic way. Reports suggest that by 2030, the sector can create up to 10 million direct jobs, and a new 50 million indirect jobs. The growth is likely to create demand for experts in the field of UI/ UX engineering, bedded electronics, battery operating systems, pall computing, and data analytics.

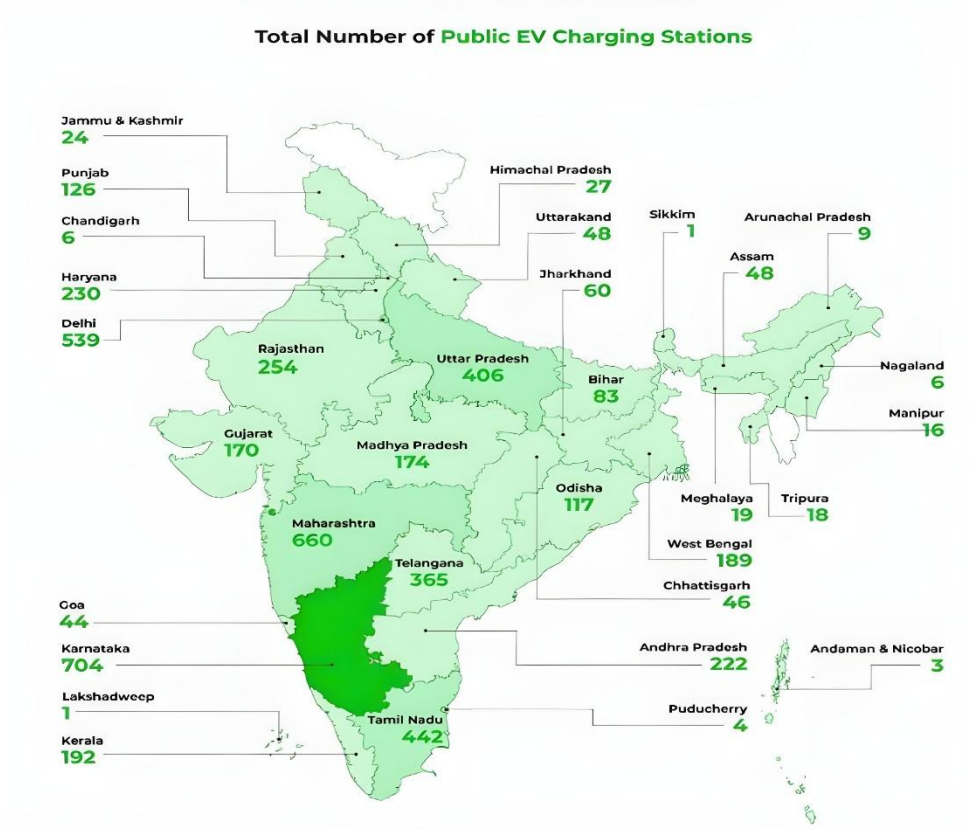
There are economic considerations as well. The minimum unskilled wage in Himachal Pradesh is ₹375 per day (₹11,250 per month). The transition to new jobs in the EV sector can potentially translate to better compensation, and therefore enhanced living standards.

The growth, however, also fuels the necessity to develop the workforce. For the government's vision of 30% EV penetration by 2030 to be met, the auto sector will require up to 200,000 skilled workers. Filling the skills gap needs considerable investment in education and training, with an estimated ₹13,552 crore to hire and reskill the workforce. [Source : HT Auto]

A just transition to electric vehicles (EVs) in Himachal Pradesh is crucial to achieve economic stability, workforce security, and environmental sustainability. The state's automotive value chain, based on the majority of its internal combustion engine (ICE) vehicles, is sustained by thousands of individuals for vehicle maintenance, fuel supply, and transport. This transition can render nearly 600,000 workers in the nation involved in ICE vehicle manufacturing, maintenance, and

fuel supply redundant, impacting regional economies significantly (Source - CEEW Report, 2023). Interventions made in reskilling and financial support are necessary to safeguard these livelihoods.

Himachal Pradesh's transport and tourism industries are major contributors to the state's GDP, with nearly 75% of local travel depending on small-scale transport operators (Source - Himachal Pradesh Economic Survey, 2023). Transition to EVs provides opportunities to these operators, if they are supported financially and infrastructurally for the transition. By leveraging the state's 10,000+ MW hydroelectric capacity, Himachal Pradesh can have an entirely renewable EV charging ecosystem, reducing reliance on fossil fuels and creating jobs in EV infrastructure maintenance, battery maintenance, and operation of charging stations.



Source – Ministry of Power, Vahan Dashboard

Figure 2 – Total Number of Public EV Charging Stations

Rural Himachal Pradesh is facing tremendous challenges in adopting EV technology, primarily due to sparse charging networks, lack of EV-ready workshops, and exorbitant costs of vehicles. While policy led EV growth is being seen by urban cities like Shimla and Dharamshala, rural Himachal Pradesh requires specific investments to provide a level playing field for the transition. Economically viable retrofitting options for 20,000+ diesel-operated taxis and private transport vehicles in the state could bridge the gap, reducing emissions without overburdening the financial resources of poor vehicle owners (Source - Himachal Pradesh EV Policy, 2022).

Seamless transition of EVs will also benefit mechanics, workshop owners, and dealership networks. Currently, 90% of mechanics perform ICE repair with minimal exposure to EV systems. Without skilling programs, over 70% of such employees will face employability issues in an EV-led market (Source - WRI Report, 2023). Establishing state-funded training centers in strategic cities and introducing EV specific modules in ITI courses will be critical in rendering workers employable.

Financial readiness remains an entrenched issue for small businesses. EV diagnostic equipment, charging point, and battery maintenance machine installation costs range between ₹5-10 lakh per unit. Prevention of increasing EV-exclusive retailer and direct online sale penetration is crucial in preserving existing dealership networks employing thousands in the state.

An effective just transition policy must attain regional equity, more precisely by bridging urban-rural gaps. Currently, 80% of EV infrastructure projects are urban-centric, with rural business and consumers remaining unserved. Boosting financial incentives for rural EV uptake and charging infrastructure deployment will bridge the gap, ensuring all the stakeholders—mechanics, transport providers, workshop owners, and small business owners—are benefiting from the transition dividends. Himachal Pradesh can be a mobility sustainability leader by including workforce training, financial support, and infrastructure deployment in its EV master plan and serving as a template for other Indian states.

4.2 Mapping Employment Impacts

Organizational Level

Transitioning to EVs will result in reduced demand for conventional components like fuel injectors, engines, radiators and exhaust systems. Workers in small and medium units producing these parts will be impacted. Roadside automobile mechanics as of now are not equipped with training to fix and maintain EV-specific parts like battery management systems (BMS), high voltage cabling and advanced driver-assistance systems (ADAS). On the contrary, jobs are emerging in EV battery manufacturing, lithium-ion battery assembly, installing charging infrastructure, and battery recycling centers driven by the green revolution.

Regional Level (Himachal Pradesh)

Himachal Pradesh's transport manpower is comprised of taxi drivers, bus drivers, and local transport operators using fossil fuels. Drastic transition to EVs could lead to job losses or

economic pressure due to the initial cost of high investment in transitioning to EVs. This could be neutralized with government incentives in retrofitting existing vehicles into EVs and special finance assistance plans for rural operators and public fleets.

EV transition also offers new opportunities in infrastructure. Himachal Pradesh's hydropower can be used to install clean energy-based EV charging stations, generating new employment opportunities for individuals at the charging stations. Green tourism can be encouraged by introducing EV buses and taxis in tourist places such as Shimla, Manali, and Dalhousie, which would place the state on the eco-tourism map. Rural mechanics will, however, have to be specially trained to carry out EV repair, diagnostics, and battery replacement processes. Around 31% of the auto industry jobs will be impacted, 14% of which will be made redundant and 17% of which have to be reskilled. Himachal Pradesh's technical institutions can collaborate with EV manufacturers to offer vocational courses specific to EV technologies.

National Level

The auto industry now employs more than 37 million individuals in India, and most of the workforce operates in the manufacturing and after-sales of internal combustion engine (ICE) automobiles. Previous studies had estimated that EV manufacturing would cut the auto workforce by 30-40% and thus result in the loss of more than 200,000 jobs.. At the same time, the EV value chain in India creates new jobs in battery manufacturing, software for smart mobility, and integration of renewable energy.

The national policies, i.e., FAME-II and Skill India Mission, have vast potential to fund skilling of the workforce and mitigate job losses. The Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME) Scheme, i.e., its Phase II (FAME-II), is the most significant scheme for the promotion of electric mobility in India. With a budgetary provision of ₹10,000 crore (approximately USD 1.4 billion) from April 2019, FAME-II is primarily concerned with demand incentives to encourage the adoption of EVs.

Demand incentives cover approximately 86% of the entire budgetary assistance to enable the deployment of 7,000 e-buses, 500,000 e-three-wheelers, 55,000 e-four-wheeler passenger vehicles, and 1 million e-two-wheelers. FAME-II, besides providing demand incentives, also provides money for charging infrastructure installation and technology development. However, independent money for skilling efforts for the workforce is not explicitly outlined in the scheme. This, therefore, is a potential gap, since the shift to electric mobility will necessitate substantial skilling of the workforce engaged in EV manufacturing, maintenance, and allied services.

The Skill India Mission is another government initiative intended to bridge the gap by providing vocational training across a variety of sectors, including emerging sectors like electric mobility. It provides a general framework for skill development, but it needs to be strengthened further to be associated with specialized EV-related training programs to cater to the changing needs of the industry.

The PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) program, initiated by the Indian government, is an innovative program for promoting the deployment of electric vehicles (EVs) in India. With an outlay of ₹10,900 crore, the program shall be rolled out over a duration of two years, from October 1, 2024, to March 31, 2026.

Principal Objectives and Elements:

- **Vehicle Support**: Financial support under the program has been provided for purchasing various types of electric vehicles, including two-wheelers, three-wheelers, e-ambulances, e-trucks, and e-buses.
- **Charging Infrastructure:** Emphasis has been particularly put on the growth of robust public charging infrastructure in support of rising numbers of EVs. newsonprojects.com
- **Testing Agencies Upgradation**: The program has also covered upgradation of the vehicle testing agencies so that the agencies can meet the specific needs of EVs.

Relevance to Himachal Pradesh's EV Transition:

Himachal Pradesh, with its characteristic topography and reliance on tourism and small-scale transport services, can immensely gain from the PM E-DRIVE program.

Economic Diversification: The support provided by the program for various categories of EVs can assist the state in transforming its transport segment, potentially enabling reduction of fossil fuel dependence and development of sustainable tourism.

Infrastructure Development: The thrust in development of charging infrastructure can assist in overcoming prevailing challenges in the state, especially in rural and off-grid areas, in supporting inclusive transition to EVs.

Workforce Reskilling: Upgradation of the testing agencies and enhanced usage of EVs can create new avenues of employment opportunities in vehicle maintenance, infrastructure servicing, and ancillary industries, resulting in reskilling of the workforce and economic resilience.

Specific Players, Technical Institutes and Non-Profits in EV Workforce Development

Category	Name	Role & Focus	Why can it benefit?
Industry Associations	Automotive Skill Development Council (ASDC)	Provides comprehensive training in EV technologies, including manufacturing, repair, and maintenance.	Can create a robust pool of EV-ready technicians and professionals across India
Educational Institutes	International Centre for Automotive Technology (ICAT)	Offers specialized certifications and training programs for EV components, battery assembly, and diagnostics.	Equips engineers and workers with advanced EV knowledge, bridging the gap between traditional automotive skills and EV requirements.
	Delhi Skill and Education University (DSEU)	Incorporates EV-related courses in existing curricula, with a focus on future-ready engineers and professionals.	Prepares the next generation of engineers for the EV industry, particularly in Himachal where skilled workers are in high required.
Training Organizations	DIYguru	Provides hands-on workshops and online courses in EV design, development and battery design.	Ideal for reskilling auto mechanics and informal workforce in rural Himachal areas.
Industry Leaders	Tata Indian Institute of Skills (TIIS)	Partners with companies like Ather Energy to deliver specialized EV training programs, focusing on battery specialization and powertrain technology.	Helps establish localized training hubs and prepares workers for advanced EV systems in key industrial zones like Baddi.
	Ather Energy	Runs workforce development programs focusing on EV manufacturing, assembly, and software systems.	Can offer technical support and resources to train Himachal's workforce for EV operations.

Non-Profits	World Resources Institute (WRI India)	Focuses on research and advocacy for just transition policies and skilling initiatives.	Can partner with Himachal Pradesh to design just transition programs for workers displaced by the shift from ICE to EVs.
	Skill Council for Green Jobs (SCGJ)	Works on workforce skilling in renewable energy and clean mobility sectors, integrating training modules for EV infrastructure and maintenance.	Can enable Himachal Pradesh to align its workforce needs with national green energy targets.
	Pragyatmika	Focuses on grassroots training for clean energy and EV-related entrepreneurship	Can help empower women and rural communities in Himachal to take up EV-related roles in areas like battery recycling and repair.
OEMs and Startups	Ola Electric	Offers dedicated training programs for battery assembly and EV design.	Ideal for creating a skilled workforce for mass EV adoption in Himachal Pradesh.
	Hero Electric	Conducts workshops and skill-building initiatives for EV maintenance, charging, and diagnostics.	Can collaborate with Himachal Pradesh's rural workforce, particularly mechanics and service technicians, to support EV adoption.
Government Initiatives	FAME-II (Govt. of India)	Provides funding and incentives for workforce skilling initiatives tailored to EV adoption.	Ensures financial support for state-led skill development programs in Himachal Pradesh.

	Skill India Mission	A national program to align training initiatives with the growing demands of the EV sector.	Supports the establishment of new training hubs in Himachal's key regions, such as Shimla and Dharamshala, to prepare for EV growth.

Table 3 – Various stakeholders in EV Workforce Development

4.3 Readiness for EV Transition

Organizational Readiness

Big auto giants like Tata Motors, Mahindra Electric, and Ashok Leyland are investing in EV R&D and reskilling initiatives. Tier-2 and Tier-3 players and small players are highly disadvantaged in the race due to the absence of financial capital and technical expertise. The transition will need government incentives—specific in finance schemes—to compel SMEs to shift their production lines to suit the EV manufacturing needs.

Regional Readiness

Himachal Pradesh's draft EV policy aims at 100% EV sales by 2030. The policy is deficient in holistic steps for workforce reskilling, skill development, and SME enablement. Infrastructure readiness is also a problem, with barely any EV charging centers in rural and far-flung areas. Small numbers of EV maintenance workshops further enhance the gaps. Hydropower-based charging grid development can go a long way in facilitating the usage of e-vehicles in rural and hill regions. Pilot smart-charging hubs in strategic tourist locations could induce adoption and as a spin-off, bring to the forefront sustainability. Himachal Pradesh has a distinctive competitive edge with its hydropower resources, which can help the state lead the green EV charging infrastructure.

4.4 Global and National Best Practices

Area of Practice	Initiatives Details	Key outcomes	Relevance to Himachal Pradesh
CALIFORNIA, USA			
Renewable Energy Integration	Integrated 100% renewable energy sources into EV charging networks by leveraging large-scale solar and wind farms.	Reduced dependency on fossil fuels for EV charging. - Achieved **40% reduction in grid emissions**.	- Himachal can use **hydropower-based grids** to create a renewable energy-driven EV ecosystem.
Workforce Development	Invested heavily in **reskilling programs** for automotive and energy sector workers transitioning to EVs.	Created a skilled workforce of **50,000 technicians and engineers** for EV roles in just 5 years.	Himachal can allocate funds to **train local rural mechanics** and develop an **EV-specialized workforce**.
CHINA (BYD)			
Vertical Integration	Consolidated EV production, including batteries, vehicles, and powertrains, into one organization to ensure efficiency.	BYD achieved **20% lower production costs** compared to competitors.	Himachal can encourage **cluster-based EV production** for SMEs, integrating battery manufacturing and EV assembly.
Workforce Training	Established training academies to reskill ICE-sector workers for battery technology and EV assembly roles.	Transitioned over **100,000 workers** into EV production roles in 3 years.	Himachal can create **EV training hubs** in partnership with educational institutions and global manufacturers.

Table 4 - Global and National Best Practices

4.5 Roadmap for a Smooth Just Transition

Himachal Pradesh is poised to make the leap towards turning into a flagship state in India's electric vehicle (EV) transition, capitalizing on its unique advantages: renewable hydropower, tourism economy, and aspirational workforce. Transition from internal combustion engines (ICEs) to EVs, however, needs to be thought out and even-handed to be in a position to safeguard the workforce, build the infrastructure, and take care of socio-economic inclusivity. A vision roadmap through targeted interventions is as follows.

Phase 1: Foundation (Years 1–2)	
Skill development and Reskilling	• Set up EV-specific training centers in Shimla, Dharamshala, and Baddi with certifications in EV maintenance, battery recycling, charging infrastructure management, and EV software applications • Collaborate with ASDC, Tata Indian Institute of Skills, and DIYguru for workforce-specific training, especially targeting unskilled rural workers • Reserve 50% of seats for women in skilling programs and provide financial incentives for women entrepreneurs in EV services and battery recycling
Infrastructure Development	• Develop charging corridors along major highways (Shimla-Manali, Dharamshala-Dalhousie) powered by hydropower. • Pilot smart charging hubs in urban centers and tourist locations via public-private partnerships. • Establish community charging stations in rural areas to improve accessibility.
Public Awareness and Policy Alignment	• Launch state-wide awareness campaigns on EV benefits, targeting rural communities. • Align state policies with FAME-II and Skill India Mission to secure funding for skilling and infrastructure projects.
Initial Financial Support	• Provide subsidies for retrofitting ICE vehicles to EVs for rural transport operators, taxi drivers, and small-scale logistics providers. • Offer low-interest loans to MSMEs transitioning to EV component manufacturing.

Phase 2: Expansion (Years 3–5)

Localized Manufacturing Hubs	• Develop EV manufacturing clusters in industrial hubs like Baddi, focusing on lightweight vehicle components, powertrains, and batteries. • Provide tax rebates and land incentives to attract investments from EV manufacturers and startups.
Green Tourism	• Electrify public transport fleets in key tourist zones (Shimla, Manali, Dalhousie). • Subsidize electric bike rental services for tourists in ecologically sensitive areas.
Battery Recycling and Circular Economy	• Establish battery recycling plants in industrial clusters for second-life applications in renewable energy storage. • Provide incentives to startups working on sustainable battery technologies and closed-loop recycling.
Targeted Workforce Interventions	• Reskill 31% of the automotive workforce, transitioning them from ICE-related roles to EV manufacturing, maintenance, and diagnostics. • Partner with ICAT and Delhi Skill and Education University for advanced training in battery management systems (BMS) and electric powertrains.

Phase 3: Consolidation (Years 6–10)

Hydropower Integration	• Fully integrate hydropower-driven charging networks, ensuring all public charging stations use renewable energy. • Deploy smart grids for efficient energy distribution, reducing grid emissions and operational costs.
Just Transition Fund	• Establish a dedicated Just Transition Fund for financial support to displaced workers, workforce skilling subsidies, and grants for rural EV entrepreneurs.
Research and Development (R&D)	• Partner with institutions like IIM Sirmaur and IIT Mandi to create an EV innovation hub, focusing on advanced batteries, autonomous vehicles, and charging solutions. • Collaborate with global leaders like BYD and Norway's EV ecosystem to adopt best practices in workforce reskilling and vertical integration.
Comprehensive Policy Framework	• Regularly update Himachal Pradesh's EV policy to align with trends in workforce inclusion, rural accessibility, and green tourism. • Introduce mandatory skill certifications for mechanics and transport operators entering EV services

Table 5 – Phased roadmap for a smooth just transition

Targeted interventions should focus on workforce upskilling, financial inclusion, and policy-driven incentives to ensure a smooth transition to the EV ecosystem. Here are some key targeted interventions for this plan:

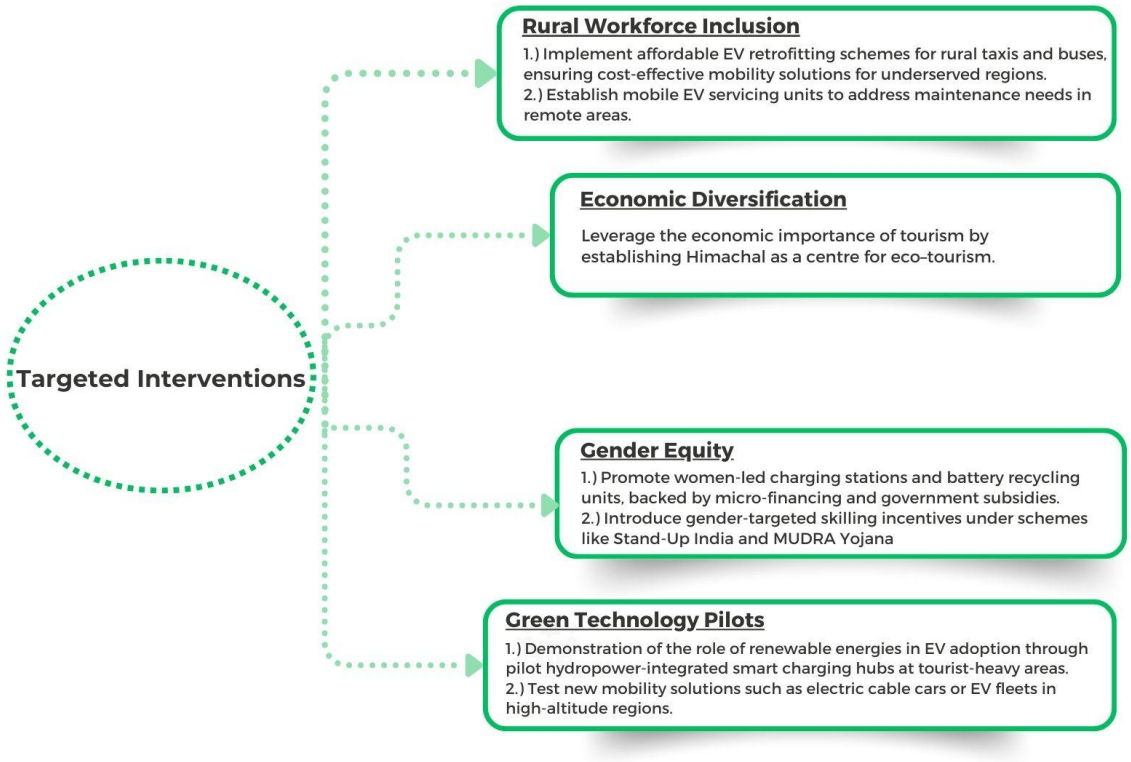


Figure 3 – Targeted interventions

5. Analysis of Skill Gaps

5.1 Identification of Skill Gaps in Each Phase at National and Regional Level

Upstream: Raw Material and Battery Manufacturing

India is import reliant on raw materials such as lithium and cobalt, which are the basis for battery manufacturing. Lack of indigenous battery cell manufacturing facilities has led to very strong skill gaps in battery chemistry, material science, and recycling. Closing the gap is of paramount importance to ensuring lower foreign dependence and a self-reliant EV ecosystem.

Himachal Pradesh can establish battery manufacturing units by leveraging renewable sources of energy. The state lacks battery manufacturing as well as recycling skills. While the region has numerous medium and large industries with over 60,000 employees, its industrial ecosystem for EV technology is still in its infancy stage. Recent initiatives to commission lithium-ion battery recycling units are an indicator of growing awareness of the economic as well as environmental advantages of localized recycling.

Closing the gap requires collaborations with institutions such as NPTEL for specialized courses in battery technologies. Apart from that, installation of pilot recycling units in industry clusters such as Baddi will enhance processes of material recovery and reduce carbon footprints in terms of disposal of batteries.

Midstream: EV Manufacturing and Assembly

Manufacturing is transforming at a fast pace with growing emphasis on automation and convergence of the digital, including EV manufacturing. India's EV market is expected to expand at 40.7% CAGR between 2025 and 2030 and will need another 5 crore skill workers in electrical drivetrains, robotics, and advanced automobile assembly processes.

Even though Himachal Pradesh lacks a big auto component cluster, it can focus on micro-mobility solutions that suit its unique topography. Electric bus launches in Shimla and green mobility policy initiatives are encouraging trends for sustainable urban mobility. There is still a pressing need, however, for training in battery management systems, robotics, and lightweight material design— critical for EV adoption in hill states.

Establishment of EV innovation centers with tie-ups with technical schools and MSME support programs for the production of EV components can help with skill development. Training in specialized areas like automation and robotics will equip the local workforce to service a transforming industry.

Downstream: Distribution, Maintenance, and Charging Infrastructure

The downstream value chain of EVs, including vehicle distribution, charging infrastructure, and aftersales maintenance, requires large-scale upscaling of the workforce and skill development. With EV penetration expected to reach 40-45% in two-wheelers and up to 20% in passenger vehicles by 2030, there is a pressing need for skilled manpower to manage the installation, maintenance, and grid integration of charging stations.

Himachal Pradesh lacks charging infrastructure, particularly along high-density tourist routes. Limited technical expertise in handling high-voltage systems and software-based vehicle diagnosis further restricts the growth of EV adoption. These challenges need to be overcome through large-scale training in high-voltage battery safety, charging station installation, and digital vehicle maintenance.

Strategic efforts like the establishment of charging corridors along national highways and the upscaling of existing petrol pump staff to manage multi-purpose EV charging stations can accelerate infrastructure growth. Industry association and technical training institutes can further support the establishment of a robust EV servicing ecosystem in the state.

5.2 Comparative Analysis of Traditional Automotive Skills and EV Industry Needs

Transformation of the workforce is a necessary condition for EV transformation. The traditional automotive sectors are experts in mechanical repair, internal combustion engine diagnosis, and metal work. The EV sector requires software-based vehicle monitoring, battery chemistry, high voltage protection, and automation-based manufacturing processes.

Battery Technology

Traditional automotive skills are based on lead-acid batteries, whereas the EV sector requires lithium-ion and solid-state battery technology skills. Thermal management, energy-efficient design, and battery management system (BMS) skills are needed to provide EV performance and safety. Absence of large-scale training programs for these skills is the greatest bottleneck to workforce preparation.

Manufacturing and Assembly

Transformation of manufacturing from manual assembly lines to robotics-based manufacturing is the greatest challenge to EV manufacturing. The sector's reliance on precision automation and digital integration requires skill-based training in robotic assembly, mechatronics, and digital manufacturing processes.

Charging Infrastructure and Grid Integration

In contrast to traditional automotive repair work, the EV sector requires high-voltage electrical system skills, charging station deployment, and grid integration. Workforce training in these areas will be the key to the creation of the EV ecosystem and ensuring efficient energy transfer for electric vehicles.

Workforce Development Strategies

Closing the gap between traditional automotive expertise and new EV sector requirements will require formal training programs, industry-academic partnerships, and policy-intervention in workforce development. Through industry-partnership-based collaborative skill development programs, Himachal Pradesh can be the pathfinder for sustainable transport and renewable energy powered mobility solutions.

6. Training Needs Assessment for EV Adoption in Himachal Pradesh

Transitioning the world to electric vehicles (EVs) requires a systematic training system to transform the workforce to the changing automotive environment. Himachal Pradesh needs to actively develop its workforce with EV technology, battery management, and charging infrastructure development capabilities. This report presents a detailed analysis of the prevailing skill gaps, training needs, and strategic implementation plans required to ensure a smooth transition to EV adoption in the state.

Training Needs Assessment

Battery Technology and Material Science. A skilled battery technology workforce is essential to establish a sustainable EV ecosystem. Since the state does not have a robust industrial base for battery production, systematic training is necessary to create competencies in assembling batteries, material processing, and recycling processes. Training programs must include assembling battery packs from imported cells with safety features, lithium-ion chemistry, and eco-friendly recycling methods. Himachal Pradesh does not have specific academic or vocational courses in battery lifecycle management. Association with the Automotive Skill Development Council (ASDC) and National Program on Technology Enhanced Learning (NPTEL) is suggested to create comprehensive training modules. Pilot recycling units must be set up to offer hands-on training and encourage second-life battery applications in renewable energy storage.

EV Production and Assembly Domestic manufacturing units for EVs are sparse, which constrains employment generation. Overcoming this necessitates investment in the training of EV powertrain employees, automation, and embedded systems. Technical training institutions must be involved with national and international EV manufacturers to design hands-on training facilities. ASDC and government skill development initiatives must introduce certification programs in drivetrain technology and robotics. An exclusive EV innovation center in partnership with ITIs/ IITs can stimulate industry-academia interface and research.

Maintenance, Charging Infrastructure, and End-of-Life Management EV deployment can only be realized if maintenance skills and charging infrastructure development are given the priority they deserve. Training must be concentrated in battery diagnostics, high-voltage safety, and fault finding by software. Installation and maintenance of charging networks must be a skill

acquired by technicians in addition to the incorporation of renewable energy sources. End-of-life battery management must be environment norm compliant. There are no Himachal Pradesh-trained EV service personnel present today. State-sponsored training institutes must specialize in EV servicing, and private sector incentives must be offered for training installing charging stations. Battery recycling programs must be dovetailed with local waste management plans to adhere to national e-waste regulation standards.

Himachal Pradesh's EV transition requires a skilled workforce, but existing training programs lack EV-specific expertise. The table below highlights current courses, their relevance, gaps, and recommendations for improvement.

Institution	Courses offered	Utility for Himachal EV transition	Gaps	Recommendations
ASDC	• Dealership Sales and Value-Added Services Executive • Automotive Service Technician (2/3-Wheelers) • Battery Electric Vehicle (BEV) Technician • Electric Vehicle Charging Station Technician	• Covers basics of EV systems like charging stations and service technician roles. • Provides a foundational understanding of EV sales and maintenance.	• Focused primarily on entry-level roles with limited advanced training. • No courses on autonomous vehicles, V2G systems, or advanced battery diagnostics. • Insufficient hands-on exposure.	• Expand curriculum to include advanced topics like EV drivetrains, battery recycling, and vehicle-to-grid (V2G) technologies. • Establish practical labs for hands-on training.
ITIs	• Electrician • Mechanic Motor Vehicle (MMV) • Wireman • Electronics Mechanic	• Relevant for foundational electrical and mechanical skills, which are transferable to EV charging stations, assembly, and maintenance.	• Courses are not specialized for EV-specific needs like high-voltage systems, battery assembly, and EV software diagnostics.	• Develop EV-focused modules within electrician and mechanic courses to include high-voltage safety, battery assembly, and software-based diagnostics.

			• Outdated training methods and equipment. • Limited EV focus in existing programs	• Upgrade facilities to include EV-specific tools and systems.
HPKVN	• IT/ITeS Courses • Logistics and Supply Chain Management • Infrastructure Equipment Training • Media and Entertainment	• Offers transferable skills in IT and logistics that can support EV software development and supply chain optimization.	• No dedicated EV-specific training programs. • Lack of focus on EV assembly, diagnostics, or charging infrastructure installation. • Limited partnerships with EV manufacturers.	• Introduce EV-specific programs on charging infrastructure deployment, battery diagnostics, and renewable energy integration. • Partner with EV manufacturers for industry-relevant training programs.

Table 6 - Assessment of Skill Development Programs for Himachal Pradesh's EV Transition

Implementation Strategy

Transitioning from ICE to EV requires a phased approach to develop a skilled workforce for the Electric Vehicle (EV) sector in Himachal Pradesh. Our recommended implementation strategy focuses on gradually expanding the training ecosystem and ensuring the workforce is equipped with evolving EV technologies

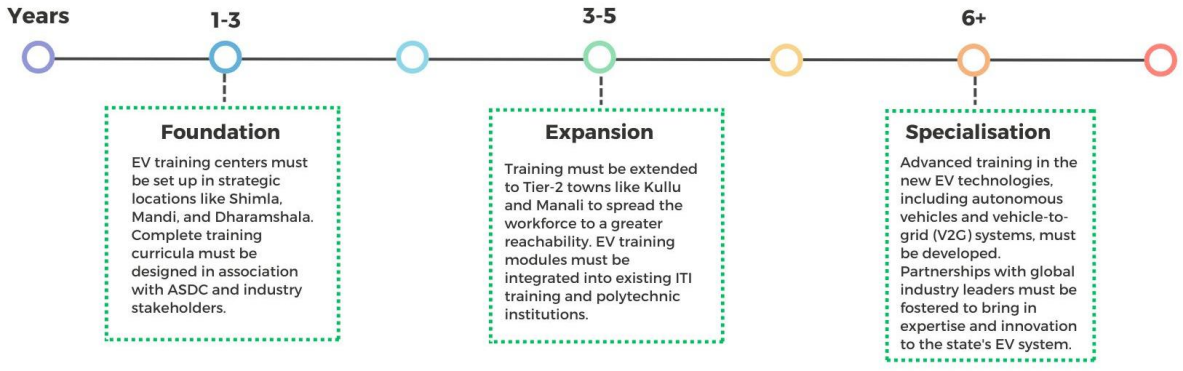


Figure 4 – Phased approach to develop a skilled workforce

7. Gender Dynamics

The transition to electric vehicles represents a once-in-a-generation opportunity to bridge gender gaps and reshape the workforce profile of the automobile sector. By giving priority to gender inclusivity, Himachal Pradesh can set the pace in the promotion of a diverse and inclusive workforce in the EV sector, resulting in both, economic and sustainable development.

Demographic and Socio-Economic Context

The state's population is approximately 7.5 million with a gender ratio of 974 females per 1,000 males and a literacy rate of more than 88%. The state's economy, traditionally agrarian, is gradually shifting towards industry and services, including tourism and hydroelectricity. Poverty levels have been declining continuously since 1994, particularly in rural areas, bridging the gap between urban and rural areas.

Geographical Context

The state has varied topography ranging from the low-lying Shivalik ranges to the Greater Himalayas. The diversified landscape influences settlement patterns, economic activities, and accessibility. The state's climate varies from subtropical in the south tracts of low levels to alpine in the north and east high mountains, influencing agricultural activity and everyday life.

Current Challenges in Gender Inclusion

Representation of Women in the Automotive Industry

The automobile and energy sector have traditionally been male-dominated. Women represent approximately 39% of the world's workforce but only 16% in the conventional energy sector. In the automobile sector, women represent less than 10% of the workforce. In India, women represent approximately 25% of the workforce in the manufacturing sector, including the automobile sector. In the renewable energy sector, women's participation is even minimal at 11%, far lower than the global average of 32%.

Barriers to Entry

Societal norms and limited access to STEM education due to cultural biases and limited access restrict women's involvement in technical and leadership positions. Moreover, the unavailability of inclusive facilities like childcare facilities and safe transport further discourages women from joining the workforce.

Lack of Skill Development Opportunities

There is no training program for EVs in rural areas, and places like Himachal Pradesh are lagging behind. Existing automotive training programs are biased toward ICE-related skills, and no scope exists for women to shift to EV industry-related jobs.

Opportunities for Gender Inclusion in the EV Sector

Emerging Industry Dynamics.

The EV sector focuses on battery technology, charging infrastructure, and software diagnostics with minimal physical labor involved, making it more suitable for women. Other aspects like battery recycling and renewable energy also offer opportunities for women entrepreneurs.

Micro-Mobility and Entrepreneurship

Micro-mobility solution, especially two- and three-wheelers for the Himachal Pradesh terrain, can offer opportunities for women in fleet management and maintenance. Encouraging women to run charging stations can also enhance gender diversity in the EV ecosystem.

Key Strategies for Gender Inclusion

Focused Skill Development Programs

ITI and ASDC partnership can offer the chance to create EV-specific training programs for women, such as battery technology training, software diagnostics training, and charging infrastructure maintenance training. Offering monetary incentives under schemes like MUDRA Yojana and Stand-Up India can also encourage women to participate more actively in these programs.

Entrepreneurship Support for Women

Investment in women-driven EV businesses, such as Omega Seiki Mobility's initiative to deploy 3,000 EVs for women entrepreneurs, can be a model for Himachal Pradesh. Setting up women-owned battery recycling units through financial support from state and national schemes can also create new employment opportunities.

Inclusive Workplace Policies

Incentivizing gender-inclusive workforce policies through tax benefits to firms adopting inclusive workforce policies is crucial. Also, offering workplace amenities like childcare centers, safe transportation arrangements, and flexible work timings can enhance female workforce participation.

Awareness and Outreach

STEM school and university programs can encourage young women to pursue EV technology careers. Outreach programs through local NGOs can overcome societal prejudice and make women's participation in the EV industry popular.

Global Best Practices

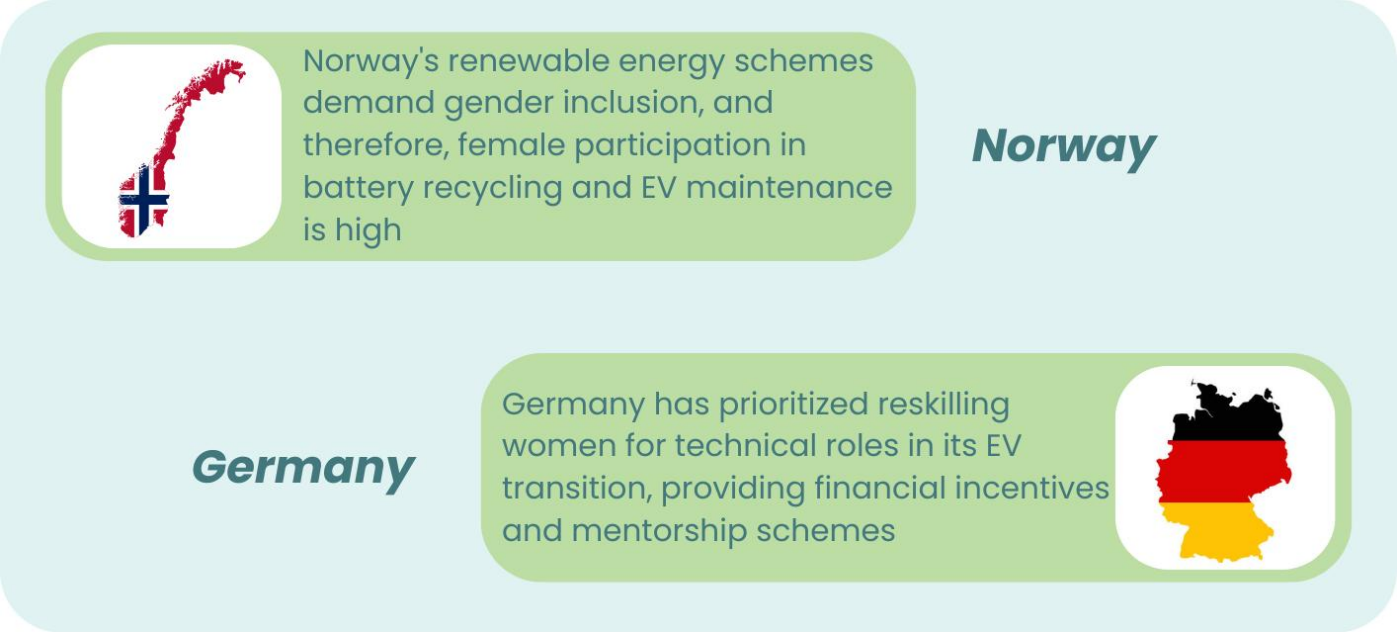


Figure 5 – Global best practice

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8. Recommendations

Skill Development

Skilled human resources are essential for a successful transition to an EV ecosystem in Himachal Pradesh. Reskilling and upskilling workers in traditional ICE-dependent industries is an immediate requirement to meet the special needs of EV manufacturing and maintenance. Establishing EV specific training centers in Shimla, Dharamshala, and Baddi will give hands-on training in battery assembling, high-voltage safety, diagnosis, and charging infrastructure maintenance. Tie-ups with IIM Sirmaur and Tata Motors can ensure industry relevance of the courses and outcome-based, experiential training.

Accessibility and Affordability

Accessibility and affordability are essential for mass-scale adoption of EVs in Himachal Pradesh. Fiscal incentives and excise tax rebates should be provided to make EVs cost-effective, particularly for rural transport operators and small-scale farmers. Expansion of the battery-swapping networks in two and three-wheelers can reduce initial costs and offer convenience, particularly in rural areas. Policies should ensure that charging stations are strategically placed to be inclusive and accessible.

Inclusive Transition

A just and equitable transition requires interaction with all the concerned stakeholders, including drivers, mechanics, and small transport operators, to address their concerns. Establishing a Just Transition Fund will benefit vulnerable communities by providing financial assistance for reskilling courses and affected workers. Special training programs for marginalized communities will ensure their access to new opportunities in the EV sector.

Charging Infrastructure

Establishing an effective charging infrastructure is crucial to enable EV adoption. Himachal Pradesh's rich hydropower resources can be utilized to develop green-powered charging corridors along highways like Shimla-Manali and Dharamshala-Pathankot. Charging stations must be installed in rural villages to serve local EV users. Public-private partnerships can be promoted to enable rapid and cost-effective growth of infrastructure.

Green Tourism

Himachal Pradesh's thriving tourism sector provides the best opportunity to promote EV adoption. Electrification of tourist buses and taxis on popular tourist circuits like Shimla, Manali, and

Dalhousie can reduce environmental damage and improve tourism experiences. Subsidies can be provided to hoteliers and tour operators to include EVs in their fleets, while electric bike rentals can offer green transport to tourists.

Gender Inclusion

Gender inclusion must be at the center of Himachal Pradesh's EV policy. Training modules must be designed with at least 50% of seats reserved for women, enabling them to take up opportunities in battery recycling, charging station management, and diagnostics. Fiscal incentives and grants can be provided to women entrepreneurs establishing EV-related businesses, creating a diversified workforce in Himachal Pradesh.

Public Awareness and Education

Public awareness campaigns are critical to dispel myths and build consumer confidence in EVs. Statewide information programs must emphasize the cost benefit, environmental advantage, and efficiency of EVs. Youth can be targeted through social media and outreach programs to emphasize EVs' role in combating climate change and building careers. Tourists must be encouraged as well to avail themselves of EV transport facilities within Himachal Pradesh.

Recycling and Circular Economy

Installation of battery recycling units in industrial clusters like Baddi can recover valuable material from waste batteries, reducing import dependence and ensuring resource conservation. Policies also need to ensure second-life use of batteries, for example, in renewable energy storage systems, to facilitate a circular economy in the EV sector.

Industry and MSME Support

The government needs to extend tax holidays and soft loans to MSMEs switching to EV production, facilitating local production. Cluster-based development programs need to focus on the production of lightweight auto parts and strategic EV parts like motors and inverters. These programs will localize industries and generate employment in targeted industrial clusters.

Renewable Energy Harnessing

Himachal Pradesh's abundant hydropower resources need to be tapped to develop a renewable energy-driven EV ecosystem. Smart-grid technology can optimize the power supply to EV charging stations and ensure a stable supply of energy to high-usage areas. Harmonization of renewable energy with EV infrastructure will make Himachal Pradesh a model for sustainable mobility.

Just Transition Fund

There must be a Just Transition Fund to assist the workers and small-scale industries which are affected as a result of the transition from ICE to EV technologies. The fund may provide grants to reskilling programs, finance MSMEs to shift to EV-dependent industries, and finance a social protection net for the affected communities.

Research and Collaboration

Association with institutions and global counterparts can accelerate the transition in Himachal Pradesh to EVs. Institutions like IIT Mandi and IIM Sirmaur must be in the forefront of the latest innovation in terms of EV technology and infrastructure. Association with global leaders like Norway and Germany would facilitate the incorporation of the best practices to build a sustainable and equitable EV platform.

Hydropower-Driven Charging Infrastructure

Himachal Pradesh can leverage its vast potential for hydropower to offer charging grids based on the principles of clean energy. Pilot smart-charging locations in tourist areas will encourage EV uptake while emphasizing initiatives towards sustainability. Such keen emphasis at the intersection of green energy and mobility solutions can place Himachal Pradesh at the pinnacle of green mobility.

Workforce Transition Public-Private Partnerships To facilitate an effortless workforce transition, public-private partnerships (PPPs) must be initiated to fund upskilling schemes. These upskilling programs must train current workers in EV industry skills like EV manufacturing, repair, and battery technology. Enabling the transition of MSMEs and current automobile workers to newer industry standards will facilitate a seamless transition to the electric mobility industry.

9. Conclusion

Himachal Pradesh's transition to electric mobility is a turning point to sustainable transport, in line with India's broader climate and energy goals. The state's geography, its tourism-based economy, and renewable energy endowments pose opportunities and challenges to EV adoption. The transition from ICE to EVs is not a technology transition but a socio-economic transition that must be managed equitably to make it an inclusive transition for all stakeholders.

The study identifies that skill development is one of the most critical elements of this transition. The auto sector in Himachal Pradesh, as in the rest of India, is currently organized around ICE technologies, and around 90% of the mechanics and workers are ICE vehicle repair experts. Without targeted reskilling efforts, upto 70% of these workers will be rendered jobless. Establishing EV-specific training centers in Shimla, Dharamshala, and Baddi, in partnership with institutions such as IITs/ITIs and industry leaders, will be crucial in equipping the workforce with the skills required in battery technology, diagnostics, and high-voltage safety.

Infrastructure development, particularly in charging networks, is another critical consideration. Himachal Pradesh's hydropower potential of over 10,000 MW is a robust base for clean energy-driven EV charging solutions. However, the lack of charging stations, especially in rural and tourist pockets, is a significant adoption hurdle. The establishment of hydropower-driven charging grids, charging corridors along highways, and smart-charging hubs in strategic tourism hubs will be critical in accelerating EV adoption while enhancing sustainability.

Affordability and access then become issues of primary concern. As much as financial incentives under national schemes such as FAME-II have encouraged EV adoption, subsidies for rural transport operators and small-scale enterprises targeting them will be required to induce deeper penetration. A battery-swapping network for two- and three-wheelers can also bypass range anxiety and the cost barrier, making EVs more affordable for more masses.

Gender inclusion in the EV industry is also brought to the fore by the study. Women presently constitute less than 10% of the automotive industry workforce, primarily in non-technical roles. Targeted skill development programs, financial incentives for women-owned EV enterprises, and gender-sensitive workplace policies can bridge the gap and develop a more diversified and inclusive industry.

Recycling and circular economy efforts will be crucial to long-term sustainability of EV adoption in Himachal Pradesh. Establishing battery recycling units in industrial estates such as Baddi will end dependence on imported raw materials, generate employment, and reduce environmental risks of battery disposal. Second-life application of EV batteries for renewable energy storage will also enable development of a sustainable energy infrastructure.

Last but not least, a comprehensive policy intervention will be required to allow a smooth transition. The state will have to utilize its renewable resources, make an investment in the re skilling of its workforce, and offer fiscal incentives for the usage of EVs. Creation of a Just Transition Fund will be required to neutralize the impact of the terminated workers, support MSMEs in the conversion of their factories to EV manufacturing, and secure a sustainable local economy. A study of the global EV technology and policy leaders like Norway and Germany can share best practices and learning in an effective transition.

With the incorporation of these steps together, Himachal Pradesh can be the nation's model of green mobility. With a holistic approach of infrastructure planning, workers' re-skilling, policy, and inclusiveness of stakeholders, the state can be a green transport model while safeguarding economic development and environmental stewardship.

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