



Policy Framework for Achieving Energy Independence in India: Governance, Institutional Reforms, and Strategic Policy Interventions

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Abstract

Energy independence has emerged as a strategic priority for India due to increasing energy demand, heavy dependence on imported fossil fuels, geopolitical uncertainties, and growing commitments toward climate change mitigation. While technological advancements in renewable energy have accelerated the transition towards a low-carbon economy, long-term energy independence depends fundamentally on effective public policy, institutional governance, industrial development, regulatory reforms, and financial innovation. This review critically examines India's policy framework for achieving energy independence through integrated governance rather than technology deployment alone. The study analyses major national policies, including the National Solar Mission, National Biofuel Policy, Production Linked Incentive (PLI) Scheme, National Green Hydrogen Mission, Faster Adoption and Manufacturing of Electric Vehicles (FAME), Renewable Purchase Obligations (RPOs), Perform Achieve and Trade (PAT), and India's updated Nationally Determined Contributions (NDCs). The review further evaluates policy gaps relating to regulatory fragmentation, domestic manufacturing, green finance, ESG governance, institutional coordination, and implementation challenges. Based on recent policy developments and international best practices, a multidimensional governance framework is proposed to strengthen

India's journey towards energy independence by 2047. The study concludes that effective governance, supported by policy consistency, industrial self-reliance, digital transformation, and sustainability-oriented institutions, will be more decisive than technology alone in ensuring long-term national energy security.

Keywords: Energy policy, Energy independence, India, Governance, Green finance, Industrial policy, Renewable energy, ESG.



1. Introduction

Energy has become one of the most important determinants of economic growth, industrial competitiveness, national security, and sustainable development. As the world's fastest-growing major economy and the most populous country, India faces an unprecedented increase in energy demand driven by rapid industrialization, urbanization, infrastructure development, and rising living standards. Although the country has made remarkable progress in expanding renewable energy capacity, fossil fuels continue to dominate the national energy mix. India remains one of the world's largest importers of crude oil, natural gas, and coking coal, making the economy highly vulnerable to global supply disruptions, price volatility, and geopolitical conflicts [1–5].

The concept of energy independence has therefore evolved beyond merely increasing domestic energy production. It now encompasses the ability of a nation to secure reliable, affordable, sustainable, and domestically controlled energy resources while minimizing dependence on external markets. For India, energy independence aligns closely with the national vision of *Atmanirbhar Bharat*, which emphasizes self-reliance in strategic sectors including energy, manufacturing, technology, and infrastructure. The Government of India has consequently introduced numerous policy initiatives aimed at diversifying the energy mix, promoting domestic manufacturing, improving energy efficiency, accelerating renewable energy deployment, and strengthening institutional governance [5–8].

Unlike earlier approaches that primarily emphasized energy generation, recent policy thinking recognizes that governance quality significantly influences the success of national energy transitions. Effective policy implementation requires coordination among multiple ministries, regulatory agencies, state governments, industries, financial institutions, research organizations, and civil society. Fragmented governance structures often delay project implementation, increase investment uncertainty, and reduce policy effectiveness. Therefore, strengthening institutional coordination has become as important as technological innovation in achieving long-term energy security.

India's policy landscape has evolved considerably during the past two decades. Major initiatives such as the National Solar Mission, National Wind-Solar Hybrid Policy, National Biofuel Policy, Production Linked Incentive (PLI) Scheme, National Green Hydrogen Mission, Green Energy Corridor Programme, Faster Adoption and Manufacturing of Electric Vehicles (FAME), Perform Achieve and Trade (PAT), and Renewable Purchase Obligations (RPOs) collectively represent one of the world's largest public policy efforts towards clean energy transition. These initiatives seek not only to reduce greenhouse gas emissions but also to improve industrial competitiveness, create employment opportunities, enhance domestic manufacturing capabilities, and reduce dependence on imported fossil fuels [4,5].

Recent global energy crises have further highlighted the importance of resilient energy systems. Disruptions in international fuel supply chains, fluctuating oil prices, and geopolitical conflicts have demonstrated that excessive dependence on imported energy creates economic and strategic vulnerabilities. Consequently, governments worldwide are increasingly integrating energy security objectives with climate policies, industrial strategies, and national economic planning. India has similarly repositioned energy policy as an instrument of economic resilience, industrial modernization, and strategic autonomy rather than solely as an environmental initiative.

In addition to renewable energy expansion, emerging policy priorities now include domestic manufacturing of solar photovoltaic modules, battery storage systems, wind turbines, electrolyzers, smart grid equipment, and critical mineral supply chains. These industrial policies aim to prevent future dependence on imported clean energy technologies while simultaneously promoting innovation, employment, and export competitiveness.



Such an integrated approach reflects the transition from conventional energy policy towards comprehensive energy governance.

Another significant development has been the increasing emphasis on environmental governance and sustainability reporting. Governments and investors are progressively recognizing that successful energy transition requires transparent institutional mechanisms capable of monitoring environmental performance, ensuring accountability, and preventing greenwashing. Strengthening Environmental, Social, and Governance (ESG) frameworks has therefore become an important policy priority for attracting sustainable investments and improving public confidence in renewable energy programmes. Studies have emphasized that robust ESG governance promotes policy transparency, enhances institutional credibility, and ensures that sustainability commitments translate into measurable environmental outcomes [9].

Digital transformation is similarly reshaping public policy implementation. Artificial intelligence, automation platforms, digital monitoring systems, smart grids, blockchain technologies, and data analytics have significantly improved regulatory efficiency, infrastructure planning, and policy evaluation. Digital governance enables governments to monitor renewable energy deployment in real time, optimize resource allocation, improve transparency, and reduce administrative delays. Recent evidence suggests that digital transformation significantly strengthens institutional performance and enhances strategic decision-making in complex policy environments [10].

Moreover, policy evaluation is increasingly moving beyond traditional economic indicators toward multidimensional sustainability assessment. Modern governance frameworks recognize that successful policies should simultaneously improve environmental quality, operational efficiency, industrial productivity, and social welfare. Comprehensive performance evaluation tools facilitate evidence-based policymaking and enable governments to prioritize investments that maximize long-term sustainability benefits. Such approaches are becoming increasingly important for evaluating national energy programmes and ensuring efficient utilization of public resources [11,12].

Despite considerable progress, numerous policy challenges continue to influence India's journey toward energy independence. Regulatory inconsistencies among states, financing constraints, inadequate grid infrastructure, limited domestic manufacturing of advanced technologies, skill shortages, and institutional fragmentation remain significant barriers. Addressing these issues requires integrated policy reforms rather than isolated technological interventions.

Objectives of the Study

This review has the following objectives:

1. To critically examine the evolution of India's energy policy framework for achieving long-term energy independence.
2. To evaluate major national policies supporting renewable energy deployment, industrial development, and energy security.
3. To identify institutional, regulatory, financial, and governance challenges affecting policy implementation.
4. To analyse the role of ESG governance, digital transformation, and sustainability assessment in strengthening energy policy.
5. To propose an integrated governance framework that supports India's vision of achieving energy independence by 2047 while promoting sustainable economic development.



Table 1. Evolution of India's Energy Policy Framework

Policy	Year	Primary Objective	Expected Contribution to Energy Independence
National Solar Mission	2010	Promote utility-scale and rooftop solar energy	Reduce coal dependence and expand renewable electricity
Perform Achieve and Trade (PAT)	2012	Improve industrial energy efficiency	Reduce national energy intensity
National Biofuel Policy	2018	Promote ethanol, biodiesel and advanced biofuels	Reduce petroleum imports
PM-KUSUM	2019	Solarization of agriculture	Replace diesel-powered irrigation systems
Production Linked Incentive (PLI) Scheme	2021	Develop domestic clean energy manufacturing	Reduce technology imports and strengthen industrial self-reliance
Updated National Determined Contributions (NDCs)	2022	Increase non-fossil electricity capacity	Accelerate clean energy transition
National Green Hydrogen Mission	2023	Promote hydrogen production and industrial decarbonization	Reduce dependence on imported fossil fuels in heavy industries

2. Evolution of India's Energy Policy Architecture

India's energy policy has undergone a significant transformation over the past three decades. Earlier policies primarily focused on ensuring adequate electricity generation and improving access to conventional energy resources. However, increasing dependence on imported fossil fuels, rapid industrialization, environmental degradation, and international climate commitments have shifted policy priorities towards energy security, sustainability, and long-term energy independence. Consequently, India's energy policy has evolved from a sector-specific approach to a comprehensive governance framework integrating industrial development, environmental protection, technological innovation, and economic resilience [1–5].

The evolution of India's energy governance reflects changing national priorities. During the initial phase, policy interventions emphasized electricity generation capacity, expansion of transmission infrastructure, and rural electrification. Although these initiatives significantly improved electricity access, they did not adequately address import dependence or environmental sustainability. The growing volatility of international crude oil prices and increasing concerns regarding climate change encouraged policymakers to diversify the national energy portfolio through renewable energy, energy efficiency, and alternative fuels.

The National Action Plan on Climate Change (NAPCC) marked a major turning point in India's energy governance. Through the National Solar Mission and associated climate initiatives, renewable energy became an integral component of national economic planning rather than merely an environmental objective. Subsequent policies expanded this vision by promoting energy efficiency, domestic manufacturing, transport electrification, and industrial decarbonization.

In recent years, the concept of energy independence has become closely aligned with the national vision of Atmanirbhar Bharat, emphasizing domestic production, technological self-reliance, resilient supply chains, and strategic autonomy. Rather than relying exclusively on imported fossil fuels or imported renewable energy technologies, India has adopted policies encouraging indigenous manufacturing, research and development,



digital innovation, and industrial competitiveness. This integrated policy approach simultaneously supports economic growth, employment generation, environmental sustainability, and national security.

The policy landscape has also become increasingly interconnected. Renewable energy policies are now closely linked with industrial policy, fiscal policy, environmental regulation, digital governance, foreign investment, and innovation strategies. Such policy integration reflects recognition that energy transition requires coordinated institutional action across multiple sectors rather than isolated technological interventions.

2.1 National Solar Mission: The Foundation of Renewable Energy Policy

The launch of the National Solar Mission represented one of the most significant milestones in India's clean energy transition. The policy established ambitious targets for solar energy deployment while creating financial incentives, regulatory mechanisms, and institutional support for both utility-scale and distributed solar projects. The mission transformed solar energy from a niche technology into one of the country's primary electricity sources [5].

Beyond increasing electricity generation, the Solar Mission also stimulated investment, technological innovation, employment generation, and manufacturing development. Falling photovoltaic costs combined with supportive government policies significantly accelerated private sector participation. The programme further encouraged state governments to formulate their own renewable energy policies, thereby strengthening decentralized governance.

The Solar Mission also demonstrated an important policy lesson: stable long-term policy commitments improve investor confidence and reduce investment risks. Consistent policy implementation has enabled India to emerge as one of the world's fastest-growing renewable energy markets while reducing dependence on fossil fuel-based electricity generation.

2.2 Production Linked Incentive (PLI) Scheme and Industrial Self-Reliance

Although renewable energy deployment expanded rapidly, policymakers recognized that excessive dependence on imported photovoltaic modules, batteries, and other clean energy technologies could create new strategic vulnerabilities. Consequently, industrial policy became an essential component of energy governance.

The Production Linked Incentive (PLI) Scheme seeks to strengthen domestic manufacturing by providing financial incentives for producing high-efficiency solar photovoltaic modules, advanced battery systems, electrolyzers, and other strategic clean energy technologies. Unlike traditional subsidy programmes, the PLI Scheme links incentives directly to manufacturing performance, encouraging productivity improvements and industrial competitiveness.

The policy contributes to energy independence through several mechanisms. First, it reduces dependence on imported renewable energy technologies. Second, it strengthens domestic supply chains for strategic equipment. Third, it generates skilled employment opportunities while encouraging technology transfer and innovation. Finally, domestic manufacturing enhances export potential and improves India's position within global clean energy markets.

Industrial localization has therefore become a central pillar of India's energy strategy. Rather than importing technologies required for future energy systems, the government increasingly emphasizes indigenous manufacturing capability capable of supporting long-term economic growth and strategic resilience.



2.3 National Green Hydrogen Mission

The National Green Hydrogen Mission represents a major expansion of India's energy policy beyond renewable electricity generation. While solar and wind energy primarily address electricity sector decarbonization, hydrogen policy focuses on reducing fossil fuel dependence within difficult-to-decarbonize industries such as steel, cement, fertilizer production, petroleum refining, shipping, and heavy transportation.

The mission promotes domestic electrolyzer manufacturing, renewable electricity integration, hydrogen infrastructure development, research and innovation, industrial demonstration projects, and international collaboration. By positioning India as both a producer and exporter of green hydrogen, the policy simultaneously addresses industrial competitiveness, energy security, and climate commitments.

Unlike earlier renewable energy policies, the Green Hydrogen Mission adopts an ecosystem approach encompassing manufacturing, research, finance, infrastructure, and skill development. Such integrated governance reflects the growing maturity of India's energy policy framework.

2.4 Policies for Energy Efficiency

Reducing energy demand is equally important as increasing renewable energy supply. India's energy governance therefore incorporates several demand-side management programmes aimed at improving industrial productivity and reducing energy intensity.

The Perform Achieve and Trade (PAT) programme encourages designated energy-intensive industries to improve operational efficiency through market-based mechanisms. Organizations achieving energy savings beyond prescribed targets can trade energy-saving certificates, thereby creating financial incentives for continuous efficiency improvement.

Complementary initiatives promoting efficient appliances, LED lighting, energy-efficient buildings, and industrial modernization further reduce national energy demand. These policies demonstrate that energy efficiency should be regarded as a strategic energy resource because every unit of energy saved reduces future dependence on fossil fuel imports while lowering infrastructure investment requirements.

2.5 Transport and Biofuel Policies

Transportation represents one of India's largest consumers of imported petroleum products. Consequently, transport policy has become increasingly integrated with national energy security objectives.

The Faster Adoption and Manufacturing of Electric Vehicles (FAME) programme promotes electric mobility through financial incentives, charging infrastructure development, and domestic manufacturing support. Simultaneously, the National Biofuel Policy encourages ethanol blending, biodiesel production, compressed biogas, and advanced biofuels to reduce petroleum consumption in sectors where electrification remains challenging.

These complementary policies illustrate the multidimensional nature of modern energy governance. Rather than relying upon a single technology, transport policy simultaneously promotes electrification, renewable fuels, domestic manufacturing, and digital mobility infrastructure.



2.6 Environmental Governance and ESG Policy

The transition toward energy independence increasingly depends on transparent environmental governance. Modern policy frameworks extend beyond regulatory compliance by incorporating Environmental, Social, and Governance (ESG) principles into decision-making, investment evaluation, and institutional accountability.

Effective ESG governance enhances investor confidence, improves policy transparency, and enables governments to evaluate environmental outcomes more systematically. Robust sustainability reporting also reduces the risk of greenwashing by ensuring that organizations demonstrate measurable environmental improvements rather than symbolic compliance.

Recent studies have highlighted that weak ESG governance often limits the effectiveness of sustainability policies because environmental commitments are not consistently translated into measurable operational performance. Strengthening ESG reporting standards, environmental auditing, and institutional accountability therefore represents an important policy priority for India's clean energy transition [6].

Furthermore, sustainability initiatives increasingly influence consumer behaviour, corporate competitiveness, and investment decisions. Integrating ESG principles into national energy governance can therefore simultaneously improve environmental performance and economic resilience [7].

2.7 Digital Governance and Policy Innovation

Digital transformation has become an increasingly important component of public policy implementation. Artificial intelligence, cloud computing, blockchain technology, digital twins, Internet of Things (IoT), and advanced analytics enable governments to improve planning, monitoring, regulation, and service delivery.

Digital governance enhances transparency by providing real-time monitoring of renewable energy projects, electricity generation, policy implementation, and financial performance. Automated information systems also reduce administrative delays, improve regulatory compliance, and strengthen evidence-based decision-making.

Automation technologies further improve institutional efficiency by reducing operational complexity and enhancing coordination among multiple government agencies. Digital platforms facilitate faster approval processes, better data management, and more effective public service delivery, thereby improving overall policy implementation [8].

As India's energy system becomes increasingly decentralized and digitally interconnected, policy frameworks must evolve to address cybersecurity, data governance, digital infrastructure, and intelligent energy management.

Table 2. Major National Policies Supporting Energy Independence

Policy Instrument	Policy Focus	Governance Objective	Contribution to Energy Independence
National Solar Mission	Renewable electricity	Renewable expansion	Reduced coal dependence
PLI Scheme	Industrial manufacturing	Domestic production	Import substitution
National Green Hydrogen Mission	Industrial decarbonization	Hydrogen economy	Reduced fossil fuel imports



PAT Programme	Energy efficiency	Demand-side management	Lower energy intensity
FAME	Electric mobility	Transport transformation	Reduced petroleum consumption
National Biofuel Policy	Renewable fuels	Fuel diversification	Lower crude oil imports
ESG Frameworks	Environmental governance	Accountability	Improved sustainability performance
Digital Governance	Smart policy implementation	Institutional efficiency	Better policy execution

3. Policy Challenges and Institutional Reforms for Energy Independence

Although India has introduced several progressive policies to reduce fossil fuel dependence, the successful implementation of these initiatives continues to face multiple institutional, regulatory, financial, and governance challenges. The transition towards energy independence is not constrained by technology availability alone but by the effectiveness of policy implementation, coordination among institutions, investment mechanisms, and long-term regulatory stability. Addressing these barriers requires comprehensive governance reforms capable of creating an enabling environment for sustainable energy development.

Unlike developed economies where policy frameworks have evolved over several decades, India's energy governance operates within a complex federal structure involving central ministries, state governments, regulatory commissions, public sector enterprises, private industries, financial institutions, and research organizations. While this decentralized system promotes regional flexibility, it also creates inconsistencies in policy implementation, investment approvals, tariff structures, and regulatory practices. Therefore, institutional coordination remains one of the most critical requirements for achieving long-term energy independence.

3.1 Policy Coordination and Institutional Integration

India's energy sector is governed by multiple ministries and agencies, including the Ministry of Power, Ministry of New and Renewable Energy, Ministry of Petroleum and Natural Gas, Ministry of Coal, Ministry of Heavy Industries, NITI Aayog, and various state electricity regulatory commissions. Although each institution performs specialized functions, overlapping responsibilities often delay policy implementation and reduce administrative efficiency.

Integrated governance is therefore essential for aligning renewable energy expansion, industrial development, transportation electrification, hydrogen deployment, manufacturing policies, and climate commitments under a unified national strategy. A coordinated institutional framework would improve policy consistency, reduce duplication of efforts, accelerate project approvals, and enhance accountability.

Creating a National Energy Independence Commission or an inter-ministerial coordination council could facilitate strategic planning, monitor policy implementation, resolve regulatory conflicts, and periodically evaluate progress towards national energy independence targets.

3.2 Regulatory Stability and Long-Term Policy Certainty

Investment in renewable energy infrastructure requires long planning horizons and substantial capital expenditure. Consequently, investors prioritize regulatory stability, predictable policy environments, and transparent administrative procedures. Frequent policy revisions, delays in regulatory approvals, changes in



tariff structures, and inconsistent implementation across states increase investment risks and discourage private participation.

Long-term policy certainty enables industries to make strategic investments in renewable energy manufacturing, battery technologies, hydrogen production, transmission infrastructure, and advanced energy systems. Stable regulations also encourage international collaboration, technology transfer, and foreign direct investment.

Strengthening regulatory governance therefore requires:

- transparent approval mechanisms;
- simplified licensing procedures;
- harmonized state-level regulations;
- predictable taxation policies;
- consistent renewable energy procurement mechanisms; and
- independent regulatory oversight.

Such reforms would significantly improve investor confidence and accelerate infrastructure development.

3.3 Green Finance and Investment Policies

One of the largest barriers to energy independence is financing. Although renewable energy technologies have become increasingly cost competitive, their deployment requires significant initial investment. Grid modernization, battery storage systems, hydrogen infrastructure, smart transmission networks, and domestic manufacturing facilities demand large-scale financial resources that cannot be supported solely through public expenditure.

India has made important progress by introducing sovereign green bonds, promoting climate finance, and encouraging private sector investment. However, financing gaps remain particularly for emerging technologies such as green hydrogen, long-duration energy storage, offshore wind, and advanced battery manufacturing.

Policy reforms should therefore encourage diversified financing mechanisms including:

- Green bonds;
- Sustainability-linked loans;
- Public-private partnerships;
- Infrastructure investment funds;
- Carbon markets;
- Climate-risk insurance;
- International climate finance; and
- Tax incentives for clean energy investments.

Developing an integrated green finance ecosystem will significantly accelerate the transition towards energy independence while reducing investment risks.

3.4 Domestic Manufacturing and Industrial Policy

Energy independence cannot be achieved if renewable energy technologies continue to depend heavily on imported equipment. Solar photovoltaic modules, lithium-ion batteries, advanced semiconductors, electrolyzers,



permanent magnets, and critical minerals remain strategic technologies requiring domestic manufacturing capability.

Industrial policy should therefore extend beyond assembly operations toward complete value-chain development encompassing:

- Raw material processing;
- Component manufacturing;
- Equipment fabrication;
- Research and development;
- Quality certification;
- Recycling industries; and
- Export promotion.

The Production Linked Incentive (PLI) Scheme represents an important step in this direction. However, additional policy support is required to strengthen research institutions, encourage technology transfer, improve industrial clusters, and promote innovation ecosystems capable of competing globally.

Developing indigenous manufacturing capability will simultaneously improve supply-chain resilience, create skilled employment, reduce import dependence, and strengthen national competitiveness.

3.5 ESG Governance and Policy Accountability

Modern energy governance increasingly emphasizes environmental accountability alongside economic performance. Governments, investors, industries, and financial institutions now expect measurable sustainability outcomes rather than symbolic policy commitments.

Environmental, Social, and Governance (ESG) frameworks provide structured mechanisms for evaluating environmental performance, institutional transparency, social responsibility, and corporate governance. Effective ESG governance strengthens policy credibility by establishing measurable indicators, disclosure standards, independent auditing, and public accountability.

Patyrykin and Vasyukova highlighted that weak ESG implementation frequently results in symbolic compliance, where organizations report sustainability commitments without demonstrating measurable environmental improvements. Such practices reduce investor confidence and weaken the effectiveness of public policies. Consequently, strengthening ESG reporting standards, independent verification systems, and environmental performance monitoring should become an integral component of India's energy governance framework [36].

Consumer awareness also increasingly influences corporate sustainability strategies. Organizations adopting credible sustainability initiatives improve public trust, market competitiveness, and stakeholder engagement. Therefore, integrating ESG principles into national energy policy provides both environmental and economic benefits [40].

3.6 Digital Governance and Institutional Modernization

Digital technologies are transforming the way governments formulate, implement, and monitor public policy. Artificial intelligence, blockchain, cloud computing, digital twins, smart meters, big data analytics, and Internet



of Things (IoT) platforms enable governments to improve transparency, operational efficiency, and decision-making.

Digital governance supports energy independence through:

- real-time monitoring of renewable energy projects;
- predictive maintenance of infrastructure;
- automated policy evaluation;
- intelligent electricity demand forecasting;
- digital approval systems;
- smart grid management; and
- integrated data sharing among government agencies.

Recent studies demonstrate that digital automation significantly improves organizational efficiency by reducing administrative complexity and enhancing strategic decision-making. Applying similar approaches within public administration can strengthen institutional performance while improving policy implementation [37].

Furthermore, artificial intelligence enables governments to analyze large datasets relating to electricity demand, renewable generation, emissions, investment flows, and infrastructure planning. Evidence-based policymaking supported by digital analytics can therefore improve both regulatory effectiveness and public service delivery.

3.7 Sustainability Assessment in Public Policy

Traditional policy evaluation has focused primarily on financial performance and economic growth. However, contemporary energy governance requires multidimensional evaluation incorporating environmental, operational, economic, and social indicators.

Comprehensive sustainability assessment enables policymakers to compare alternative investment strategies based on long-term national benefits rather than short-term economic returns. Such frameworks improve transparency, facilitate evidence-based resource allocation, and strengthen public accountability.

The Environmental–Efficiency–Economic (EEE) Impact Model provides a multidimensional framework capable of simultaneously evaluating environmental performance, operational efficiency, and economic viability. Similarly, the Plant Overall Performance (POP) Index supports continuous performance monitoring by integrating productivity, sustainability, and operational excellence into a unified assessment framework [38,39].

Integrating such sustainability assessment tools into national energy planning would improve investment prioritization, policy evaluation, and programme monitoring while ensuring efficient utilization of public resources.

Table 3. Policy Challenges and Recommended Institutional Reforms

Policy Challenge	Existing Limitation	Recommended Reform	Expected Outcome
Institutional fragmentation	Multiple agencies with overlapping responsibilities	National Energy Independence Commission	Improved coordination
Regulatory uncertainty	Policy inconsistency across states	Harmonized regulatory framework	Increased investor confidence



Financing constraints	Limited access to green finance	Green bonds, PPPs, climate funds	Faster infrastructure development
Technology imports	Dependence on imported equipment	Domestic manufacturing ecosystem	Industrial self-reliance
ESG implementation	Weak accountability and disclosure	Mandatory ESG reporting and auditing	Improved transparency
Digital governance	Fragmented information systems	AI-enabled integrated digital platforms	Better policy implementation
Sustainability evaluation	Economic indicators dominating decision-making	EEE Model and POP Index adoption	Evidence-based policymaking
Human resource capacity	Limited specialized workforce	Skill development and research collaboration	Strong innovation ecosystem

4. Strategic Policy Roadmap for Energy Independence

The analysis of India's existing policy framework demonstrates that substantial progress has been achieved in promoting renewable energy, industrial development, energy efficiency, and transport electrification. However, achieving complete energy independence by 2047 requires a more integrated governance framework capable of coordinating technological innovation, industrial policy, financial systems, environmental regulation, and institutional reforms. Rather than introducing isolated sector-specific interventions, future policies should adopt a systems-based approach that simultaneously strengthens energy security, economic competitiveness, environmental sustainability, and technological self-reliance.

A successful policy framework should therefore be based on five interconnected pillars: institutional governance, industrial transformation, financial innovation, digital modernization, and sustainability-oriented decision-making. These pillars should function collectively to create a resilient and adaptive energy governance system capable of responding to future technological, economic, and geopolitical challenges.

4.1 Institutional Reforms for Effective Governance

Institutional effectiveness remains the foundation of successful public policy. Although India has established multiple agencies responsible for energy planning and regulation, greater coordination among ministries and regulatory authorities is required to improve policy consistency and implementation efficiency.

A centralized institutional mechanism dedicated to energy independence could improve long-term planning, reduce duplication of responsibilities, facilitate inter-ministerial coordination, and monitor policy outcomes. Such an institution should regularly evaluate national progress, recommend policy revisions based on technological developments, and coordinate state-level implementation strategies.

Similarly, strengthening the role of state governments is essential because energy infrastructure development, renewable energy deployment, land acquisition, electricity distribution, and industrial investment largely occur at the regional level. Improved coordination between central and state governments would accelerate project implementation while reducing regulatory uncertainty.

Periodic policy evaluation should become mandatory to ensure that national programmes continue to achieve their intended objectives. Independent assessment committees comprising policymakers, researchers, industry representatives, and financial experts can provide objective evaluations and recommend corrective measures where necessary.



4.2 Strengthening Industrial and Manufacturing Policies

Industrial development should remain one of the central pillars of India's energy independence strategy. Domestic manufacturing not only reduces dependence on imported technologies but also generates employment, stimulates innovation, strengthens supply chains, and improves export competitiveness.

Future industrial policies should focus on developing complete value chains for strategic energy technologies including solar photovoltaic modules, wind turbine components, advanced battery systems, hydrogen electrolyzers, smart grid equipment, power electronics, and battery recycling industries.

Special emphasis should also be placed on developing domestic capabilities in critical minerals, semiconductor technologies, and advanced materials required for clean energy manufacturing. Investment in research and development, industrial clusters, technology parks, and university-industry collaboration will further strengthen India's innovation ecosystem.

Public procurement policies may also encourage adoption of domestically manufactured clean energy technologies while ensuring quality standards and international competitiveness.

4.3 Financial Policies Supporting Energy Transition

Long-term energy independence requires sustained financial investment. Although government support remains important during early stages of technology deployment, private investment must become the principal driver of future energy infrastructure development.

Policy reforms should therefore strengthen financial instruments supporting renewable energy projects, battery manufacturing, hydrogen infrastructure, digital energy systems, and industrial modernization.

Key financial priorities include:

- Expansion of sovereign green bonds.
- Development of green infrastructure investment funds.
- Promotion of sustainability-linked financing.
- Strengthening public-private partnerships.
- Carbon pricing mechanisms.
- Risk-sharing instruments for emerging technologies.
- Tax incentives for clean energy investments.
- Easier access to low-interest financing for domestic manufacturers.

A diversified green finance ecosystem would improve investment certainty while accelerating large-scale infrastructure development.

4.4 Digital Transformation of Energy Governance

Digital technologies are rapidly transforming policy implementation across the world. Artificial intelligence, cloud computing, blockchain, Internet of Things (IoT), digital twins, and advanced analytics provide governments with new capabilities for planning, monitoring, and evaluating complex infrastructure systems.

India should continue expanding digital governance across the entire energy sector through:



- national digital energy databases;
- AI-based electricity demand forecasting;
- smart grid management systems;
- digital monitoring of renewable energy projects;
- automated regulatory compliance systems;
- integrated project approval platforms; and
- predictive maintenance of national energy infrastructure.

Digital governance also improves transparency by providing real-time information on project progress, financial expenditure, renewable energy generation, and policy outcomes. Improved data availability supports evidence-based policymaking while reducing administrative inefficiencies.

Automation and digital decision-support systems can further enhance institutional productivity by improving coordination among ministries, regulators, industries, and financial institutions

4.5 ESG Governance and Sustainability Policies

Future energy governance should emphasize measurable sustainability outcomes rather than policy announcements alone. Transparent Environmental, Social, and Governance (ESG) reporting systems should therefore become integral components of India's energy transition strategy.

Mandatory sustainability reporting for large energy companies, independent environmental auditing, standardized ESG disclosure frameworks, and digital sustainability monitoring would improve transparency and investor confidence.

Strong ESG governance also encourages responsible investment, reduces environmental risks, and enhances institutional accountability. By integrating environmental performance indicators into public policy evaluation, governments can ensure that clean energy investments generate measurable social, economic, and environmental benefits.

Sustainability assessment should also become mandatory for large public investments in energy infrastructure. Comprehensive evaluation frameworks that simultaneously consider environmental performance, operational efficiency, economic feasibility, and social impacts provide more balanced policy decisions than conventional financial analysis alone.

4.6 Research, Innovation, and Human Capital Development

Technological leadership is closely linked to research capacity and skilled human resources. Universities, national laboratories, industries, and innovation centres should collaborate more closely to accelerate technology development and commercialization.

Future research priorities should include:

- advanced battery technologies;
- hydrogen production and storage;
- offshore wind systems;
- floating solar technologies;
- carbon capture and utilization;



- circular economy applications;
- battery recycling;
- artificial intelligence for energy management;
- smart grid cybersecurity; and
- integrated energy system optimization.

Skill development programmes should prepare engineers, policymakers, researchers, technicians, and administrators capable of supporting India's evolving clean energy economy.

Strengthening collaboration between academic institutions and industries will facilitate technology transfer while improving workforce readiness for future energy systems.

5. Policy Implications

The findings of this review provide several important policy implications.

First, energy independence should be treated as a comprehensive national development objective rather than solely as an energy sector initiative. Future policies must integrate industrial development, environmental sustainability, technological innovation, digital governance, and financial reforms within a unified strategic framework.

Second, institutional coordination should become a major policy priority. Better collaboration among ministries, regulatory authorities, state governments, industries, financial institutions, and research organizations will improve implementation efficiency and reduce policy fragmentation.

Third, domestic manufacturing should receive continued policy support to reduce dependence on imported renewable energy technologies and strengthen national industrial competitiveness.

Fourth, governments should adopt digital governance tools to improve transparency, evidence-based policymaking, infrastructure monitoring, and public accountability.

Finally, sustainability assessment frameworks should become integral components of national energy planning to ensure that public investments maximize environmental, economic, and social benefits.

6. Future Policy Priorities

India's energy governance should increasingly focus on the following strategic priorities:

- Establish a National Energy Independence Commission for integrated policy coordination.
- Expand domestic manufacturing under the Production Linked Incentive programme.
- Strengthen green finance through sovereign green bonds and climate investment funds.
- Accelerate implementation of the National Green Hydrogen Mission.
- Modernize electricity transmission through smart grid technologies.
- Develop national battery recycling and critical mineral strategies.
- Promote digital governance and artificial intelligence in policy implementation.
- Strengthen ESG disclosure standards and environmental accountability.
- Encourage university-industry-government partnerships for clean energy innovation.
- Establish comprehensive sustainability assessment mechanisms for all major public energy investments.



7. Conclusion

Energy independence has become one of India's most important strategic priorities for ensuring long-term economic resilience, national security, and sustainable development. The review demonstrates that achieving this objective depends fundamentally on effective governance rather than technological deployment alone. Although renewable energy expansion remains an essential component of the transition, successful implementation requires coordinated public policies that integrate industrial development, institutional reform, financial innovation, digital governance, and environmental accountability.

India has already established a strong policy foundation through initiatives such as the National Solar Mission, National Green Hydrogen Mission, Production Linked Incentive Scheme, National Biofuel Policy, Perform Achieve and Trade programme, and electric mobility policies. Collectively, these initiatives have accelerated renewable energy deployment, strengthened domestic manufacturing, promoted energy efficiency, and improved investment confidence. However, policy fragmentation, financing constraints, regulatory inconsistencies, technology dependence, and institutional coordination continue to present significant challenges.

The review further indicates that future energy governance should prioritize long-term policy stability, integrated institutional planning, domestic manufacturing ecosystems, digital transformation, and transparent sustainability reporting. Strengthening ESG governance, expanding green finance, improving regulatory coordination, and adopting evidence-based policy evaluation frameworks will enhance implementation efficiency while increasing investor confidence and public accountability.

A multidimensional governance framework integrating industrial policy, financial mechanisms, digital technologies, sustainability assessment, and institutional collaboration provides the most effective pathway toward achieving energy independence. Such an approach will not only reduce dependence on imported fossil fuels but also promote technological innovation, employment generation, industrial competitiveness, environmental protection, and inclusive economic growth.

Ultimately, India's transition to energy independence should be viewed as a national governance transformation rather than solely an energy transition. Through sustained policy commitment, institutional excellence, and strategic long-term planning, India can establish a resilient, self-reliant, and sustainable energy system that supports economic prosperity while contributing to global climate objectives.

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