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Assessing the Role of Policy and Regulatory Frameworks in Pakistan's Energy Crisis: Developing an Alternative Model for Sustainable Transformation

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ABSTRACT

This study investigates how Pakistan's energy policies and regulations shape the sector, focusing on governance hurdles and outlining more sustainable pathways. Using an explanatory sequential mixed-methods approach, it compares secondary quantitative indicators from national energy publications with primary qualitative insights drawn from semi-structured interviews and focus groups, thus placing top-level policy ambitions beside everyday implementation challenges. The analysis shows that, while the Alternative and Renewable Energy Policy 2019, the National Electricity Policy 2021, and pledges under the Paris Agreement and SDG 7-follow global sustainability norms, real-world outcomes remain disappointing owing to fragmented institutions, uncertain rules, poor finances, and limited technical know-how. Overlapping responsibilities at NEPRA, AEDB, WAPDA, CPPA-G, and provincial authorities breed duplication, delays, and skewed incentives. Meanwhile, circular debt exceeding PKR 2.6 trillion compounds inefficiencies in procurement, billing, subsidies, and cost recovery, undermining public confidence. In addition, ageing infrastructure and a lack of trained staff slow grid upgrades and the smooth entry of renewables. Local actors warn that top-down planning ignores community priorities and call for decentralized, inclusive models such as solar mini-grids backed by capacity-building and capital. Drawing on the frameworks of Institutional Rational Choice and fiscal federalism, this article contends that Pakistan's enduring energy shortfall is, at its core, a crisis of governance. Absent institutional coherence rooted in stable rules, realistic finances, coordinated planning, strengthened capacities, and decentralization that centers on

communities, the country's long-term energy goals will remain out of reach. The analysis therefore puts forward a comprehensive governance model that includes a centralized Energy Transition Authority, clearer regulatory pathways, open tariff-setting, capacity-building initiatives, and planning frameworks grounded in local priorities.

Keywords: Energy Governance; Policy implementation; Circular Debt; Institutional Fragmentation and Decentralized Energy Planning

INTRODUCTION

Pakistan's energy system now sits on the edge of crisis, and the situation worsens with the nations roughly 2 percent yearly population growth. More people means more lights, factories, and hospitals, yet wiring, grids, and power plants built decades ago struggle to meet the surge. Demand keeps climbing while reliable supply slips further out of reach. By 2020 the shortfall topped 35.6 terawatt-hours (TWh), leaving blackouts across homes and businesses and costing the economy dearly, especially those who can afford it least [1,2]. This problem goes far beyond the daily hassle of blackouts; the economy takes a serious hit, crippling factories that must run nonstop and putting a brake on growth prospects for years to come [3]. In 2020 the gap between how much power people wanted and what the grid delivered stood at an eye-popping 35.6 TWh, draining public and private wallets alike while heaping more hardship on already poor households [4]. Because of that shortfall production lines stalled, layoffs surged in energy-hungry sectors, and the longer brighter future every citizen hopes for slipped a bit further out of reach [5]. Looking at national demand patterns in Figure 1, it is clear that Pakistan still leans heavily on traditional fuels-oil, natural gas, coal, and liquefied petroleum gas-instead of the diverse mix that modern economies use [6,7,8]. By 2020 total consumption hit 75.6 million tons of oil equivalent (MTOE), a figure that keeps rising as population and industry grow [9]. Yet even with domestic reserves scattered across the landscape, countless villages, especially in the rural heartland, still pay far too much-or nothing at all-for power that is neither cheap nor reliable.

The situation therefore calls for urgent action to harness the countrys abundant renewable options-especially solar, wind, and hydropower-in order to bridge the widening demand-supply gap and furnish lasting energy solutions (10). Throughout the 1990s, Pakistans energy landscape shifted dramatically, moving from heavy reliance on hydroelectric generation to a growing dependence on imported oil (11, 12). This pivot has worsened the current energy deficit and left the nation vulnerable to global price swings and supply disruptions (13, 14). In answer to these challenges, the government has launched several initiatives designed to reduce imports and promote the use of home-grown energy resources.

The National Energy Efficiency and Conservation Policy 2023 therefore seeks to foster a culture of saving energy while increasing overall resource efficiency, aiming to double energy effectiveness through market-oriented measures [15].

Central to this initiative is the notion that energy efficiency serves as the First Fuel, a perspective that underscores its crucial role in securing and sustaining the nations energy future [2,16]. The National Electricity Plan 2023-2027 further reinforces this goal by calling for greater integration of renewable power into the grid, thereby diversifying the energy mix and reducing dependence on fossil fuels [17,18].

Notwithstanding these regulatory developments, particularly during high demand seasons, energy shortages continue. While winter months are characterized by natural gas shortages, summer months typically see spikes in electrical demand causing regular load shedding. These ongoing problems underline the need of ongoing investments in energy infrastructure, diversification of energy sources, and stronger regulations supporting energy efficiency and sustainability [6, 19, 20]. Not just to meet growing power demand but also to lower Pakistan's dependency on fossil fuels, which are more and more vulnerable to supply interruptions and price volatility, the move to renewable energy has become absolutely necessary [21].

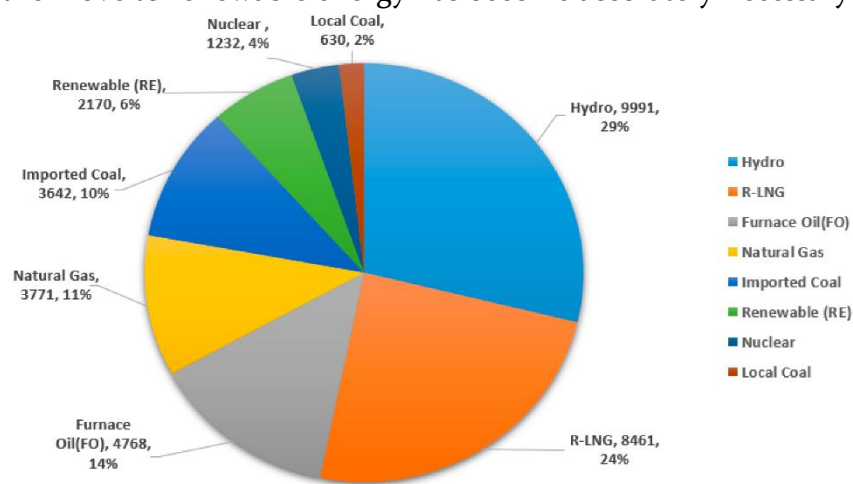


Figure 1: Energy mix of Pakistan in 2020 in MW and percentage share

Incorporating renewable energy technologies like solar and wind into its energy infrastructure would help Pakistan to offset the negative consequences of climate change, lower carbon emissions, and provide a more consistent and steady electricity supply. For off-grid rural communities, where traditional energy infrastructure is undeveloped, renewable energy sources offer significant promise. In this regard, solar energy offers a cheap and decentralized answer, especially in distant areas, but wind energy, especially in Sindh and Balochistan, offers the possibility of large-scale power production [22,23]. Driven by the demand for sustainability and the need to fight climate change, the energy industry worldwide is experiencing fundamental transition. To cut reliance on fossil fuels and limit greenhouse gas emissions, several nations are turning more and more to renewable energy sources such as wind, solar, and hydropower [24,25]. Advancements in technology and falling prices have helped renewable energy technologies, especially solar and wind, to make notable progress in recent years [26]. Setting an example for Pakistan to follow, countries such as China, Germany, and the United States have led large-scale solar and wind energy development.

Increasing energy security also depends on renewable energy as countries

strive to diversify their energy source under geopolitical tensions and erratic worldwide markets [29]. Given Pakistan's excessive dependence on imported oil and natural gas, the need for energy security is especially urgent [30]. Including renewable energy into the national grid might lower susceptibility to global price changes, provide energy security, and support sustainable development [30]. Moreover, Pakistan's energy infrastructure is marked by inefficiencies, especially in the electrical sector, where ongoing power shortages—usually coupled with load shedding—hinder industrial and home production [31]. Solar, wind and hydropower among other renewable energy sources provide unexploited potential to help to offset these difficulties. Wind power is best in areas like Sindh and Balochistan, whereas the southern parts of Pakistan get great sun radiation, which makes them perfect for big-scale solar energy use [34,35,36]. Though the need for energy in the nation is rising, development of renewable energy sources lags given great promise. Advanced energy modeling techniques are very necessary if Pakistan is to create a more sustainable energy future as they will help to maximize operational efficiency as well as long-term planning. Integrated ways to solving these energy issues are provided by energy modeling methods such the Load Utilization Technology (LUT) model and the Long-Range Energy Alternatives Planning (LEAP) model. LEAP offers insights on renewable energy integration and future energy security by modeling long-term energy demand and policy effects (Figure 2). The LUT framework, oriented toward real-time decision-making (see Figure 3), boosts grid performance while cutting transmission losses [41,43]. If Pakistan merges it with LEAP, the nation can better use its plants, forecast future demand, and draft smoother plans for adding renewables [45]. Pairing long-range planning with instant control, this dual approach should fortify Pakistans energy system against shocks. LEAP can test policy options, while LUT fine-tunes daily operations; together they offer a clearer, more sustainable path through persistent energy challenges [45,46].

The argument for using both the LEAP and LUT models rests on their individual strengths and the way they complement each other when tackling energy-planning problems. The LEAP tool offers valuable projections of how policies, new technologies, and rising shares of renewables will shape energy use over decades. Yet these long-term insights mean little if decision-makers ignore daily realities such as load matching, grid wear, and on-the-fly dispatching, tasks that only LUT can handle. Conversely, LUT excels at short-term optimization but lacks the horizon scanning required to steer investments and policies far into the future. Joining the two therefore gives planners both the minute-to-minute agility and the thirty-year roadmap needed for a cleaner, safer energy system. After laying this theoretical groundwork, the study turned to Pakistans own energy troubles. It stressed that any solution must start with strong, clear rules if growth in demand is to be met without devastating the environment. On that basis, the paper then reviews how todays governance actually works and sketches the reforms needed to tighten security and boost performance.

The research sought to further build a stronger and more sustainable energy

grid in Pakistan by concentrating on two interrelated tasks: weaving additional renewable sources into the current mix and fine-tuning the assets already in place.

Research Questions and Objectives

The study explored three key questions concerning the sustainability of Pakistan's energy sector as framed by current regulatory structures. The country faced an energy crisis because managerial capacity and governmental oversight proved woefully inadequate and weak. To achieve meaningful change, Pakistan therefore requires a fresh set of rules and accompanying policies designed to strengthen, streamline, and modernize the sector.

The research evaluated existing policy frameworks to measure their effectiveness while identifying governance weaknesses to establish an evidence-based sustainable energy transition framework. The research design combined qualitative and quantitative methods to provide a deep understanding of Pakistan's energy problems and develop implementable solutions for change.

The study established specific research objectives, which concentrated on analyzing three essential aspects: (1) To analyze the effectiveness of current policy and regulatory frameworks in addressing Pakistan's energy challenges. (2) To identify key gaps and inefficiencies in governance mechanisms and their impact on energy sustainability and (3) To develop and propose an evidence-based alternative model for sustainable energy transformation in Pakistan.

Theoretical framework

The research follows critical realism principles to identify foundational structures and mechanisms which affect Pakistan's energy sector. Critical realism enables researchers to analyze energy governance mechanisms that extend past observable facts and involves the study of systemic inefficiencies and institutional complexities [47,48]. The research draws on grounded theory to examine interview and focus group data systematically which produces findings that deeply reflect empirical evidence and actual settings [49].

METHODOLOGY

Study Design

The research design of the study integrated qualitative methods with quantitative data to establish a thorough comprehension of the energy crisis. The current study employed an explanatory sequential design that commenced with the examination of secondary quantitative data and subsequently transitioned to the acquisition of primary qualitative data. This mixed-methods design offered rich explanations for the issues flagged and, at the same time, painted a broad picture of long-term trends. The IEP Outlook and the SDPI Renewable Energy Reports acted as useful secondary records, revealing overall sector performance, renewable uptake, and lingering governance gaps. To look behind those numbers, the researcher conducted interviews, focus groups, and stakeholder seminars, gathering firsthand accounts that unpacked patterns and surfaced tangled policy and management hurdles.

In short, the inquiry leaned on both primary testimonies and pre-existing documents. Quantitative figures supplied hard metrics- adoption rates, efficiency scores, and other benchmarks-that, when read together, spotlighted systemic operational cracks. Interviews and group discussions added depth, showing how socio-economic pressures and regulatory binders drive or stifle change. By cross-referencing these two data worlds, the study not only mapped barriers but also sketched actionable paths toward a greener, more resilient energy system.

Study Population and Sampling

Purposive sampling allowed the investigators to select individuals who hold distinct professional roles and engage directly with Pakistan's energy landscape. Participants thus included policymakers, regulators, private-industry executives, and academic scholars. Data was gathered through interviews and focus-group discussions, each session purposely directed at people whose experience promised a broad and informed outlook.

Interviews involved senior NEPRA officials, Ministry of Energy staff, and executives from private renewable-energy firms. This lineup was intended to build a comprehensive picture of the country's governance architecture and the machinery of policy creation. Focus groups then convened sector officials, community representatives, and NGO activists, blending voices from various regions. Together, these discussions unearthed insights into operational hurdles, regulatory roadblocks, and the socio-economic fallout of ongoing energy reforms.

Data Collection

The study tackled its core problem by blending new, firsthand information with existing written material. Specifically, evidence came from direct interviews and focus-group talks, plus archived policy papers and official reports. Primary sources shed light on the day-to-day hurdles and rules staff face, while the background documents revealed how these rules have worked over time. For the latter, the team turned to publications from NEPRAs own output, the Ministry of Energy, and global databases such as the IEA [1-6, 23, 50-55]. First-hand insight stemmed from semi-structured chats and group sessions with government officials, factory managers, and civil-society experts, offering rich, local colour to the numbers. These interactions framed the countrys energy troubles in plain language, far beyond dry statistics. To guide those talks, each research goal was translated into a set list of questions and exercises. Before the main fieldwork, a pilot ran checked that the tools made sense and produced consistent replies. Sessions then covered the full policy cycle-design choices, regulatory bottlenecks, green-power uptake, and the wider social and economic fallout. Following a clear schedule, the team spoke with community leaders, industrial heads, and rule-makers, weaving their voices into one cohesive story.

Data Analysis and Synthesis

The study first carried out thematic analysis on qualitative insights from interviews and focus group discussions, pinpointing repeated issues such as weak governance and barriers to renewable energy uptake. It then turned to quantitative

methods to test policy effectiveness and measure actual energy output. In addition, qualitative and numeric results were deepened by comparing Pakistans energy sector with global leaders such as Germany and China. A scenario simulation of the alternative model, built from earlier findings, assessed how well it might perform in practice. Feedback from stakeholders and sensitivity checks were folded into the final design, producing a cohesive framework for a sustainable energy shift.

DATA ANALYSIS

The mixed-methods study shows a basic contradiction at the heart of Pakistans energy management . Although the country has put in place a forward-looking sustainability frame-work, most notably the Alternative and Renewable Energy Policy of 2019, its regulatory systems and day-to-day operational capacity remain weak. Evidence reveals that energy objectives align with national development goals and international green targets, yet implementation stalls because governance is fragmented, politics are volatile, equipment is outdated, and the economy is financially unstable. These conclusions are backed by policy reviews plus sixteen interviews and twenty-three focus-group sessions held in Faisalabad, Lahore, and Islamabad.

Overview of Current Policy and Regulatory Frameworks

In answering the first research question, the investigation catalogues several current policy tools aimed at widening energy access, securing financial viability, and boosting renewable uptake. Among these are the 2021 National Electricity Policy and the 2016 National Energy Efficiency and Conservation Act, alongside the 2019 Renewable Energy Policy [54, 55, 56]. Although these documents share broad goals of affordability, sustainability, and diversification, the fieldwork reveals that turning them into action is hampered by unclear rules and weak inter-agency cooperation. Interviews with officials from NEPRA, WAPDA, and the Ministry of Energy confirmed a persistent gap between what is written on paper and what happens on the ground. Take the Alternative Energy Development Board (AEDB): tasked with leading renewables, it remains constrained by a lack of autonomy and scarce funding, which hobbles progress. NEPRAs duty to set tariffs is likewise undermined when political pressure intervenes, eroding the very independence that effective regulation requires. So long as the regulatory environment stays reactive and fractured, with overlapping federal and provincial mandates tugging in different directions, integrated plans cannot be rolled out smoothly and project approvals are repeatedly stalled. Even with these frameworks in place, therefore, their power to steer the energy sector toward a sustainable future is severely limited by shortcomings in implementation and fundamental structural weaknesses.

Interviews conducted with senior personnel from NEPRA and the Ministry of Energy disclose a notable divide between policy drafting and on-the-ground execution. One NEPRA official remarked, "Our policies look robust on paper, but implementation fails because federal and provincial agencies never sync."

A policy advisor echoed the point: "No single unit is charged with monitoring progress, and that vacuum invites mismanagement."

Private sector actors, such as Reon Energy, expressed frustration with procedural inefficiencies:

“We face months of delays in getting project clearances because we have to navigate multiple layers of bureaucracy. This increases project costs and discourages investment.”

These governance challenges are further compounded at the community level. FGD participants in rural Faisalabad highlighted how electrification efforts often falter due to top-down policymaking. One participant noted:

“Policies are made in Islamabad, but they don’t reflect our realities. Electrification projects stall because local authorities aren’t empowered or lack resources.”

Alignment with National and International Sustainability Standards

The second research question, is addressed through a comparative analysis of Pakistan’s energy goals vis-à-vis the Sustainable Development Goals (SDG-7 and SDG-13), the Paris Climate Agreement, and benchmarks from countries like Germany and China. Pakistan’s renewable energy targets—30% of electricity generation by 2030 and 60% clean energy by 2040—demonstrate formal alignment with global climate goals [57]. The Nationally Determined Contributions (NDCs) also set emissions reduction targets contingent on international financial support [58]. However, findings from policy performance indicators (Table 1.) indicate that these targets remain largely unmet due to systemic inefficiencies. Quantitative data shows that the share of renewable energy remains stagnant at 6.8%, well below regional benchmarks. Grid losses continue to hover around 18–20%, and transmission infrastructure is outdated and insufficiently upgraded. In contrast, countries like Germany have modernized their grid and enforced policy predictability to achieve over 40% renewable penetration, while China has successfully centralized policy authority to streamline energy transition. Despite stated intentions, Pakistan’s regulatory and operational misalignments constrain effective adherence to both national and international sustainability standards. The analysis highlights a critical implementation gap between policy rhetoric and ground realities.

Institutional Barriers to Effective Energy Governance

Addressing the third research question—Why does Pakistan face an energy crisis due to weaknesses in governance and management? —the research identifies four interlinked institutional barriers that impede the effectiveness of energy governance:

Fragmented Governance Structures

The existence of multiple regulatory bodies (e.g., NEPRA, AEDB, PPIB, WAPDA, CPPA) with overlapping and sometimes conflicting mandates creates coordination failures. As one participant succinctly described:

“It’s a tower of Babel—everyone speaks energy but no one coordinates energy.”

FGDs echoed this dysfunction. A participant from the Islamabad session

emphasized:

“There is no single authority to bring coherence. You have overlapping responsibilities and everyone is stepping on each other’s toes.”

The interviews and FGDs (Table 2,3 & 4) consistently pointed to the lack of a central coordinating mechanism that could harmonize planning, implementation, and monitoring. This fragmentation leads to inefficiencies in policy execution and confuses both local and foreign investors.

Chronic Circular Debt and Financial Unsustainability

The circular debt in the power sector, now exceeding PKR 2.5 trillion, is a product of revenue shortfalls, non-cost reflective tariffs, poor recovery rates, and unaddressed subsidies. Policy delays in tariff rationalization and the absence of automatic pass-through mechanisms further exacerbate financial pressures. This has undermined the operational and financial viability of DISCOs and IPPs alike.

A WAPDA official remarked:

“We are trapped in a vicious cycle where power producers don’t get paid on time, causing fuel shortages and operational disruptions.”

Bureaucratic and Regulatory Inertia

The regulatory environment is characterized by long and opaque approval processes, especially for renewable energy projects. Developers report significant delays in securing permits, power purchase agreements (PPAs), and interconnection facilities. These bureaucratic inefficiencies increase transaction costs, discourage investment, and delay project commissioning.

Capacity Gaps and Technological Obsolescence

Institutional capacity remains a critical bottleneck. Both public and private actors report a lack of skilled personnel capable of managing modern energy systems, particularly those involving renewable integration, smart grid technologies, and energy forecasting. The sector also lacks digitized data platforms that are essential for performance monitoring and real-time management. An engineer from IESCO noted:

“Our grid isn’t equipped to handle the variability of solar or wind. We’re using 20th-century tools for 21st-century problems.”

Strategies for Reform and Alternative Governance Model

In response to the fourth research question—What new policies and regulatory mechanisms are needed to catalyze sustainable energy transformation?—the study proposes a strategic restructuring of energy governance through the development of a unified, multi-tiered model. Drawing on global best practices and informed by stakeholder input, the proposed model (Figure 1 and Table 6) includes the following pillars:

Integrated Institutional Coordination

Establishment of a centralized Energy Transition Authority (ETA) to coordinate policy formulation, investment approvals, and regulatory enforcement. This body would bridge institutional silos and align the efforts of NEPRA, AEDB, and the Ministry of Energy.

Regulatory Predictability and Investor Confidence

Implementation of a transparent and stable tariff structure, including long-term feed-in tariffs or competitive auctions for renewables. Political insulation of NEPRA is essential to restore investor trust and facilitate long-term planning.

Modernization of Infrastructure and Data Systems

Investment in grid upgrades, digital monitoring systems, and demand-side management tools. Leveraging smart metering and data analytics can reduce losses and improve system efficiency.

Capacity Building and Human Resource Development

Design and deployment of energy-focused technical training programs, especially in provinces. Special emphasis should be placed on energy modeling, project finance, and integrated resource planning.

Provincial Decentralization and Community Energy Projects

Encouragement of provincial energy plans, particularly in off-grid and underserved areas. Support for community-based solar mini-grids and micro-hydro projects can increase energy access and resilience.

Table 3.1 : Thematic Analysis Summary from Interviews

| Key Theme | Sub-Themes | Representative Quotes | Stakeholder Group |
|---|---|--|---------------------------|
| 1. Policy Effectiveness and Governance Gaps | Fragmented Governance | “We have strong policies on paper, but execution fails due to lack of synchronization between federal and provincial agencies.” – NEPRA Official | NEPRA, Ministry of Energy |
| | Inter-Agency Coordination Challenges | “There’s no single entity responsible for tracking progress, and this leaves room for mismanagement.” – Policy Advisor, Ministry of Energy | Ministry of Energy, NEPRA |
| 2. Financial Constraints and Circular Debt | Delayed Payments and Impact on Operations | “We are stuck in a vicious cycle where power producers don’t get paid on time, causing fuel shortages and operational disruptions.” – | WAPDA, Ministry of Energy |

| | | | |
|--|--|--|---------------------------|
| | | WAPDA Official | |
| | Lack of Stable Financing Mechanisms | “Without stable financing mechanisms like feed-in tariffs, the private sector is hesitant to invest in large-scale renewable projects.” – ADB Specialist | ADB, Reon Energy |
| 3. Infrastructure Deficiencies | Outdated Transmission and Distribution Systems | “Our grid infrastructure is not designed to handle the intermittent nature of renewables like solar and wind.” – Senior Engineer, IESCO | IESCO, WAPDA |
| 4. Socio-Political Influences and Regulatory Ineffectiveness | Political Interference in Regulatory Decisions | “Our regulatory decisions often face pushback from politicians who prioritize short-term gains over long-term sustainability.” – NEPRA Official | NEPRA, Ministry of Energy |
| 5. Perspectives on Developing an Alternative Model | Decentralized Governance and Community Participation | “A successful alternative model should combine decentralized decision-making at the local level with strong oversight from a central authority.” – Ministry of Energy Official | Ministry of Energy, NEPRA |
| | Financial Mechanisms for Renewable Energy Expansion | “We need innovative financing models, including public- | NEPRA, ADB, Reon Energy |

| | | | |
|--|--|---|--|
| | | private partnerships and international green funds, to support renewable energy projects.” – NEPRA Official | |
|--|--|---|--|

Table 3.2 : Thematic Analysis Summary from FGDs

| Key Theme | Sub-Themes | Representative Quotes | Stakeholder Group |
|---|--|---|---|
| 1. Policy Effectiveness and Governance Gaps | Disconnect Between High-Level Policies and Local Realities | “Policies often don’t trickle down to rural communities. Electrification projects stall because local authorities aren’t empowered or lack resources.” – Community Leader | Community Representatives, NGO Participants |
| 2. Financial Constraints and Affordability Issues | Affordability Issues for Low-Income Households | “When the government can’t pay power producers, we suffer. Power outages become more frequent, and energy tariffs keep rising.” – FGD Participant | Rural Communities, NGOs |
| 3. Infrastructure Deficiencies | Rural Energy Access Issues | “We experience power outages daily. When electricity is available, the voltage fluctuations damage our appliances.” – Community Participant | Rural Participants, NGOs |
| 4. Public-Private | Social Safeguards | “Private companies | Rural |

| | | | |
|--|--|---|--------------------------|
| Partnerships | and Equity | prioritize profits, not people. We need safeguards to ensure that rural areas aren't neglected." – Community Representative | Communities, NGOs |
| 5. Renewable Energy Adoption Challenges | Financial Barriers to Adoption | "We want solar panels, but they're expensive, and we don't get any subsidies or support." – Rural Representative | Rural Participants, NGOs |
| 6. Environmental Sustainability and Climate Resilience | Environmental Considerations in Policy Design | "Pakistan's energy model must prioritize reducing emissions and protecting ecosystems." – WWF Representative | NGO Representatives |
| | Climate Adaptation through Decentralized Solutions | "Solar-powered water pumps can help farmers in drought-prone areas while reducing their reliance on diesel generators." – FGD Participant | Community Members, NGOs |

Table 3.3: Overlapping and Distinctive Themes from Interviews and FGDs

| Key Theme | Overlapping Insights (Interviews and FGDs) | Unique Insights from Interviews |
|---|---|---|
| 1. Policy Effectiveness and Governance Gaps | Both groups emphasized fragmented governance and poor inter-agency coordination as barriers to policy implementation. | Policymakers stressed the need for a centralized oversight authority. |

| | | |
|--|--|---|
| 2. Financial Constraints and Circular Debt | Agreement that circular debt affects all aspects of energy delivery, from production to consumer affordability. | NEPRA and WAPDA officials linked financial issues to delayed project timelines and investments. |
| 3. Infrastructure Deficiencies | Both groups identified outdated infrastructure and grid instability as critical bottlenecks for energy access and renewable integration. | Technical experts called for large-scale grid modernization projects. |
| 4. Public-Private Partnerships | Agreement on the potential of public-private partnerships to address investment gaps, with a focus on proper regulation and monitoring. | Private sector representatives emphasized predictable policy environments to attract investors. |
| 5. Renewable Energy Adoption Challenges | Both groups identified financial and bureaucratic barriers as major obstacles to renewable energy growth. | Policymakers focused on utility-scale renewable projects. |
| 6. Environmental Sustainability | General consensus on the importance of integrating environmental sustainability into energy planning. | Policymakers mentioned large hydropower projects as part of sustainability efforts. |
| 7. Socio-Political Influences and Regulatory Ineffectiveness | Both groups acknowledged that political interference undermines regulatory autonomy and policy consistency. | NEPRA officials highlighted the role of delayed tariff approvals due to political pressures. |

Synthesis of Findings

This research reveals a comprehensive array of policies and regulatory frameworks that shape the landscape of Pakistan's energy sector. Key instruments include the National Power Policy (2021) [55], the Alternative and Renewable Energy Policy (2019) [54], the National Energy Efficiency and Conservation Act

(2016) [56], and guidelines issued by regulatory bodies such as NEPRA and AEDB [7,54]. These frameworks collectively articulate a vision of sustainable energy development, improved energy access, and enhanced private sector participation. On paper, these policies reflect a degree of alignment with international mandates such as the United Nations Sustainable Development Goals (SDG 7 and SDG 13) and the Paris Climate Agreement [58], particularly in their emphasis on clean energy transitions, emission reductions, and renewable energy penetration. Despite this formal alignment, however, the study identifies a persistent gap between policy formulation and implementation. The analysis of both qualitative (interviews and focus group discussions) and quantitative data points to a multitude of institutional, financial, and structural barriers that significantly impede the realisation of policy objectives. Among the most critical issues are fragmented governance structures, where overlapping roles between institutions such as NEPRA, AEDB, WAPDA, and the Ministry of Energy result in disjointed planning and regulatory bottlenecks. A lack of clearly delineated responsibilities and poor inter-agency communication have led to inconsistent decision-making and policy execution, undermining trust among private investors and multilateral partners. Another major barrier identified is the chronic and escalating circular debt, which currently exceeds PKR 2.5 trillion. This financial burden stems from under-collection of tariffs, politically influenced pricing structures, inefficiencies in the distribution system, and subsidy delays. The result is a continuous liquidity crisis in the power sector, which affects both operational stability and long-term planning. Coupled with regulatory volatility—where tariff decisions and project approvals are frequently delayed or reversed—the financial ecosystem necessary for renewable energy investments remains fragile and uncertain. The data analysis also highlights bureaucratic and procedural delays in project implementation. Lengthy approval processes for grid interconnection, power purchase agreements, and environmental clearances act as deterrents for local and foreign investors alike. These regulatory and administrative inefficiencies are further exacerbated by limited institutional capacity, especially at the provincial and local levels, where energy departments often lack the technical expertise, data systems, and planning tools needed to manage complex energy transitions.

To address these critical gaps the research proposes a series of strategic interventions grounded in stakeholder perspectives and comparative policy analysis. First, the establishment of a centralized Energy Transition Authority is recommended to harmonize the roles of disparate institutions, facilitate policy coherence, and provide a unified platform for energy planning and governance. Second, there is an urgent need for regulatory predictability, particularly in tariff regimes and investment policies, to restore market confidence and attract long-term capital for energy projects. Third, simplification of administrative procedures, through the adoption of digital portals, one-window clearance systems, and automatic approval timelines, can reduce bureaucratic inertia and accelerate project roll-outs.

Moreover, the research underscores the need for robust capacity-building

efforts, notably targeted training courses for energy planners, regulators, and on-the-ground personnel. Deepening institutional expertise in integrated resource planning, renewable system integration, and sound financial modeling will be vital if policies are to be carried out effectively. Lastly, broadening stakeholder engagement-by actively including business leaders, scholars, community organizations, and residents-can create more inclusive policy design, heighten transparency, and reinforce the accountability of agencies charged with implementation.

By pursuing these overlapping tactics, Pakistan stands a fair chance of dismantling the structural and institutional roadblocks that now stall reform in its energy sector. A single governing framework can pull federal and provincial actions into step, and clearer rules will trim costs and cut delays at every stage. Smart debt management and tariffs that truly cover costs should boost the sectors financial health, thus drawing in private money for cleaner generation. At the same time, training people and building modern digital networks will equip planners with real-time data and faster, more agile tools. Evidence from this study shows that Pakistans policies, on paper, match global best practice and its own development goals, yet their effects are muted by divided power, patchy rules, money woes, and clumsy operations. Targeted changes to institutions and rules are therefore vital, not just to end the current crisis but also to put the nation on a sturdy, fair, low-carbon path. Only a united, data-driven, and open process will let Pakistan turn its energy hopes into lasting security, sustainability, and broad-based growth.

Alternative model for sustainable transformation

An integrated modeling platform that combines LEAP (Long-range Energy Alternatives Planning) with the LUT (Low-Emission Transition) Energy System Transition Model, referred to here as LUT-ESTM, delivers a robust analytical framework (see Figure 4). The LEAP component functions as a forecasting tool, producing long-term scenarios for energy demand and supply, and it weaves in key socio-economic drivers such as economic growth, urbanization trends, and changes in population structure.

The model calculates both consumption behavior and environmental effects, such as greenhouse emissions, to provide precise predictions about energy requirements in the residential, industrial, and transport sectors. Policymakers charting Pakistans long-term energy plans, gauging renewable impacts, or exploring feasible routes to sustainability can rely on the LEAP modelling platform as their backbone. While LEAP excels at horizon-wide projections, it stops short of fine-tuning system operations minute by minute. For that real-time task, practitioners turn to the LUT model. The LUT-ESTM merges power, heat, transport, and industry into one coherent framework, enabling daily and seasonal optimization. Without such tuning, production and use swing wildly, costs climb, and emissions drift upward. The LUT model therefore guides the grid through peak periods, trimming losses at the wires and steering voltage and frequency. By embedding renewables, balancing plants and storage, and tightening everyday dispatch, it offers Pakistan's future a reliable, affordable, and greener power backbone that complements LEAPs

vision.

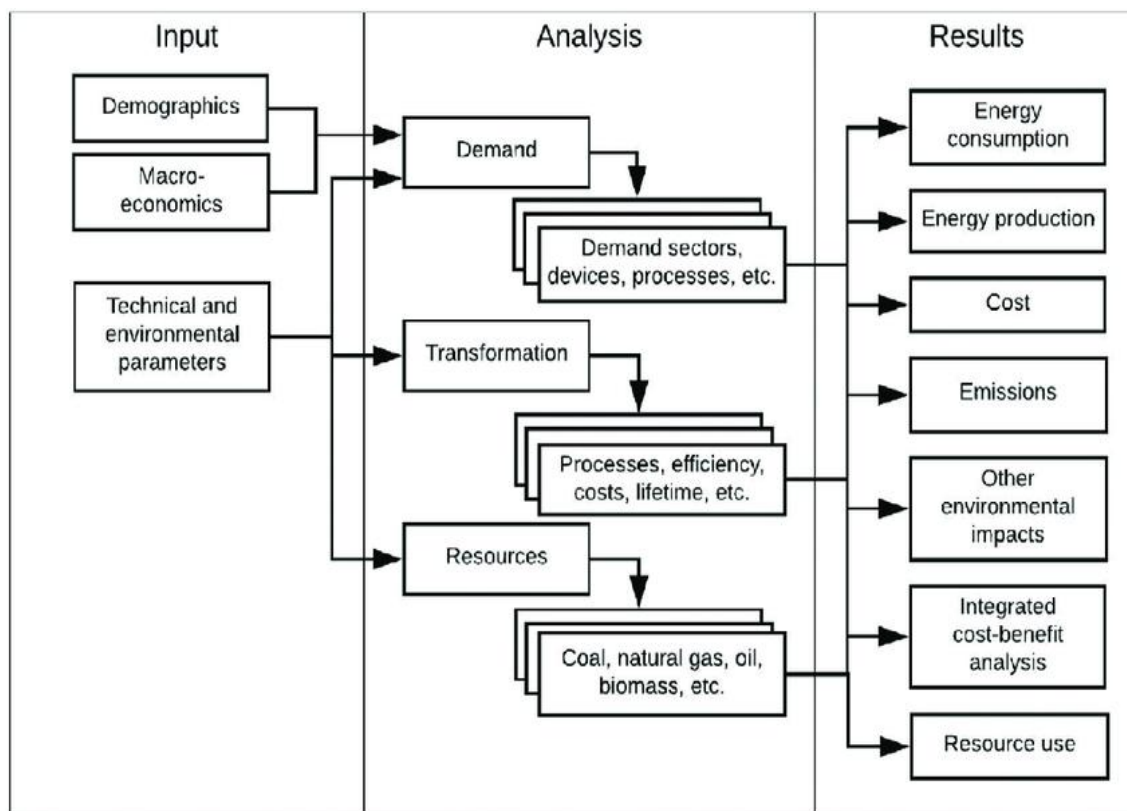


Figure 2: Basic LUT Energy System Transition Model [37]

The two models work in concert, with LEAP running long-term policy experiments while LUT tracks day-to-day operational performance. A vital feedback loop sends LEAPs demand estimates back to LUT; in turn, LUTs real-world data informs LEAPs future scenarios, creating an energy plan that can adjust as conditions change. Together they allow Pakistan not only to forecast future energy needs but also to monitor and boost the performance of current plants, which cuts the number and length of outages. By modeling many kinds of renewable technology, mainly solar and wind, the system lets planners fine-tune daily operations today and lay out a credible path for greener power tomorrow. This joined-up approach also trims fuel imports, bolstering national energy security while staying on course with Pakistans sustainability goals. Because different policies can be tested side by side, decision-makers see how each option affects costs, emissions and access, making choices that serve both the economy and citizens. LEAP can spot rising solar capacity early; LUT then maps the quickest, most reliable ways to weave that energy into the grid. In short, the LEAP-LUT partnership builds a more resilient Pakistan power system that meets tomorrow's demand with less carbon today.

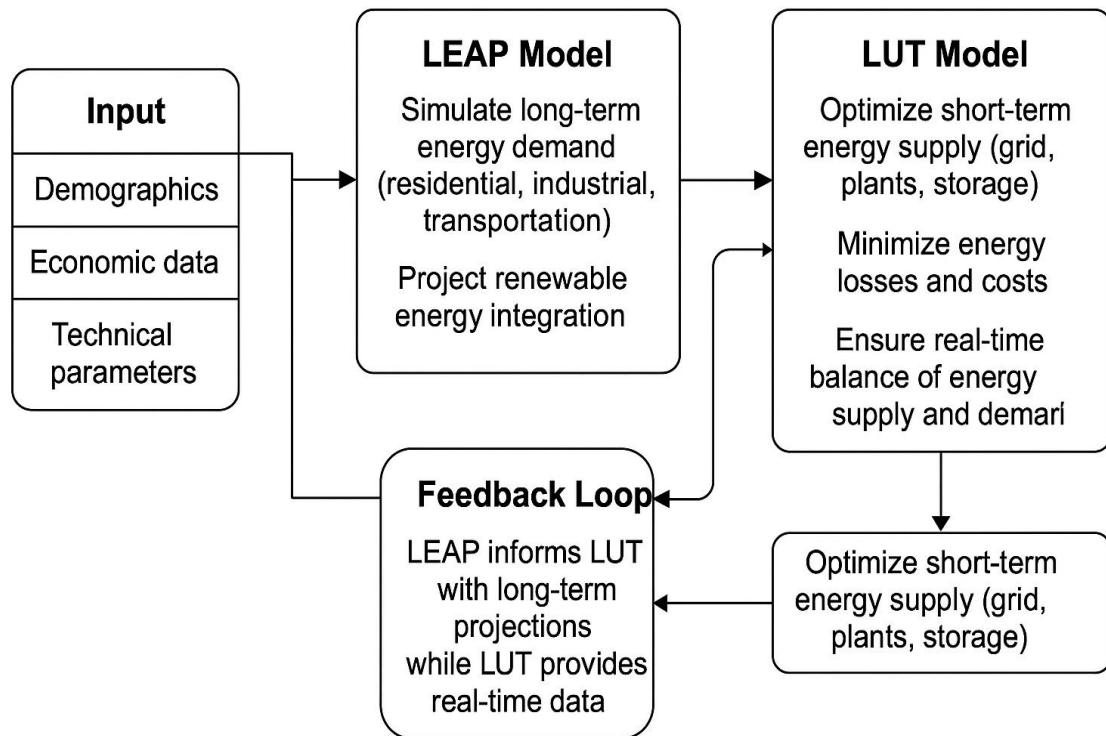


Figure 4: Proposed Integrated LEAP and LUT Framework

RESULTS DISCUSSION

This study investigates whether Pakistan's present policy and regulatory structures can ease the country's energy emergency, while also exploring diverse governance models needed for long-lasting, clean-energy change. It employs a mixed-methods design, combining a systematic review of national policies with interviews of key stakeholders and the main insights from focus-group sessions, all of which expose large gaps between promised reforms and their day-to-day outcomes. Although Pakistan's forward-looking energy plans sound progressive on paper, they stumble in practice because institutions are split, rules shift unpredictably, and funding remains persistently weak. The section that follows reflects on these results in light of relevant theories, reiterates the original research questions, and considers broader lessons for energy-governance overhaul. At the rhetorical level, the country's energy policies align neatly with global sustainability targets, yet the real test lies in the concrete translation of that ambition into reliably functioning programs.

The Alternative and Renewable Energy Policy (2019) along with Pakistani agreements in the Paris Agreement and SDG 7 became instruments that drive the nation toward diverse energy systems combined with climate-friendly infrastructure. However, the study finds that these frameworks are insufficiently supported by institutional coherence and administrative capacity. This disconnect aligns with observations in policy implementation theory, which posits that well-intentioned policies often fail when the institutional environment lacks the authority, resources, or coordination to act decisively [59]. The empirical evidence presented here

supports this theory: despite the presence of targeted policies, actual energy generation from renewables remains below 7%, and energy deficits persist across much of the population. For example, the interviews revealed widespread frustration among key institutional actors. Total regulatory uncertainty exists due to multiple authorities' overlapping authorities according to NEPRA officials with private sector energy developers describing a complicated approval process as “labyrinthine and discouraging.” The research shows that operational synergy matters more than policy coherence to achieve sectoral transformation.

The ongoing operational issues between NEPRA, AEDB, WAPDA and CPPA-G indicate that Institutional Rational Choice (IRC) Theory correctly explains the sector's structural problems. IRC explains that institutions need to synchronize different actors' incentives and activities to accomplish shared policy objectives [60]. The regulatory bodies in Pakistan fail to establish the necessary alignment between their policies. The assessment data revealed poor inter-institutional communication and restricted mutual trust because such deficiencies produced duplicate operations and delayed program advancement. Institutional drift poses a problem in Pakistan's energy governance system according to IRC theorists because legislative frameworks develop without parallel regulatory coordination structures. The Energy Transition Authority (ETA) functions to solve organizational deficiencies through focused leadership overseeing strategy development as well as lower operational costs and modified stakeholder reward structures. IRC establishes that institutions achieve effectiveness by lowering uncertainty and creating predictable expectations. Yet, as highlighted by private investors in the study, tariff unpredictability and policy reversals are common, eroding investor confidence. Thus, regulatory stability emerges not only as an economic imperative but also as an institutional necessity.

One of the most salient barriers identified is Pakistan's circular debt, which now exceeds PKR 2.6 trillion. The study reveals that this debt is not merely a financial issue but reflects deep structural weaknesses in the governance of billing, subsidies, and procurement. Stakeholders across interviews repeatedly described the circular debt crisis as a “systemic pathology”, a chronic condition that recycles inefficiencies through the power sector's supply chain. This finding resonates with public finance literature, particularly theories of fiscal federalism, which argue that misaligned fiscal incentives between central and subnational actors exacerbate inefficiencies in utility governance. In Pakistan, weak cost recovery and politically motivated tariffs have disincentivized performance at the distribution level, resulting in under-collection and delayed payments to power producers. Focus group discussions confirmed the social consequences of this dysfunction: communities experience regular load shedding despite paying for services, leading to a loss of public trust. These financial imbalances, if left unchecked, will continue to undermine technical reforms and policy efforts, regardless of how well-designed they may be.

Another key challenge discussed by participants is the sector's limited technical and institutional capacity. The study finds that outdated infrastructure,

lack of training, and digital backwardness are major impediments to modernizing Pakistan's grid and scaling renewable technologies. This confirms the literature on energy transitions, which emphasizes the importance of "enabling conditions" such as technological readiness, human capital, and real-time data systems [61]. Respondents noted that current energy personnel are not trained in variable renewable integration, smart grid management, or energy storage technologies. Moreover, without digitized systems, utilities struggle to forecast demand or manage decentralized energy inputs. This limits the capacity for demand-side response, energy efficiency improvements, and accurate billing—all core components of a sustainable energy transition. The study's findings further highlight how capacity gaps intersect with regulatory constraints to delay progress. For example, the lack of a one-window facility for renewable approvals and prolonged licensing processes create bureaucratic inertia that stifles innovation and market entry.

The study reveals a fundamental mismatch occurs between nationwide policy guidelines and local community needs. The participants in the focus groups continuously emphasized that technical energy planning happens at central locations while ignoring local voices and contextual requirements. The research supports top-down energy governance criticisms because communities achieve better energy transition outcomes when they function as equal creators versus mere recipients of systems [62]. The people living in rural areas see solar mini-grids and off-grid solutions as promising but need financial support and policy backing along with training for their successful implementation. The message emerges that Pakistan must build its sustainable energy framework through inclusive community-centered decentralization for its future energy needs to succeed. Engaging communities not only strengthens democratic legitimacy but also enhances accountability, reduces theft and losses, and ensures that solutions are tailored to specific geographies and livelihoods. The proposed model's emphasis on decentralized energy planning

CONCLUSIONS

This study investigated the role of policy and regulatory frameworks in shaping the trajectory of Pakistan's energy sector, with a particular focus on identifying governance barriers and proposing viable alternatives for sustainable transformation. The findings, drawn from a robust mixed-methods approach incorporating policy analysis, stakeholder interviews, focus group discussions, and scenario benchmarking, provide a multi-layered understanding of the country's energy governance ecosystem. The analysis confirms that Pakistan possesses a substantial body of energy policies aligned with global sustainability goals—including the Alternative and Renewable Energy Policy (2019), National Electricity Policy (2021), and commitments under the Paris Agreement and Sustainable Development Goal 7 [54,55,58]. These policies produce minimal results because the program experiences structural fragmentation together with regulatory uncertainties and fiscal inefficiencies and insufficient institutional expertise. The research demonstrates that the multiple organizations NEPRA AEDB WAPDA CPPA-G and provincial entities

manage effectively leads to poorly integrated planning methods and duplicate clearance processes and decreased business trust in Pakistan's electricity systems. The excessive PKR 2.6 trillion debt that plagues the power industry continues as a fundamental structural problem that originates from operational inefficiencies throughout the electricity production and transmission and distribution networks. NEPRA and similar regulatory bodies suffer from deterioration of their autonomy because of regulatory environment issues caused by political interventions coupled with delayed tariff proceedings and bureaucratic processes. The sector faces two critical barriers which prevent it from successfully including renewable energy sources and modernizing its grids and handling energy changes: technological deficiencies combined with insufficient skilled personnel. The national energy policy remains unaligned with community life experiences particularly for remote communities and those lacking access to sufficient services. The exclusionary approach causes the current frameworks to lose legitimacy and effectiveness. Taken together, the findings lead to a singular, inescapable conclusion: Pakistan's energy crisis is fundamentally a crisis of governance. Without institutional reform, even the most ambitious policy goals will continue to fall short. Thus, the study argues for a comprehensive rethinking of energy governance—one that is integrated, participatory, data-driven, and anchored in fiscal and regulatory realism.

Policy Recommendations

Based on the empirical and theoretical insights derived from the study, the following strategic recommendations are proposed to support the transformation of Pakistan's energy sector:

Establish a Centralized Energy Transition Authority (ETA)

Create an autonomous, technocratic institution Energy Transition Authority, tasked with coordinating national and provincial policies, overseeing implementation, facilitating donor alignment, and eliminating redundancies across agencies. This body should serve as the central command for long-term planning and integrated energy governance.

Stabilize the Regulatory Framework and Protect NEPRA's Independence

Ensure that tariff-setting and licensing remain free from political influence by legally insulating NEPRA and empowering it with automatic adjustment mechanisms. This stability is essential to build investor confidence and ensure cost-reflective pricing that addresses circular debt.

Implement Provincial Energy Planning Frameworks

Develop decentralized energy plans at the provincial and local levels to ensure that energy solutions are context-sensitive, inclusive, and responsive to geographic disparities. Local governments must be empowered with financial and technical autonomy to develop mini-grids, off-grid renewables, and energy cooperatives.

Address Circular Debt through Structural Reform

Tackle circular debt not through bailouts but through structural adjustments such as improving revenue collection, rationalizing subsidies, digitizing metering,

and penalizing distribution losses. Implement performance-based incentives for DISCOs to enhance accountability and efficiency.

Digitalize Infrastructure and Invest in Smart Grids

Modernize grid infrastructure to support real-time monitoring, demand forecasting, and renewable energy integration. Investments should focus on smart meters, SCADA systems, and Geographic Information Systems (GIS) to optimize operations and reduce losses.

Build Human Capital for Energy Transition

Establish national training programs in partnership with universities, technical institutes, and international agencies to build the skills needed in renewable energy integration, energy finance, data analytics, and climate-resilient infrastructure.

Develop Innovative Financing Mechanisms

Mobilize climate finance, green bonds, and blended finance instruments to support large-scale renewable energy deployment. Facilitate public-private partnerships (PPPs) and ensure transparent, risk-sharing contracts that attract long-term investment.

Promote Stakeholder and Community Engagement

Institutionalize participatory planning mechanisms involving civil society, academia, and the private sector. At the community level, support energy cooperatives and micro-grid initiatives to increase energy ownership and reduce reliance on centralized systems.

Implications for Policy and Practice

The empirical evidence from this study calls for a fundamental rethinking of energy governance in Pakistan. Incremental changes will not suffice to resolve systemic inefficiencies, nor will donor-driven pilot projects substitute for robust institutional reform. A coordinated, evidence-based, and politically insulated governance model is essential. The proposed Energy Transition Authority serves as a strategic vehicle to operationalize this shift, by centralizing accountability, harmonizing regulations, and building adaptive capacity. Moreover, regulatory insulation for NEPRA, fiscal reforms to resolve circular debt, and targeted investments in capacity building must be prioritized. International development partners, too, must recalibrate their engagement—from project financing to capacity and systems strengthening, particularly at subnational levels. Similarly, civil society and academia should play a more active role in policy design, monitoring, and innovation.

Theoretical Contributions and Future Research

This study contributes to the theoretical discourse on institutional design, energy transitions, and implementation politics in low- and middle-income countries. It extends Institutional Rational Choice Theory by showing how misaligned incentives and fragmented authority lead to collective policy failure in the energy sector. It also reinforces implementation literature that highlights the difference between policy output and policy outcomes. Future research may focus on

subnational energy governance in Pakistan, the political economy of tariff reform, and the role of digital technologies in grid modernization. Longitudinal studies tracking the performance of proposed reforms would also provide valuable insights.

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