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Article

Strategic management of renewable energy transition in Pakistan: International partnerships and policy implementation under SDGs 7 & 13

Muhammad Bahar Khan[1], Syed Afzal Moshadi Shah[2,*], Imran Naseem[1], Noureen Fatima[2], Abdullah Hamoud Ali Seraj[2], Khalid Zaman[3,*]

[1] Department of Pakistan Studies and International Relations, Abbottabad University of Science and Technology, Abbottabad 22620, Pakistan
[2] Department of Management, College of Business Administration, King Faisal University, Eastern Province - AlAhsa Hofuf KSA 31982, Saudi Arabia
[3] Department of Economics, The University of Haripur, Haripur Khyber Pakhtunkhwa 22620, Pakistan
***Corresponding author:** Syed Afzal Moshadi Shah, sashah@kfu.edu.sa; Khalid Zaman, khalid_zaman786@yahoo.com

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Abstract: The strategic management of the transition to renewable energy sources is an utmost priority for developing nations to combat energy instability and climate change. Global cooperation and SDG–aligned policy execution are increasingly driving this transition in Pakistan. Pakistan's foreign policy focuses on sustainable energy transition to address environmental problems and the growing energy demand, in line with SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action). This qualitative strategy research examines Pakistan's renewable energy policies, international collaboration, and the implementation of large-scale projects. Systematic content analysis was used to scrutinize government reports, treaties, policy papers, and multilateral agreements. Theme coding and inclusion criteria highlighted important policy measures, diplomatic efforts, and project outcomes. This research is unique because it weighs the pros and cons of energy projects, such as the China-Pakistan Economic Corridor (CPEC), big hydropower dams, solar and wind parks, and guidelines for electric cars. Debt sustainability, social and environmental effects, governance problems, and grid integration are all important. The study systematically records bilateral and multilateral MoUs, project capacity, financial sources, and operational status to assess Pakistan's energy diplomacy and strategic standing. The research shows that global partnerships and legislative initiatives have accelerated the adoption of renewable energy; however, institutional barriers and socio-environmental trade-offs persist. The study offers a distinctive perspective on Pakistan's foreign policy's influence on its transition to renewable energy, along with pragmatic suggestions to enhance governance, financing, and sustainable energy diplomacy.

Keywords: clean energy; climate action; energy diplomacy; sustainable development goals; fossil fuels; global partnerships

1. Introduction

Climate change and environmental issues are becoming more urgent globally due to the 46.7% rise in GHG emissions from 1990 to 2016 [1]. Due to increasing global temperatures, more severe weather, and climate-related threats, strong policy measures are needed directly. Despite cooperative attempts like the Kyoto Protocol and the Paris Agreement, subsequent publications like the Progress Report on the Sustainable Development Goals (SDGs) have emphasized emerging nations' inability to control rising emissions [2]. Renewable energy is crucial to a cleaner future since energy is both the cause of the climate issue and the method of mitigating it via water [3]. The science is precise, and emissions must be cut in half

by 2030 and zero by 2050 to avert global warming. Since 80% of the world's population lives in net importers of fossil fuels, six billion people are subject to geopolitical crises and shocks [4]. IRENA aims to produce 90% of the world's electricity from renewable sources by 2050. Renewable energy sources reduce nations' dependency on imports, diversify their economies, and shield them from fossil fuel price fluctuations, promoting equitable economic growth, job creation, and poverty alleviation [5].

Renewable energy is the most cost-effective electricity source in much of the globe. Renewable energy costs are falling. Solar power prices fell 85% from 2010 to 2020 [6]. Onshore wind power expenditure plummeted 56%, and offshore wind power spending declined 48%. Since most of the new power demand comes from low- and middle-income countries, renewable energy becomes more attractive when prices drop. Due to falling prices, low-carbon sources could supply a large portion of new power [7]. By 2030, cheap, renewable electricity may provide 65% of the world's power. It intends to decarbonize 90% of the electricity industry by 2050, reducing carbon emissions and fighting global warming. The International Energy Agency (IEA) predicts that solar and wind power costs will remain higher than pre-COVID-19 levels in 2022 and 2023 due to high commodity and freight prices. However, steeper gas and coal price increases would make them more affordable [8].

Renewable energy creates three times more jobs per dollar than fossil fuels. The shift to net-zero emissions is expected to cost 5 million fossil fuel employment by 2030, but it creates 14 million renewable energy jobs and 9 million energy sector jobs [9]. Finally, the energy industry requires 16 million more workers to produce electric automobiles, hyper-efficient household appliances, and cutting-edge technologies like hydrogen. In 2030, the clean energy, efficiency, and low-emissions technology sectors will create over 30 million jobs. To prevent leaving anyone behind, achieving a fair transition that emphasizes people's needs and rights throughout the energy transformation is vital [10].

In 2022, the fossil fuel industry was subsidized to $7 trillion. This includes direct subsidies, tax incentives, and unaccounted-for health and environmental impacts from fossil fuels. To reach net-zero emissions by 2050, renewable energy investments, including technology and infrastructure, must amount to about $4.5 trillion annually until 2030 [11]. The initial cost may be too high for specific countries, while others may require financial and technical assistance to transition. However, renewable energy investments pay off. Lowering pollution and environmental damage might save $4.2 trillion annually by 2030. Secure and cost-effective renewable technologies will broaden power sources and mitigate market shocks, boosting energy resilience and safety [12].

The Sustainable Development Goals (SDGs) are becoming more and more important since they provide a worldwide standard for sustainable development. The SDGs deal with a number of economic, social, and environmental problems, such as poverty, hunger, injustice, and climate change [13]. This is because they are all related to each other. They provide a comprehensive method for encouraging individuals, organizations, and governments to achieve ecologically sustainable development. The SDGs are very important for the economy to expand throughout time, for people to be healthy, and for people to be happy. To achieve inclusion, they

make sure that everyone has an equal opportunity to succeed and that no one is left behind. More and more people know that the SDGs are important for fighting climate change. They are getting countries ready to safeguard ecosystems and natural resources, utilize more renewable energy, and cut down on greenhouse gas emissions [14]. **Table 1** shows the key aspects of renewable energy policies in relation with the SDGs.

Table 1. Green energy initiatives and sustainable development goals.

Key aspect	Policy initiatives	International collaborations	Challenges	Alignment with SDGs
Renewable energy targets	30% renewable share by 2030	China (CPEC), Germany, UAE	Policy implementation delays	SDG 7: Affordable and Clean Energy
Solar and Wind Projects	Development of 3,000 MW wind and solar farms	Saudi Arabia, China, Turkey	Infrastructure and grid limitations	SDG 7, SDG 13: Climate Action
Hydropower expansion	Diamer-Bhasha, Dasu, and Mohmand dams	World Bank, ADB, China	Financing and resettlement concerns	SDG 7, SDG 13
Electric vehicles (EVs)	National EV Policy 2019	Collaboration with China, Japan	High initial costs, charging infrastructure	SDG 7, SDG 13
Green financing	Green bond issuance, climate finance policies	UNDP, IMF, World Bank	Limited private sector participation	SDG 7, SDG 13
Energy efficiency measures	Net metering, energy conservation programs	Germany, USAID	Public awareness and regulatory gaps	SDG 7
Nuclear energy for clean power	Expansion of nuclear plants for low-carbon energy	IAEA, China	Safety concerns, political resistance	SDG 7, SDG 13
Regional energy cooperation	CASA-1000, TAPI Gas Pipeline	Central Asia, Afghanistan, Iran	Geopolitical tensions, security issues	SDG 7, SDG 13
Climate policies & agreements	Paris Agreement, National Climate Change Policy	UNFCCC, GCF, Global Climate Alliances	Implementation gaps, funding constraints	SDG 13
Public-private partnerships	Incentives for clean energy investments	Foreign investors, local industry players	Bureaucratic hurdles, inconsistent policies	SDG 7, SDG 13

Source: Adapted from Behera et al. [15] and Kar et al. [16].

Sustainability requires partnerships and global involvement. As global challenges become more complicated and interrelated, these partnerships are becoming increasingly vital for tackling common concerns that need coordinated measures [17]. The SDGs are global transformative goals for sustainable development. Pakistan aims to achieve upper-middle-income status by 2030 via the Sustainable Development Goals and several national development initiatives. In response to post-MDG stakeholder interactions, the government will build national and provincial SDG units, data reporting platforms, and national coordination meetings [18]. The Pakistan's Ministry of Planning, Development, and Reforms Planning Commission present "Vision-2025." The five pillars of this vision are social fairness, the rule of law, peace and security, political stability and policy continuity, and a shared vision. Pakistan aims to be in the top 10 global economies by 2047 and 25 by 2025 [19]. Seven pillars and supporting variables are needed to achieve equitable development in line with the SDGs and make Pakistan the next "Asian Tiger". These pillars include water, energy, food security, human and social capital, democratic governance, long-term indigenous inclusive growth, public sector modernization, institutional reform, private sector growth, value addition to create a

competitive knowledge economy, improved regional connectivity, and modernized infrastructure. **Table 2** shows the Pakistan's foreign policy strategies for sustainable energy development.

Table 2. Key drivers, stakeholders, and future prospects of green energy development.

Perspective	Key strategies	Major stakeholders	Policy gaps & barriers	Future prospects
Diplomatic engagements	Climate diplomacy, MoUs on renewable energy	Ministry of Foreign Affairs, UNFCCC	Limited regional energy cooperation	Strengthened energy alliances
Investment & trade policies	Tax incentives, green energy tariffs	Ministry of Finance, foreign investors	Unstable policies, slow approvals	Enhanced FDI in renewable sector
Regional energy corridors	CPEC energy projects, CASA-1000, TAPI	China, Central Asia, Iran	Security risks, political tensions	Regional energy integration
Technology transfer	Agreements on solar and wind tech	Germany, China, UAE, Japan	High costs, lack of technical expertise	Expansion of local renewable manufacturing
Public-private partnerships	Green investment funds, carbon credits	Private sector, development banks	Bureaucracy, weak regulatory framework	Strengthening PPP frameworks
Energy security & policy	Diversification of energy mix	NEPRA, AEDB, provincial governments	Fossil fuel dependence, slow reforms	Balanced energy transition
Sustainable financing	Green bonds, climate adaptation funds	IMF, World Bank, ADB, UNDP	Low private sector participation	Increased green financing access
Renewable infrastructure	Expansion of solar and wind farms	Power division, foreign donors	Grid limitations, storage challenges	Smart grids and modern infrastructure
Climate change commitments	Paris Agreement, SDG-aligned policies	MoCC, GCF, International climate groups	Weak enforcement, insufficient monitoring	Stricter policy enforcement
Research & development	Green energy innovation, academia-industry links	Universities, research institutions	Funding shortages, limited innovation	Strengthening R&D in clean technologies

Source: Adapted from Sharif & Faisal [20] and Jesse et al. [21].

Lack of a well-defined national vision, accountability, and a preference for personal advantage above national welfare have prevented the crucial enablers from arriving in the country. Most other pillars have declined and deteriorated owing to COVID-19. "Water, energy, and food security," human life's foundations, are ignored. The result is an alarming worldwide hunger index, with just 35.84% of the population having appropriate water and 24% having inadequate energy [22].

The growing literature on Pakistan's energy revolution has overlooked foreign-policy processes enabling renewable technology access, climate funding, and strategic energy partnerships. There is little research on how international agreements, geopolitical restrictions, and diplomatic alignments affect SDG-7 (Affordable and Clean Energy) and SDG-13 (Climate Action). Most research has focused on energy reforms in Pakistan or individual projects. This study evaluates Pakistan's clean-energy transition from a strategic, foreign-policy viewpoint. The study poses the following research questions:

I. How has Pakistan's foreign policy influenced its renewable energy financing, technology transfer, and global climate assistance?
II. What global and bilateral diplomatic instruments have helped Pakistan meet its SDG-7 and SDG-13 goals?
III. How do geopolitics, institutional limitations, and foreign partnerships influence Pakistan's enduring transition to a low-carbon economy?

The study delineates its research aims in accordance with the articulated questions, namely,

- To evaluate the strategic role of foreign policy in accelerating the development of renewable energy.
- To find diplomatic routes and agreements that lead to real advantages, and
- To look at Pakistan's energy diplomacy using evidence based analysis.

Pakistan's perilous position at the convergence of expanding energy demand, budgetary constraints, and climate vulnerability necessitates a sustainable energy transition. Solar irradiation belts, wind corridors, hydrological systems, and biomass resources provide significant renewable energy resources that the country has yet to tap. Even yet, the energy mix relies significantly on imported energy and fossil fuels. Due to this structural mismatch, fiscal constraints worsen, and long-term energy security and environmental resilience decrease. Due to these issues, Pakistan's foreign policy and international cooperation agenda increasingly involve energy transformation aims. Multilateral frameworks and strategic alliances have made renewable energy a major sector of economic and political cooperation, notably in infrastructure development, energy financing, and technology transfer. The inconsistent translation of international promises into sustained domestic energy reform shows a gap between policy purpose and implementation capacity. Pakistan's renewable energy research has largely focused on particular projects, regulations, or macro-level energy economics. A comprehensive analytical tool that links global energy diplomacy to local implementation, institution efficiency, and sustainable governance structures is needed. The discontinuous form of reality makes it hard to determine how external contacts affect energy transfers. Thus, there is little research on Pakistan's international energy involvement, renewable energy transition, and progress in climate mitigation. The absence of a governance and execution structure is a big issue. This study employs a structured analytical technique to assess the effects of international cooperation, policy alignment, and institutional processes on sustainable energy transformation under SDGs 7 and 13 to address this knowledge gap.

2. Literature review

2.1. Theoretical foundations of energy diplomacy and global evidence

The global literature on energy diplomacy explains how states strategically employ international relations to achieve clean-energy and climate objectives. Moghani and Maleki [23] and Chaziza and Lutmar [24] argued that energy diplomacy controls low-carbon technologies, foreign investment, and long-term security partnerships. The UNFCCC, GCF, and bilateral agreements impact diplomatic decisions that affect energy markets and technology transfer. Green energy sources like solar, wind, and nuclear power are spreading worldwide, creating new geopolitical conflicts. According to South-South cooperation literature, developing countries are increasingly using politically mediated partnerships to overcome financial and technical barriers to renewable deployment [25,26]. These studies provide the theoretical framework for understanding how Pakistan's foreign policy may affect its access to renewable energy sources. However, they do not

explain how these ideas would play out in Pakistan's institutional and geopolitical context.

2.2. Financing, technology transfer, and regional energy integration

The study explores how finance, technological transfer, and regional linkage affect renewable energy development in disadvantaged countries. International Renewable Energy Agency [27], the International Energy Agency [28], and UNDP [29] found that green-energy transitions require nations to access climate financing, public-private partnerships, FDI-driven technology transfers, and concessional loans. Cost reductions and state-led diplomatic alignment with technology-exporting countries like Japan, Germany, and China are vital for technological acceptance, notably in utility-scale wind and solar [30]. Regional power cooperation study shows that multinational projects like CASA-1000 and TUTAP reduce seasonal energy shortages and diversify supplies [31,32]. These studies identify structural constraints as fiscal flexibility, sovereign risk, and foreign knowledge dependence. Although significant, Pakistan's diplomatic actions, rather than only internal energy planning, are seldom studied in the literature. Due to this absence, Pakistan's foreign-policy instruments must be assessed collectively to determine how they affect regional energy alliances, financial pipelines, and technology linkages.

2.3. Pakistan-specific scholarship and positioning of the current study

There has been a lot of recent writing on renewable energy in Pakistan, but much of it has been focused on individual areas or regions, not on foreign policy. Bensadi [33] examines renewable energy investment within the framework of CPEC, emphasizing financial incentives while excluding political processes. Khan et al. [34] investigate governance challenges within Pakistan's energy regulatory framework, whereas Moeen et al. [35] analyze the integration of renewable resources to advance sustainability objectives. Some environmental studies [36,37] address climate vulnerability and strategies for carbon emission reduction, although they overlook Pakistan's international commitments on its climate responsibilities. Pakistan has made progress on SDG-7 and SDG-13 via bilateral agreements, climate talks with other countries, changes in the way it does business with other countries, and improvements in its institutions. There is still no clear synthesis of foreign policy. This research addresses the knowledge deficit by situating Pakistan's transition to renewable energy sources within the framework of global energy diplomacy. This research connects diplomatic efforts to the flow of funds, project results, and institutional restrictions in order to better understand how Pakistan's foreign policy influences renewable energy.

Several crucial yet often disjointed aspects of the problem have been highlighted in the current literature on climate governance and Pakistan's transition to renewable energy. Pakistan's renewable energy potential and policy development show that structural inefficiencies and inconsistent rules are hindering the nation's use of wind, solar, and hydroelectric resources. External collaborations have increased renewable energy capacity in energy financing and infrastructure investment. Governance challenges, debt sustainability concerns, and institutional

coordination issues might limit their contributions, making them less effective over time. Notably, to link the energy transition to sustainability frameworks and technological innovation, integrated policy frameworks, institutional capacity development, and effective implementation strategies are also required, in addition to technological advances. Despite these advances, global energy diplomacy, domestic policy implementation, and quantitative climate outcomes in the literature are still inconsistent. Thus, a more focused and analytical synthesis is needed to evaluate how external interactions and internal governance structures affect the renewable energy transition. In line with SDGs 7 and 13, institutions may transition to sustainable energy.

3. Conceptual framework of sustainable energy diplomacy

This study conceptualizes Pakistan's green energy diplomacy as a strategic mechanism linking foreign alliances, domestic policy, and SDGs 7 and 13. It moves beyond descriptive assessments of energy agreements or institutional activities. The study establishes a triangle connection by critically synthesizing government policy papers, international accords (e.g., the Paris Agreement), and bilateral energy cooperation with China, the US, and Saudi Arabia. Foreign policy, institutional and regulatory processes (e.g., the Alternative Energy Development Board, or AEDB), and limits (e.g., energy insecurity, restricted budgets, and political instability) all contribute. By using sustainable energy diplomacy, this study illuminates how international relations may affect domestic energy transitions. **Figure 1** shows the triangulation of foreign policy, institutional mechanisms and constraint & opportunities to achieve sustainable energy transition.

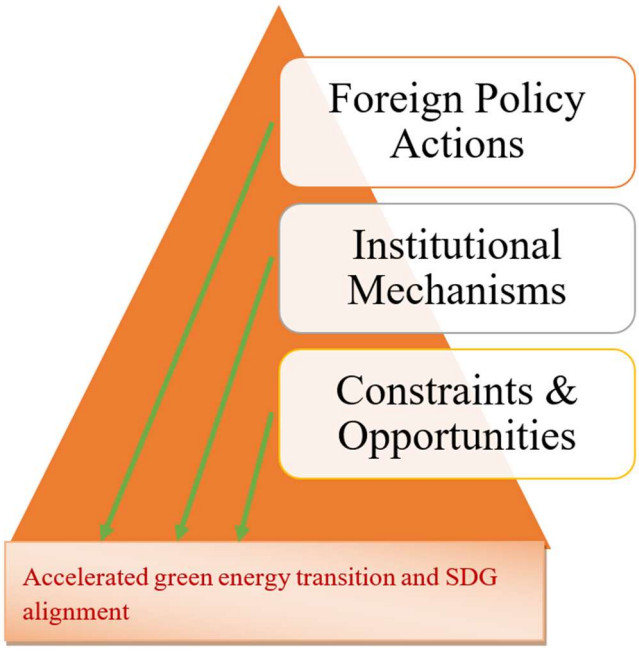

Figure 1. Conceptual framework of the study.

Source: Author's work.

These processes were formerly considered autonomous or reactive. The study reveals the following linkages, i.e.,

- Foreign strategic alliances affect Pakistan's green energy policies, but political instability and fossil fuel dependency are slowing development.
- Underutilized private sector engagement and foreign investment might accelerate energy transformation.
- Pakistan's renewable energy leadership may be strengthened by incorporating climate goals into foreign policy.

This study links sustainable energy deployment, international cooperation, and foreign policy to offer practical and theoretical implications for scholars and policymakers interested in diplomacy and energy transitions.

Pakistan's 30% renewable energy target by 2030 and large solar, wind, and hydropower projects have been hindered by regulatory delays, infrastructure issues, and financial constraints [38]. Despite international relationships with Saudi Arabia, China, Germany, and the World Bank and UNDP, technology transfer and private sector participation have not realized their full potential. Diplomatic agreements may not yield outcomes. To obtain socioeconomic advantages including new employment, rural electrification, and industrial expansion, grid limits, regulatory gaps, and bureaucratic hurdles must be overcome notwithstanding green bonds, public-private partnerships, and electric car regulations. Lack of cross-sectoral planning unequally distributes environmental and technical benefits like smart grids, AI-powered agriculture, and lower emissions [39]. Finally, it contrasts Pakistan's energy goals with its international policy. Investment flows and infrastructure projects usually outweigh local technical skills and regulatory enforcement in bilateral agreements. Despite inadequate surveillance and enforcement, global climate commitments provide normative direction. These images highlight Pakistan's green energy diplomacy's potential. More government, domestic, and business sector collaboration is required to transform global promises into long-term energy sustainability.

4. Methods

4.1. Data sources

The study's qualitative strategic analysis uses authoritative policy literature. This dataset includes the Alternative Energy Development Board (AEDB) annual reports, NEPARA state of industry reports, Pakistan's NDCs, MoCC policy directives, and relevant Ministry of Foreign Affairs memoranda, treaties, and MoUs. IRENA and IEA policy briefings, UNFCCC submissions, regional cooperation agreements, and Iran, Turkey, Russia, China, and Turkey energy cooperation frameworks were international sources. Pakistan formulates and implements its climate change foreign policy using these sources.

4.2. Search strategy

Structured document searches occurred in January–March 2025. AEDB, NEPRA, MoCC, MoFA, IEA, IRENA, UNFCCC, and treaty repositories were

searched. “Green transition Pakistan,” “bilateral environmental agreements,” “regional climate governance,” “energy cooperation Pakistan China/Turkey/Iran/Russia,” “renewable energy policy Pakistan,” and others were utilized. Only 2000–2024 documents were searchable. Pakistan had its best climate and energy diplomacy. Each search was manually double-checked for accuracy.

4.3. Selection and exclusion criteria

Addressing climate change, energy, and Pakistan’s foreign policy required collaboration among several countries and pertinent facts on Pakistan’s participation in international organizations or laws. Technical documents, advertisements, extraneous news stories, and politically neutral speeches were omitted. Redundant policy reports were eliminated. A thematic analysis was conducted on 93 articles that satisfied the inclusion criteria.

4.4. Analytical approach

An inductive theme coding technique was used for analysis. The first phase was to review each document for patterns or themes related to Pakistan’s ambitions, diplomatic priorities, regulatory requirements, or geopolitical restrictions. Through qualitative content analysis, themes were iteratively derived and refined to identify four key groupings. These groupings include bilateral climate-energy relationships, economic and geopolitical drivers of cooperation, institutional capabilities and regulatory frameworks, and impediments and diplomatic difficulties. Constant-comparative hand coding guaranteed conceptual integrity across sources. Cross-document triangulation verified findings, reduced bias, and strengthened overarching themes.

4.5. Conceptual framework of the study

This study uses governance to link Pakistan’s global energy activities to Sustainable Development Goals 7 and 13. In the framework, the energy transition is influenced by domestic policy implementation structures, sustainability outcomes related to renewable energy and climate mitigation, and foreign policy and international cooperation mechanisms. The framework considers large-scale energy projects, bilateral and multilateral cooperation, and international agreements as essential policymaking instruments. These techniques alter domestic energy output through financial inflows, technological transfers, institutional alliances, and infrastructure upgrades. The approach also recognizes that institutional coordination, regulatory consistency, and governance competency affect the success of these instruments. These parameters influence how much international contacts affect quantitative outcomes of the energy transition.

4.6. Justification and application of systematic content analysis

Systematic content analysis is the main qualitative research technique in this study, as it is optimal for transparent, rigorous, policy-oriented, and documentary analysis. The research uses systematic content analysis to identify, classify, and explain policy trends and recurring themes in government papers, treaties, reports,

and international agreements. The study goes beyond descriptive reporting of papers, as the tool can systematically examine the wording, execution, and alignment of energy-related pledges with sustainability objectives. That ensures the analysis is evidence-based, open, and replicable. The study uses a systematic approach to select appropriate documents based on inclusion criteria, categorize textual data into themes such as renewable energy deployment, climate mitigation, international cooperation, and governance, and interpret patterns to assess the efficacy and consistency of Pakistan's energy transition plan. This systematic approach ensures consistency and a thorough examination of policy execution and strategic goals.

5. Quantifying Pakistan's renewable energy transition and foreign policy outcomes

The NEPRA [40] and PPDB [41] declare that Pakistan's installed renewable energy capacity, not including hydropower, grew from 0.4 GW in 2010 to approximately 2.7 GW in 2024. Wind power added 1.8 GW, solar power added 0.63 GW, and biomass/bagasse added 0.25 GW. Pakistan has roughly 10.7 GW of clean energy capacity, and 34% to 36% of it comes from renewable sources. This isn't enough to meet Pakistan's Updated NDC target of getting 60% of its power from renewable sources by 2030. The two sets of objectives are quite different. There are fourteen energy projects worth roughly $20.4 billion in the China-Pakistan Economic Corridor (CPEC). But around 70% of the finished capacity comes from coal. The only renewable energy projects CPEC has are the 50 MW HydroChina Dawood Wind Project, the 100 MW UEP Wind Farm, and the 50 MW Sachal Wind Project. Some hydroelectric projects, like Karot 720 MW, are helping to make low-carbon electricity, but CPEC's energy mix is still primarily made up of fossil fuels. This indicates that geopolitically, energy security is more important than decarbonization. There are also fundamental problems with Pakistan's climate finance inflows. The World Bank, the Asian Development Bank, and the UNDP claim that Pakistan got $1.6 to $1.8 billion in climate-related development financing between 2015 and 2023. There weren't much private funds in this amount. The Water & Power Development Authority issued Pakistan's first green bond in 2021 and raised $500 million, which showed that investors were a little more confident. Pakistan's NDC finance framework predicts that the country would require USD 101 billion in investment by 2030. Overall, these steps show that Pakistan's ambitious foreign policy aims have had some success and some failure. Because the expansion of installed capacity, the mobilization of climate funds, and the mix of CPEC projects have all happened slowly, policy action has to be more focused, consistent, and institutionalized.

Pakistan's ultimate renewable and clean-energy projects have made significant, although uneven, low-carbon capacity gains. The Quaid-e-Azam Solar Park (QASP) in Bahawalpur was commissioned in phases from 2015 to 2018; however, financial and grid integration issues prevented it from reaching 1000 MW [33]. Jhimpir Wind Corridor, which comprises the 100 MW UEP, 50 MW Hawa, 52.8 MW Jhimpir Sapphire, and 50 MW HydroChina Dawood farms, is the nation's strongest wind cluster with 1850 MW of installed wind power from over 22 projects [40]. These

projects improve Pakistan's installed electricity capacity by 6-7%, up from nearly nothing before 2013. International cooperation with China, Germany, and the UAE has accelerated implementation. Pakistan's grid has also changed due to hydropower developments. The fully functioning Neelum-Jhelum Hydropower Project (969 MW) delivers 4.6 billion kWh per year, while the Karot Hydropower Project (720 MW) added 3.2 billion kWh in 2022 as part of CPEC. Thus, hydropower accounts for 24–25.4% of Pakistan's installed capacity, or 10.7–11.5 GW [42]. QASP, Karot, and Neelum-Jhelum received funding from China's Zonergy investment, China Three Gorges South Asia Investment Ltd., and local banks, the Exim Bank of China, and the Islamic Development Bank, respectively. The Neelum-Jhelum project was delayed by over 10 years, and many wind projects were delayed by two to three years due to security, land, and regulatory issues [43]. Total clean capacity (including hydro) exceeds 10.7 GW, and renewable electricity capacity (excluding hydro) grew from 0.35 GW in 2015 to 2.7 GW in 2024, demonstrating Pakistan's remarkable but uneven development. Pakistan's Updated National Development Plan (NDC) calls for 60% clean electricity by 2030; however, renewables are still behind that objective.

Table 3 shows Pakistan's most important green energy projects from 2010 to 2024. These projects include solar, wind, hydropower, electric vehicles, and other renewable and low-carbon energy sources. It shows the installed capacity, technology, funding sources, and operating status of each initiative.

Table 3. Key green energy initiatives in Pakistan (2010–2024).

Initiative	Technology	Capacity (MW)	Financing source	Operational status	Source
Quaid-e-Azam Solar Park	Solar PV	400 MW	Zonergy China	Operational (2018)	PPDB [41]
Jhimpir Wind Corridor	Wind	1850 MW (22 projects)	China, Germany, UAE	Operational/Partial	NEPRA [40]
Neelum–Jhelum Hydropower	Hydro	969 MW	China, IDB	Operational (2018)	The News [42]
Karot Hydropower	Hydro	720 MW	China Three Gorges	Operational (2022)	CPEC Secretariat [43]
National EV Policy	EV adoption, charging	N/A	China, Japan	Policy implemented	MoCC [44]

The 400 MW Quaid-e-Azam Solar Park opened in 2018 with Zonergy China finance. However, China, Germany, and the UAE support the Jhimpir Wind Corridor, which contains 22 wind projects with 1,850 MW of power. Foreign-sponsored large-scale dams provide energy security to Pakistan. These projects include Neelum-Jhelum (969 MW) and Karot (720 MW). The National EV Policy shows the government's commitment to low-carbon transportation.

Table 4 lists key agreements and MoUs that promote Pakistan's renewable energy transition and contains a detailed history. This table lists governments and organizations that have established partnerships, their signing dates, their stated aims, and their current status.

Table 4. Timeline of bilateral MoUs and agreements.

Partner country / organization	MoU/agreement	Year signed	Objective	Current status
China	CPEC Energy Projects	2013	Renewable & hydro energy development	Ongoing
Saudi Arabia	Solar & Wind Cooperation	2017	Technology transfer & financing	Partially implemented
Germany	Renewable Technology MoU	2015	Wind & solar tech transfer	Ongoing
Japan	EV & Battery Tech	2019	EV adoption & charging network	Ongoing
UNDP / GCF	Climate Finance MoU	2016	Green financing	Ongoing

Source: CPEC Secretariat [43], NEPRA [40], and MoCC [44].

Pakistan's foreign-led energy development is shown by the CPEC energy projects. These renewable energy and hydropower projects from 2013 are still going strong. The 2017 Saudi Arabian and 2015 German accords focus on subsidizing renewable energy and transferring technology. The 2019 Japanese memorandum of understanding, on the other hand, supports electric automobiles and battery technology. Pakistan's carbon emissions go down when countries make agreements with each other, as the UNDP/GCF MoU in 2016. The historical statistics show how Pakistan's energy and SDG goals have been met via international collaboration, how diplomatic participation has changed and stayed the same, and how diverse the partners have been. This research also points up areas where policies need to be strengthened, including agreements that aren't fully carried out or technology transfer responsibilities.

6. Global and regional perspectives on clean energy transitions

Global climate change (CC), current and predicted for the 21st century, and global warming acceleration are two important worldwide developments during the previous 65 years. Climate change (CC) affects biology, ecology, politics, and economics globally [45]. Global warming raises several countries' average temperatures. Earth's climate was poor before the Industrial Revolution. Due to increased knowledge and climatic uncertainty in national and local policy, sectoral climate change (CC) implications cannot be accurately quantified. Climate change is characterized by long-term patterns in precipitation, temperature, pressure, and humidity. The melting of polar ice caps and rising sea levels are major domestic and worldwide repercussions of climate change [46].

Before the industrial revolution, forest fires, earthquakes, and volcanoes were thought to release most GHGs. On December 12, 2015, the Paris UNFCCC Conference of the Parties (COP-21) reached a historic climate change accord and accelerated the actions and investments required for a sustainable, low-carbon future. The Paris Agreement, which went beyond the Convention, united all governments to vigorously combat climate change and prepare for its effects, with impoverished nations getting extra financial assistance [47]. The global environmental movement considers it a turning point for this reason. The Paris Agreement intends to strengthen global climate response by lowering global temperature rise this century

to far below 2 degrees Celsius over preindustrial levels and aiming for 1.5 degrees Celsius [48]. The pact aims to align financial resources with climate change mitigation and resilience plans to help countries cope with its repercussions.

A new technical framework, capacity development, and sufficient financial resources are needed to help the most vulnerable and developing nations achieve their goals. The pact also makes action and aid more public. The Paris Agreement requires each party to make "nationally determined contributions" (NDCs) in future years [49]. It requires frequent stakeholder reporting on implementation and emissions. A global inventory will be done every five years to assess the agreement's progress and guide the parties' future efforts. Paris has started a program to produce standards, rules, and recommendations on several areas to implement the Paris Agreement. Since 2016, newly constituted organizations and subsidiaries (APA, SBSTA, and SBI) have helped parties collaborate. At COP22 in Marrakech in November 2016, the Conference of the Parties (CMA) passed the first two resolutions. Work was expected to finish in 2018. Thus, climate disasters, primarily caused by humans, impact local, national, and worldwide health, production, and infrastructure [50]. Many studies, including Chang et al. [51], Alsunousi and Kayabasi [52], and Bhatti et a. [53] have found that developing countries' fossil fuel use has increased greenhouse gas levels and raised temperatures.

Pakistan's significance in regional energy partnerships is understudied. Group renewable energy initiatives may be better understood by examining how foreign policy policies help or hinder cooperation with adjacent governments. When addressing sustainable energy, most studies explore the issue widely rather than focusing on one sector [54,55]. Research on how foreign policy affects solar, wind, and hydro energy would be helpful. Pakistan's foreign policy must be examined to see whether it follows international climate agreements and frameworks and has plans to implement them. There is much to learn about the transfer of clean energy technology, mainly how foreign policy affects access to new solutions. **Table 5** shows socio-economic and environmental drivers of clean and green energy development

Table 5. Socio-economic, environmental, and technological perspectives for green energy development.

Perspective	Key initiatives	Socio-economic impact	Environmental benefits	Technological advancements
Job creation & economy	Green jobs in solar, wind, and EV sectors	Employment in clean energy industries	Reduction in fossil fuel dependency	Expansion of local renewable firms
Energy access & affordability	Off-grid solar solutions, microgrids	Improved rural electrification	Lower household emissions	Smart metering, grid modernization
Industrial development	Incentives for green industrial zones	Sustainable business practices	Decreased industrial pollution	Adoption of green manufacturing
Public awareness & behavior	Renewable energy campaigns, subsidies	Shift towards sustainable energy use	Reduced air pollution, better health	Smart home technologies, IoT-based energy systems
Urban development	Solar-powered public transport, green buildings	Energy-efficient cities, reduced costs	Lower urban heat effects	Smart city infrastructure

Table 5. (*Continued*).

Perspective	Key initiatives	Socio-economic impact	Environmental benefits	Technological advancements
Agriculture & rural development	Solar-powered irrigation, bio-energy	Increased agricultural productivity	Reduction in water and soil pollution	Use of AI in precision agriculture
Climate resilience & adaptation	Disaster-resilient energy infrastructure	Improved community resilience	Less dependency on climate-vulnerable energy	Climate-adaptive grid technologies
Energy storage & efficiency	Battery storage solutions, efficiency programs	Reduced energy costs, economic stability	Sustainable resource utilization	Advancements in lithium and hydrogen storage
Transport electrification	EV adoption, charging stations network	Affordable, sustainable mobility	Reduced vehicular emissions	Innovations in battery and charging tech
Research & innovation	University-led green energy R&D	Knowledge-driven economic growth	Breakthroughs in carbon reduction	Development of advanced solar, wind, and nuclear tech

Research may study public opinion on foreign policy and renewable energy project adoption. Further research is needed to understand how Pakistan's foreign policy handles vulnerable areas' climate change resistance and renewable energy growth. Few quantitative studies have examined how foreign policy affects renewable energy. Data-driven assessments may clarify international aid, investments, and partnerships.

7. Role of Pakistan's foreign policy in advancing SDG 7 and SDG 13

Pakistan is involved in the Belt and Road and Paris Agreement climate change and renewable energy accords. Pakistan's foreign policy emphasizes diplomacy and global partnerships to achieve Goals 7 (renewable and inexpensive energy) and 13 (climate action). Pakistan plans to join worldwide renewable energy and environmental collaborations [56]. Pakistan exhibited its environmental commitment by ratifying the Paris Agreement in 2016. In return for GHG reductions, Pakistan agreed to improve climate resilience. The Government of Pakistan has developed Nationally Determined Contributions (NDCs) to improve climate resilience and move toward cleaner energy, while economic and technological challenges make implementation difficult [57]. The Paris Agreement strengthens Pakistan's international status and access to climate funds, crucial for increasing its renewable energy share. Pakistan invests in energy infrastructure under the Belt and Road Initiative (BRI). This collaboration has led to the China-Pakistan Economic Corridor (CPEC), which includes wind and solar power installations. These actions assist Pakistan switch to renewable energy and reach SDG 7. Pakistan also engages with SAARC and the UNFCCC to exchange knowledge, technology, and solutions for climate change. Pakistan's foreign policy actively supports SDGs 7 and 13, which aim to combat climate change and create long-lasting energy infrastructure via global partnerships, multilateral agreements, and international cooperation. **Figure 2** illustrates Pakistan's foreign policy effort aimed at the sustainable growth of renewable energy.

Figure 2. Pakistan's global energy strategy aligning with climate and sustainability goals.
Source: Author's work.

7.1. Debt and financial trade-offs

Pakistan's energy capacity has grown because of CPEC and other big renewable and hydroelectric projects, but they have also caused financial concerns. Many energy projects in Pakistan, like coal and hydropower, need loans and concessional funding from other countries. This makes the country's debt payments higher. The financial problems are clear in the Karot and Neelum-Jhelum dams, which cost more than $5 billion and were primarily paid for using loans from the Chinese Exim Bank. These investments make energy security better, but there are still concerns about the loan's long-term viability, repayment period, and currency rate risk [58]. So, a fair evaluation must take into consideration that these initiatives increase the amount of renewable energy in the electrical grid while eliminating financing for other social and environmental programs.

7.2. Trade-offs between the environment and society

Social and environmental effects must be taken into account for big energy projects like solar parks and hydroelectric dams. The Neelum-Jhelum Hydropower Project destroyed riverine ecosystems and wildlife, forced thousands of villages to move, created problems with resettlement, and kept social tensions high [59]. The Quaid-e-Azam Solar Park produced 400 MW of renewable electricity but was criticized for displacing local species and ruining agriculture owing to its huge land acquisition [60]. Renewable energy projects like Jhimpir Wind Farms include environmental trade-offs, such as how they affect bird populations and how they compete for land usage. A thorough analysis of the literature indicated that not managing the social and environmental implications of Pakistan's energy advantages might hurt the project's long-term profitability and acceptability in the area.

7.3. Limitations in governance, institutions, and technology

Pakistan's efforts to improve its energy system are being held up by problems with administration, technology, the environment, and capital. Grid integration problems, regulatory problems, and gaps in coordination across institutions are all slowing down development [61]. When adding wind and solar power, which are not always available, to the national grid, the transmission infrastructure and storage capacity need to be improved. Bureaucratic delays in project approvals, poor environmental regulation, and a lack of private sector involvement slow down the transition to cleaner energy and make operations less efficient.

8. Key drivers for advancing SDG 7 and SDG 13

SDG 7 is an international sustainable development goal that aims to increase funding for energy infrastructure and renewable energy technologies until 2030 and increase access to clean energy research and technology through international cooperation [62]. Energy storage systems, which allow renewable energy, need many metals, largely energy-producing components. The growing need for renewable energy sources is straining the precious metals manufacturing process, which is already failing to satisfy demand. The move to renewable energy storage requires cobalt, lithium, and other costly and rare earth elements. Primary metal mining requires a lot of energy, water, and garbage, making it unsustainable. Secondary sources, including scrap metal, abandoned electronics, and mining by-products (urban mining), are more effective and eco-friendly ways to extract valuable metals from garbage [63]. This discipline uses hydrometallurgy and pyrometallurgy, two established technologies. In rare battery repurposing situations, only 5% of LIBs are carefully exploited for metal extraction due to the significant financial and infrastructural requirements and lack of alternative supplies. Chemicals that reduce waste, pollution, and energy usage have replaced environmentally hazardous metal recycling methods. This strategy meets Goal 13 of the Sustainable Development Agenda by reducing greenhouse gas emissions without compromising mineral processing efficiency [64]. Reducing carbon footprint and increasing access to cheap, clean energy will help accomplish Sustainable Development Goals 7 and 13, which seek to reduce poverty and adapt to climate change. These goals may be achieved via technology, policymaker support, financial resources, human resources, and international partnerships.

SDG 7 aims to provide cheap, dependable, ecologically sustainable, and technologically sophisticated energy. Pakistan has made tremendous progress in solar, wind, and hydroelectric, contributing to its achievement [65]. These efforts support energy security, climate change mitigation, and sustainable development. When Pakistan worked with other nations, foreign investments helped its energy sector access new, environmentally friendly energy sources. In Bahawalpur, Punjab, Pakistan's Quaid-e-Azam Solar Park is a stunning solar energy facility. One of the world's biggest solar parks, the 1000 MW solar park brings renewable energy to people. Chinese contributions via public-private partnerships under the CPEC framework were crucial to its design and development. This project stabilized the southern grid and dramatically reduced Pakistan's fossil fuel use [66]. The solar

project's short success validates SDG 7 and proves solar energy's feasibility in a sunny country.

Pakistan gets wind electricity from Jhimpir, a Sindhi town that has become an industrial powerhouse. Despite the investment, the Jhimpir Wind Corridor has 50,000 MW of untapped potential. Foreign enterprises, including Zorlu Enerji of Turkey, helped create the 50 MW First Wind Energy project. This shows a good connection in Pakistan's renewable energy sector. Pakistan still uses hydropower, its oldest renewable energy source, for up to 30% of its electricity. Chinese and Indian teams developed the 969 MW Neelum-Jhelum Hydropower Project for CPEC. This project is essential for Pakistan's energy security and renewable energy infrastructure [67]. The Tarbela Dam expansion plan improved flood control and irrigation and attracted over $1 billion in foreign investments, giving Pakistan greater clean, renewable electricity potential. Pakistan needs international collaboration to accomplish SDG 7 via renewable energy programs. They increase energy availability, ecological living, and wealth.

9. Climate adaptation and mitigation initiatives

Climate change has hit Pakistan hard, raising temperatures and causing more floods and droughts. Due to these issues, Pakistan has made considerable climate adaptation and mitigation efforts, mostly from international organizations. The Ten Billion Tree Tsunami Program, funded by GEF and other international donors, is a large-scale restoration initiative in Pakistan [68]. Restoring Pakistan's forest cover may mitigate climate change and assist rural people in making a livelihood. As of 2023, the effort has planted over three billion trees, helping Pakistan meet its Paris Agreement climate goals. Natural and artificial disasters, most notably floods, have historically targeted Pakistanis. It stressed the need for technology to construct strong infrastructure and early warning systems to avert future catastrophes. The Pakistan Climate Change Adaptation Project (PCCAP) makes these communities more climate-resistant. It relies on high-quality stakeholders and works with local governments and international agencies like US aid. This includes water accessibility, climate-smart agriculture, and community-based infrastructure investments to survive climate change. Up to 2024, US aid projects, programs, and activities in Pakistan [69].

10. Pakistan's foreign policy and green energy transition

Pakistan's foreign policy and diplomatic relationships with other countries have an impact on its transition to green energy. The SDGs and the Paris Agreement are examples of global frameworks that help Pakistan's renewable energy projects. However, these projects are mostly driven by collaboration between two or more countries. The China-Pakistan Economic Corridor (CPEC) investments in solar and hydroelectric projects indicate how geopolitical ties might help local energy objectives [70]. These steps make Pakistan's energy infrastructure better and encourage energy cooperation, which makes it easier to share technologies. Working with Saudi Arabia, the US, and foreign financial institutions can aid with domestic

energy development by giving money, establishing capacity, and cutting-edge renewable technology.

Through international forums and bilateral agreements, Pakistan has made its foreign policy commitment to renewable energy stronger. Pakistan's energy strategy is in line with its international climate obligations since it takes part in global climate finance systems, regional energy conferences, and international climate discussions [71]. These meetings indicate that Pakistan is serious about taking action on climate change as a regional player and help the country get money for installing renewable energy sources. These diplomatic strategies don't work as well because of political instability, problems with energy security, and budget constraints. This underscores the need for foreign policy coordination to harmonize international energy engagement with domestic priorities.

Pakistan's renewable energy initiatives reduce carbon emissions and promote sustainability. Environmental innovation and policy optimization can help developing nations transition to low-carbon energy systems more quickly [72]. Even though Pakistan has significant renewable energy potential, governance inefficiencies, infrastructure constraints, and policy inconsistencies hinder its large-scale energy transformation [73]. Technological advancement is necessary to achieve global sustainability goals [74]. This study on sustainable energy diplomacy looks at the triangle made up of Pakistan's foreign policy goals, institutional frameworks, and structural limits. Pakistan may speed up its switch to green energy, make its relationships with other countries better, and boost its position in the energy market in the area by utilizing foreign policy as a strategic weapon. The research shows that Pakistan has to integrate its foreign policy with its domestic energy ambitions and its international climate obligations in order to establish a safe, low-carbon energy system and overcome structural problems.

11. Discussion

This study illuminates Pakistan's energy activities and their influence on renewable energy and climate mitigation in light of SDGs 7 and 13. International cooperation has improved renewable energy capacity, infrastructure development, and policy alignment. These efforts' effectiveness is uneven due to governance, finance, and implementation issues.

11.1. Comparison with existing literature

This research confirms previous findings and emphasizes the need for international cooperation to support Pakistan's renewable energy development. In line with prior studies, Pakistan has tremendous renewable energy potential, but institutional inefficiencies and policy inconsistencies prevent its full implementation. Qudrat-Ullah [75] emphasizes the importance of clean energy policies and environmental innovation in reducing carbon emissions, as international cooperation has accelerated renewable energy adoption in Pakistan. Xing et al. [76] argued that the SDGs cannot be achieved without new technologies and international cooperation, and the findings support this result. This study reveals that international collaboration and technology transfer continue to drive Pakistan's energy revolution.

11.2. Differences from previous studies

Though similar, these factors do not justify the major divergence from the literature in the present study. This research links foreign policy participation to implementation success, offering a more holistic evaluation than earlier studies that examined only policy potential or project outcomes [77,78]. Despite past studies showing it is usually beneficial, international cooperation may lead to debt sustainability issues, governance inefficiencies, and reliance on technology transfer. Most of the literature regards the switch to renewable energy as economic or technical [79,80]. This study reveals that the energy transition is closely integrated with diplomatic, institutional, and governance frameworks, making it a complex policy and infrastructural issue.

11.3. Novel contributions of the study

This study's new analytical paradigm unites energy policy, sustainable governance, and international politics. Unlike previous fragmented research, this study evaluates the aggregate impact of international agreements, bilateral cooperation, and large-scale energy projects on renewable energy outcomes in Pakistan. The study also contributes to the energy transition governance literature by highlighting institutional capabilities and policy continuity as moderators of global interactions. It critically evaluates the pros and cons of external energy financing and partnership arrangements, adding to the field's study.

Beyond descriptive research, the study organizes, compares, and assesses Pakistan's transition to renewable energy sources in a policy-relevant manner, in light of global sustainability goals.

12. Suggestions for future research and policy

Pakistan is in danger from climate change and a lack of energy; thus it is important to figure out what research goals may help the nation. International agreements and Pakistan's energy and climate policies were used to study energy policy and how to deal with climate change. Climate change might hurt Pakistan. So, it's looking at how international climate deals like the Paris Agreement have changed how it gets its electricity. Part of this process is looking at how Pakistan is making its energy policy fit with international climate goals and how foreign groups and banks are helping Pakistan meet its promises. Another significant issue is how renewable energy may help Pakistan use less fossil fuel. There is a lot of study going on to see whether adding solar, wind, and hydropower to the electrical system is possible. It also looks at ways to use renewable energy to help those who live off the grid or in rural regions who can't afford to pay for electricity.

Pakistan is strengthening its sustainable energy transition policies to ensure a sustainable future. By merging energy and climate change policies, the government shows its commitment to fighting climate change. This requires setting quantitative renewable energy deployment targets and aligning the energy sector with climate goals. Setting legally binding renewable energy objectives and assigning funding and help from appropriate authorities is essential. Public-private partnerships must also be strengthened in the energy sector. The private sector has the skills and resources

to innovate, but ambiguous laws and a lack of sustainable incentives frequently hinder progress. PPPs benefit from government reductions in administrative hurdles, investment guarantees, and long-term renewable energy incentive schemes. The government also prioritizes capacity-building projects to help area companies switch to renewable energy. Policy concerns include energy planning and climate change adaptation. Climate change threatens Pakistan's energy infrastructure; thus, it must be resilient. Clean, climate-resistant energy solutions are promoted to provide energy security during extreme weather occurrences.

Pakistan must first reform its project-level public-private partnership (PPP) procedures by creating independent technical regulators, provincial-federal coordination units, and transparent risk-sharing formulas to prevent energy, transportation, and water contract failures. A results-based budgeting approach should replace the existing climate strategy. Provinces would get conditional subsidies based on their renewable energy adoption, climate-resilient infrastructure, and emissions monitoring performance, not ad hoc project funding. Given Pakistan's institutional fragmentation and political turnover, the government should create a cross-party "Climate Commitment Charter" that commits all major parties to climate-energy reforms beyond election cycles. In Pakistan, the Green Climate Fund's preparation initiatives should prioritize improving MRV (Monitoring, Reporting, and Verification) systems, disaster-risk modeling units, and climate-finance absorption capability. These efforts fit Pakistan's government realities by combining policy formulation with institutional feasibility.

Energy availability in unnerved and rural areas is increasingly becoming a priority. Policy makers emphasis distributed renewable energy options to reduce fossil fuel use and improve local living conditions. Policies that support energy cooperatives and local energy management systems should guarantee community engagement in energy governance and decision-making. Pakistan's foreign policy is advancing SDGs 7 and 13 by fostering multilateral partnerships and encouraging foreign investment in renewable energy policies. Pakistan must act decisively by attending global climate negotiations and seeking technical and financial support for energy reform. Pakistan is strengthening diplomatic ties with renewable energy technology leaders like the US, China, and Germany to promote information sharing, technological know-how sharing, and green energy funding. Pakistan is also seeking international partnerships, particularly with its neighbors, to promote renewable energy infrastructure projects and cross-border energy trade. The Central Asia-South Asia (CASA) power project is being upgraded to accommodate renewable energy from neighboring countries. This development aims to boost Central Asian hydropower exports to South Asia. Pakistan's foreign policy promotes regional climate change adaptation and mitigation.

Pakistan is seeking international investments in clean energy as part of its foreign policy to support renewable energy development. Pakistan uses its World Bank and Asian Infrastructure Investment Bank memberships to achieve this. Large renewable energy projects are receiving foreign finance to help Pakistan reduce its dependence on fossil fuels and power underserved regions. Pakistan's foreign policy promotes climate-friendly technology, such as smart grid systems, energy efficiency,

and energy storage. This is achieved by participating in global renewable energy efforts, partnering with international organizations, and signing bilateral agreements.

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