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Decarbonization and Net-Zero Transition in Pakistan

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Abstract— *The crisis of climate change today is a global issue in the 21st century. In developing countries as well as others around the globe, the challenge is for countries to develop their economies while simultaneously decreasing their GHG (greenhouse gas) emissions. Pakistan is one of the least polluters of all the countries of the world whose contribution to global GHGs is less than 1% but unfortunately Pakistan is one of the countries which is most sensitive towards climate change phenomenon such as rise in average atmospheric temperature, floods, droughts, shrinkage of glaciers and most importantly in security of energy supply. Energy switching towards renewable energy, Modernization of the industries, Policy changes, Transportation Electrification and Climate Finance have been addressed in the research study as critical parameters to assess the journey of Pakistan towards decarbonization and achieving net zero emission. The study looks into the emissions profile of Pakistan, how it consumes energy through different sectors of the country, the vast potential of renewable energy and Pakistan's climate change commitments under the global agreements. The report further highlights the obstacles that are created by inadequate and ineffective institutions, paucity of finances and absence of right technology to combat climate change. In the past few years, it has been found that total GHGs emitted in Pakistan increased from 606 $MtCO_2e$ in 2021 to 609 $MtCO_2e$ in 2022, whereas GHG-CO_2 from fossil fuel increased from more than 200 $MtCO_2e$ in 2021 to more than 204 $MtCO_2e$ in 2022. The study showed that Pakistan has enormous potential in terms of renewable energy which if harnessed for Solar and Wind would help in revolutionizing the energy scenario of the country. To achieve the long-term aspiration of 'Net Zero' in the country, a holistic and time-bound approach, coupled with energy efficient industrial development and funding for climate changes through the global platform of policies and regulations is needed.*

Keywords *–* ***Climate Change, Greenhouse Gas Emissions, Renewable Energy, Decarbonization, Net Zero Emissions.***

INTRODUCTION

There has been an increased climate change globally due to high consumption of fossil fuels such as coal, petroleum and natural gas. As the amount of greenhouse gases increases, global warming has also been increased, causing catastrophic environmental and socioeconomic impacts. Thus, the countries have been encouraged to agree to decarbonization and long-term commitments to "Net Zero". In Pakistan, we have been facing extreme climate events like severe heat waves, melting glaciers, drought and floods.

Pakistan contributes to emission in a modest proportion to the world. The aftermath of the floods in 2022, however, provided enough proof of climatic changes' chilling impacts. Millions became internally displaced and infrastructure loss incurred costs millions. exceeded $40 billion. However, the government of Pakistan is now focusing on two policy objectives – Climate Resilience and Energy transition – both as key goals. Import of fossil fuel is a necessity for Pakistan. They are gasping to import oil and LNG and squeezing hundreds-and possibly thousands-of millions of dollars out of our financial budget and making this economy very vulnerable to swings in global oil and gas prices. Also, load shedding, circular debt and an outdated transmission system reduce any

prospects of economic development. By transitioning to clean energy, Pakistan has a significant opportunity to strengthen its economy and support sustainable development. The adoption of renewable energy sources can enhance energy security by reducing dependence on imported fossil fuels and ensuring a more reliable and diversified energy supply. A decrease in fuel imports can also help lower the country's import bill, improve the balance of payments, and reduce vulnerability to fluctuations in global energy prices. Furthermore, clean energy investments can increase industrial competitiveness by providing more efficient and cost-effective energy solutions, enabling industries to modernize and improve productivity. The transition to a low-carbon economy can also create a wide range of green jobs in sectors such as renewable energy, energy efficiency, manufacturing, construction, and research and development. In addition, expanding the use of clean energy contributes to greater environmental sustainability by reducing greenhouse gas emissions, improving air quality, and supporting efforts to mitigate climate change, thereby benefiting both current and future generations.

The research will examine Pakistan's initiatives in pursuing a low carbon economy and its their potential long-term commitments to become a net-zero.

Research Objectives

This study is designed to:

1. Discuss the scope and scale of GHG emissions in Pakistan.

2. Explore opportunities for renewable energy and decarbonization.

3. Work on emissions from the industrial and transport sectors.

4. Identify what is involved in policy making and how to value the commitment towards climate goals.

5. Examination of the research challenges towards achieving net zero.

6. Provide recommendations.

RESEARCH METHODOLOGY

The methodology adopted in this study is a mixed-methods approach that combines both qualitative and quantitative research techniques to provide a comprehensive analysis of Pakistan's energy transition and decarbonization pathways. The study relies on a range of data collection and analysis methods, including the examination of government energy reports, renewable energy statistics, policy analyses, and sectoral emission studies. In addition, experts review published journal articles and international climate databases to gather relevant information and insights. Secondary data for the research are obtained from reputable sources such as the International Energy Agency (IEA), the United Nations Framework Convention on Climate Change (UNFCCC), scientific journals, energy policy studies, and renewable energy reports. By integrating qualitative assessments with quantitative data analysis, the study aims to evaluate current trends, identify challenges and opportunities, and develop informed recommendations for achieving sustainable energy and climate goals in Pakistan.

CONCEPTUAL FRAMEWORK OF DECARBONIZATION

- *Definition of Decarbonization*

Carbon dioxide emissions reductions into the atmosphere from energy generation, movement, industry and economic activity is the systematic process of reducing carbon emissions, this is termed decarbonization.

Key strategies for reducing emissions and promoting sustainability include integrating renewable energy sources such as solar, wind, and hydro power into energy systems, improving energy efficiency across buildings, transportation, and industrial operations, and increasing electrification by replacing fossil fuel-based technologies with electric alternatives. Additional approaches involve deploying carbon capture technologies to reduce greenhouse gas emissions from industrial processes and power generation, as well as adopting sustainable industrial practices that minimize resource consumption, waste, and environmental impacts while maintaining productivity.

- *Net-Zero Emissions Concept*

A state of net-zero emissions is achieved when the amount of greenhouse gases (GHGs) released into the atmosphere is balanced by the amount removed through various mitigation measures. These measures may include natural carbon sinks such as forests,

carbon capture and storage (CCS) technologies, sustainable land-use practices, and bioenergy systems. The goal is not necessarily to eliminate all emissions entirely, but rather to offset any remaining emissions by removing an equivalent amount of GHGs from the atmosphere, thereby achieving an overall balance between emissions and mitigation efforts.

The GHG emissions trends of Pakistan derives from the Green House Gases Emissions Profile.

Pakistan's growing greenhouse gas emissions can be attributed to several interconnected factors, including rapid population growth, increasing urbanization, expanding industrial activities, and a heavy dependence on fossil fuels for energy production and transportation. As the population continues to rise, demand for energy, housing, transportation, and industrial goods also increases, leading to higher energy consumption and emissions. Urbanization further contributes to this trend by increasing infrastructure development and transportation needs, while industrialization drives greater use of energy-intensive processes. The country's reliance on fossil fuels, such as coal, oil, and natural gas, remains a major source of greenhouse gas emissions, making it a significant challenge in efforts to achieve sustainable development and climate goals.

Table 1: Pakistan GHG Emissions Trend

Year	Total GHG Emissions ($MtCO_2e$)	Per Capita Emissions
2021	526.9	2.48
2022	537.7	2.49
2023	522.2	2.38
2024	525.9	2.36

Data sourced from World emissions databases and climate reports.

Sectoral Contribution to Emissions.

Sector	Estimated Contribution
Energy	46%
Agriculture	41%
Industry	6%
Waste	7%

Livestock and rice farming continue to be two significant sources of CH_4.

Energy Sector Challenges and Decarbonization Process.

Pakistan's energy system is heavily dependent on imported fossil fuels.

- *Current Energy Portfolio.*

Pakistan's electricity supply is generated from a diverse energy mix that includes natural gas, coal, hydropower, nuclear energy, solar power, and wind energy. While this combination helps meet the country's growing energy demands, fossil fuel-based sources such as natural gas and coal continue to contribute significantly to greenhouse gas emissions. Additionally, the development of energy and infrastructure projects under the China–Pakistan Economic Corridor (CPEC) has raised concerns regarding increased carbon emissions, particularly due to investments in coal-fired power plants and other energy-intensive projects. These concerns have highlighted the need to balance economic development and energy security with environmental sustainability and climate change mitigation efforts.

- *Energy Crisis and Circular Debt*

The use of energy generated from landfill gas recovery projects can present financial challenges, particularly due to the high costs associated with infrastructure development, operation, and maintenance. At the same time, Pakistan's energy sector faces several persistent issues, including significant transmission and distribution losses, widespread electricity theft, mounting circular debt, reliance on expensive imported fuels, and aging infrastructure. These challenges place considerable strain on the energy system, limiting investment in cleaner technologies and hindering the transition toward a more sustainable and environmentally friendly energy future.

Potential of Renewable Energy in Pakistan

Pakistan's renewable energy potential is one of the world's highest in South Asia. The renewable energy potential is presented in Table 2.

Table 2 presents the renewable energy potential.

Renewable Source	Estimated Potential
Solar Energy	>2.9 million MW
Wind Energy	50,000 MW

Hydropower	60,000 MW
Biomass	20,000 MW

Solar energy revolution in Pakistan

The energy sector in Pakistan is quickly undergoing a transition with the addition of solar power. Recent research shows that there have been huge developments in Distributed Solar Generation in the house, industry, and agricultural sectors. Here are the solar growth indicators.

Table 3: Solar Growth Indicators

Indicator	Value
Solar Imports in 2024	16–17 GW
Solar Imports in 2025	18 GW
Net-Metered Capacity	4–6 GW
Distributed Solar Estimation	>24 GW

With the growing popularity of rooftop systems, Pakistan can be termed a decentralized solar economy. Solar adoption is driven by economic factors, as shown in 8.1 Drivers of Solar Adoption

- *Drivers of Solar Adoption Economic Factors*

High electricity tariffs and rising diesel costs have placed increasing financial pressure on households, businesses, and industries, making energy consumption more expensive across Pakistan. These rising energy costs have also encouraged consumers to explore alternative energy sources. At the same time, the cost of solar panels has been steadily decreasing due to technological advancements and increased global production, making solar energy a more affordable and attractive option. As a result, the declining cost of solar technology presents an opportunity to reduce dependence on conventional energy sources and promote a cleaner and more sustainable energy future.

Several technical and social factors are driving the adoption of renewable energy technologies, particularly solar power. On the technical side, advancements in battery technologies have improved energy storage capabilities, making renewable energy systems more reliable and efficient. The implementation of net-metering systems has further encouraged solar energy adoption by allowing consumers to sell excess electricity back to the grid. In addition, the availability of competitively priced Chinese solar panels has significantly reduced installation costs, making solar energy more accessible. From a social perspective, frequent load shedding has increased the demand for alternative and dependable energy sources, while the desire for greater energy independence has motivated households and businesses to generate their own electricity. Furthermore, growing environmental awareness has encouraged individuals and organizations to support cleaner energy solutions and contribute to efforts aimed at reducing greenhouse gas emissions and combating climate change.

Wind Energy Development

The coastal corridor of Sindh possesses significant wind energy potential and is considered one of the most promising regions for wind power development in Pakistan. Major wind development areas in this corridor include Jhimpir, Gharo, and Keti Bandar, where favorable wind conditions support large-scale electricity generation. The development of wind energy in these areas offers several important benefits, including low greenhouse gas emissions, reduced dependence on imported fuels, and greater long-term stability in electricity supply. By harnessing its abundant wind resources, Pakistan can enhance its energy security, lower environmental impacts, and support the transition toward a more sustainable energy system.

Power and Clean Energy

Hydropower is still the biggest low carbon generating source in Pakistan. Major Projects.

Project	Capacity
Tarbela Dam	4,888 MW
Dasu Hydropower	4,320 MW
Diamer-Bhasha	4,500 MW

Hydropower is an important pathway to decarbonization and is vulnerable to climate-induced water variability.

Industrial Decarbonization

Industries consume a substantial amount of energy and are among the major contributors to greenhouse gas emissions. Several industrial sectors are particularly

emission-intensive due to the nature of their production processes and energy requirements. In the cement industry, a significant portion of emissions originates from clinker production, which releases carbon dioxide during the chemical conversion of limestone. The steel industry generates high emissions primarily through coal combustion used in steel manufacturing processes. Fertilizer production relies heavily on natural gas, making it a major source of emissions, while the textile industry contributes to emissions through the extensive use of thermal boilers for heating and processing operations. Addressing emissions from these high-emission industries is essential for achieving national climate and sustainability goals.

- *Decarbonization Strategies for Industry*

Industrial sectors consume large amounts of energy and are significant contributors to greenhouse gas emissions, making decarbonization efforts essential for sustainable development. One of the key approaches to reducing industrial emissions is improving energy efficiency through measures such as waste heat recovery, the use of efficient motors, and the adoption of smart manufacturing technologies that optimize energy consumption. Electrification also plays an important role by replacing fossil fuel-based heating systems with electric heaters, particularly through hybrid solar-grid mechanisms that provide cleaner and more reliable energy. Another promising solution is the use of green hydrogen as a low-carbon fuel for industrial heating processes. Additionally, carbon capture technologies offer potential for reducing emissions in high-emission sectors such as the cement and fertilizer industries by capturing and storing carbon dioxide before it is released into the atmosphere.

The transport sector is another rapidly growing source of greenhouse gas emissions in Pakistan. Key challenges include the dominance of diesel-powered vehicles, increasing urban congestion, inadequate public transportation systems, and low vehicle efficiency. To address these issues and curb emissions, Pakistan has introduced an Electric Vehicle (EV) Policy aimed at accelerating the transition to cleaner transportation. The policy focuses on promoting electric motorcycles, developing EV charging infrastructure, reducing dependence on imported oil, and improving urban air quality through lower vehicle emissions.

Agriculture is also a major source of methane emissions, primarily from livestock, rice paddies, and fertilizer use. Since methane is a potent greenhouse gas, reducing agricultural emissions is critical for climate change mitigation. Several measures can help achieve this goal, including precision agriculture techniques that optimize resource use, efficient irrigation systems that reduce water and methane emissions, improved livestock feeding practices that lower methane production, and the adoption of organic farming methods that enhance sustainability while reducing environmental impacts. Together, these strategies can contribute significantly to lowering emissions and supporting a more sustainable future.

Pakistan's Climate policies and international commitments.

Pakistan is a signatory to the Paris Agreement and has committed to addressing climate change through a range of national policies and international commitments. Key climate-related policies include the National Climate Change Policy, which focuses on enhancing climate resilience; the Alternative and Renewable Energy (ARE) Policy 2019, which promotes the expansion of renewable energy sources; the Electric Vehicle (EV) Policy, which supports the transition to greener transportation; and the Nationally Determined Contributions (NDCs), which outline the country's emission reduction targets. Pakistan’s revised NDC aims to significantly reduce greenhouse gas emissions compared to business-as-usual (BAU) levels, with a target of achieving a 50% reduction in emissions by 2035. This objective is expected to be achieved through large-scale growth in renewable energy, improvements in energy efficiency, and increased financing for climate adaptation and mitigation measures.

Research and energy system modeling indicate that Pakistan has substantial potential to achieve deep decarbonization through the adoption of renewable energy technologies, enhanced energy efficiency, greater electrification, and sustainable industrial transformation. Studies based on LEAP and Energy PLAN models suggest that, under ambitious policy scenarios, the country could reduce its emissions by more than 90% by 2050. Such long-term net-zero pathways would support economic development while significantly lowering the environmental impact of energy production and consumption.

Carbon Capture and Storage (CCS) technologies also offer opportunities to reduce emissions from hard-to-abate sectors, including cement plants, fertilizer industries, and thermal power stations. However, the widespread deployment of CCS faces several challenges, such as high implementation costs, technological limitations, and the need for extensive supporting infrastructure. Despite these barriers, CCS remains a potentially important tool for achieving deep emission reductions in industrial sectors.

Green hydrogen represents another promising opportunity for Pakistan's low-carbon future. It has potential applications in fertilizer manufacturing, heavy industries, export-oriented energy markets, and long-duration energy storage systems. Pakistan's abundant solar and wind energy resources provide favorable conditions for producing green hydrogen through renewable-powered electrolysis. By leveraging its renewable energy potential, the country could develop a competitive green hydrogen sector that contributes to both domestic decarbonization and future economic growth.

Climate Finance Requirements

Climate finance is needed in significant amounts for decarbonizing Pakistan. The estimated investment areas are listed below.

Table 4: Estimated Investment Areas

Sector	Investment Requirement
Renewable Energy	Very High
Grid Modernization	High
EV Infrastructure	High
Climate Adaptation	Extensive

- *Financing Sources*

Achieving deep decarbonization and expanding renewable energy systems requires substantial financial investment from a variety of sources. These may include green bonds, international climate funds, carbon markets, public-private partnerships, and multilateral development banks, all of which can provide critical funding for clean energy projects and climate initiatives. In addition to financing, the successful integration of renewable energy into the electricity system depends on modernizing the power grid. Because renewable energy sources such as solar and wind are variable in nature, they require advanced grid infrastructure capable of efficiently managing electricity generation, transmission, and distribution. Key improvements include the development of smart grids, battery energy storage systems, upgraded transmission networks, and digital monitoring and control technologies that enhance grid reliability and flexibility.

While renewable energy integration is more effective with a modernized grid, progress can still be made even where grid modernization is limited, although challenges related to reliability and efficiency may persist. Beyond environmental benefits, decarbonization offers significant social and economic advantages at local, national, and international levels. These benefits include improved public health through reduced air pollution, enhanced energy security, job creation in renewable energy industries, reduced dependence on imported fuels, greater resilience to climate change impacts, and contributions to global efforts to limit greenhouse gas emissions and achieve sustainable development goals.

Socioeconomic Benefits of Decarbonization

- *Economic Benefits*

Decarbonization can generate significant economic and social benefits by reducing import bills, creating green employment opportunities, and promoting industrial modernization. A lower dependence on imported fossil fuels helps improve energy security and reduces the financial burden associated with fuel imports, thereby strengthening the national economy. At the same time, investments in renewable energy, energy efficiency, and clean technologies can create a wide range of green jobs in sectors such as manufacturing, installation, operation, maintenance, and research and development. Furthermore, the transition to low-carbon technologies encourages industrial modernization by improving productivity, enhancing competitiveness, and fostering innovation, enabling industries to operate more sustainably while supporting long-term economic growth.

- *Environmental Benefits*

Decarbonization and the adoption of cleaner energy sources can lead to substantial environmental benefits, including reduced air pollution, improved water

quality, and lower carbon emissions. By decreasing the reliance on fossil fuels and promoting renewable energy technologies, harmful pollutants such as particulate matter, sulfur dioxide, and nitrogen oxides can be significantly reduced, resulting in cleaner air and better public health outcomes. Cleaner industrial and energy production processes also help protect water resources by reducing contamination and minimizing the environmental impacts associated with fossil fuel extraction and use. Furthermore, lowering carbon emissions contributes directly to mitigating climate change by reducing the concentration of greenhouse gases in the atmosphere, supporting both national and global sustainability goals.

- *Social Benefits*

Decarbonization can significantly enhance public well-being by improving public health and expanding access to energy. The reduction of air and environmental pollution resulting from cleaner energy sources can decrease the incidence of respiratory and cardiovascular diseases, leading to healthier communities and lower healthcare costs. At the same time, investments in renewable energy infrastructure can improve energy access, particularly in remote and underserved areas where conventional energy systems may be limited or unreliable. Greater access to affordable and sustainable energy supports economic development, improves living standards, and enhances opportunities for education, healthcare, and other essential services.

Barriers to Net-Zero Transition

- *Financial Constraints*

Pakistan faces several economic challenges that can hinder investment in sustainable development and climate initiatives. These challenges include a high level of external debt, which places significant pressure on national finances and limits the government's ability to allocate resources to development projects. Limited fiscal space further constrains public spending, making it difficult to invest in infrastructure, renewable energy, and climate adaptation measures. Additionally, currency depreciation increases the cost of imports, including energy resources, technology, and equipment, while also raising debt-servicing obligations. Together, these factors create financial constraints that can slow economic growth and complicate efforts to achieve long-term sustainability and decarbonization goals.

- *Institutional Challenges*

Weak governance, regulatory inconsistency, and delayed project approvals are significant challenges that can impede economic development and the implementation of sustainability initiatives. Weak governance can reduce the effectiveness of policy implementation and oversight, while inconsistent regulations create uncertainty for investors and businesses, discouraging long-term commitments and investments. Furthermore, delays in project approvals can slow the development of critical infrastructure, renewable energy projects, and industrial investments, leading to increased costs and missed opportunities. Together, these issues can hinder progress toward economic growth, energy transition, and climate objectives by creating barriers to efficient planning and execution.

- *Technical Challenges*

Limited domestic manufacturing capacity, weak research and development capabilities, and grid instability are key challenges that can slow technological advancement and sustainable economic growth. A lack of strong domestic manufacturing limits the country's ability to produce renewable energy technologies, industrial equipment, and other critical components locally, increasing reliance on imports. Weak research capacity can hinder innovation, reduce the development of locally adapted solutions, and limit the country's competitiveness in emerging technologies. Meanwhile, grid instability affects the reliability and efficiency of electricity supply, creating challenges for industries, businesses, and the integration of renewable energy sources. Collectively, these constraints can impede efforts to modernize the economy, strengthen energy security, and accelerate the transition to a low-carbon future.

COMPARATIVE INTERNATIONAL EXPERIENCE

Countries such as China, Germany, and India have successfully accelerated the adoption and expansion of renewable energy through a combination of stable and supportive policies, strong domestic manufacturing capabilities, large-scale investments, and continuous technological innovation. These measures have enabled them to reduce costs, attract private and public investment, improve energy security, and enhance the

competitiveness of their renewable energy sectors. Pakistan can learn from these experiences by implementing similar strategies while adapting them to its own economic, social, and institutional conditions. By developing tailored policies, encouraging local manufacturing, investing in clean energy infrastructure, and promoting research and innovation, Pakistan can strengthen its renewable energy sector and support a sustainable transition to a low-carbon economy.

Pakistan Strategic Roadmap

A phased approach is essential for achieving Pakistan's long-term decarbonization and sustainability goals. In the short term (2025–2030), priorities should include expanding rooftop solar installations, reducing transmission and distribution losses in the power sector, encouraging the adoption of electric vehicles (EVs), and improving industrial energy efficiency. These measures can deliver immediate reductions in energy costs and greenhouse gas emissions while strengthening energy security.

In the medium term (2030–2040), efforts should focus on developing a green hydrogen industry, modernizing the national electricity grid, expanding battery energy storage systems, and promoting carbon markets to incentivize emission reductions. These initiatives will help integrate larger shares of renewable energy into the energy system and support the transition toward a low-carbon economy.

In the long term (2040–2050), Pakistan should aim to achieve deep decarbonization across all major sectors of the economy. This will involve scaling up Carbon Capture and Storage (CCS) technologies for hard-to-abate industries, accelerating the adoption of advanced clean energy solutions, and ultimately transitioning to a net-zero economy. By following this roadmap, Pakistan can significantly reduce its greenhouse gas emissions while promoting sustainable economic growth and environmental resilience.

RECOMMENDATIONS

- *Policy Recommendations*
    1. Implement legally binding targets for climate action.
    2. Increase the number of renewable energy auctions.
    3. Speedy renewable energy auctions. Phase Down Inefficient Plants Based on Fossil Fuel.
    4. Promote domestic production of solar products.
- *Institutional Recommendations*
    1. Strengthen energy governance.
    2. Improve policy consistency.
    3. Enhance provincial coordination.
- *Technical Recommendations*
    1. Invest in smart grids
    2. Foment research and innovation
    3. Increase energy storage technologies
- *Financial Recommendations*
    1. Improve green investment policies and methods.
    2. Promote green financing tools.
    3. Call in foreign climate investments.
    4. Promote carbon-credit markets.

CONCLUSIONS

Pakistan is at a fork in the road to advance towards climate sustainability and to encourage national economic growth. We must do so and somehow accelerate this low carbon economy due to the increasing emission value, energy insecurity and climate vulnerability. All of these are potential benefits of an effective decarbonization and net zero pathway to improve energy security, reduce fuel dependence and create sustainable economic development. Pakistan is equally having amazing potential in RE Sector, especially in Solar and Wind Sector. The more rapid than expected development of distributed solar systems, is a testament to how fast the market can accept clean technologies that are lower in cost and have available policy incentives. But recognize a regime change is needed in order to achieve net zero emissions with:

Achieving a sustainable and low-carbon future in Pakistan will require coordinated efforts across multiple sectors. Key priorities include expanding renewable energy capacity to reduce dependence on fossil fuels and increase the share of clean energy in the national energy mix. Industrial modernization is also essential to improve productivity, enhance energy

efficiency, and lower greenhouse gas emissions from manufacturing processes. The electrification of vehicles can further contribute to emission reductions by decreasing reliance on conventional fossil-fuel-powered transportation. In addition, transforming and modernizing the national power grid is necessary to support the integration of renewable energy sources, improve reliability, and enhance overall system efficiency. Mobilizing climate finance through domestic and international funding mechanisms will provide the resources needed to implement large-scale sustainability projects. Finally, strengthening institutions and governance frameworks will be critical for ensuring effective policy implementation, regulatory consistency, and long-term success in achieving climate and development goals.

Although reaching a net zero by 2050 is ambitious, it is certainly possible to achieve large emission reductions through national and international cooperation on emission reductions intensity. A sustainable decarbonization can be a gamechanger for the development of a more resilient, energy secure and environment friendly economy for Pakistan.

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