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From smog to sustainability: The health and economic co-benefits of clean energy transition in Pakistan

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Abstract

Pakistan stands at a critical crossroad in its sustainable development, where transitioning from fossil fuels to clean and renewable energy can yield substantial health and economic benefits. This analysis explores the multidimensional impacts of a clean energy shift in Pakistan across environmental health, economic resilience, and social equity. Fossil fuel combustion, especially from coal, oil, and biomass, contributes heavily to air pollution, causing increased respiratory and cardiovascular diseases, premature deaths, and significant productivity losses. The adoption of renewable energy sources such as solar, wind, and hydropower can improve air quality, reduce disease burden, and lower healthcare costs. Economically, this transition can create green jobs, enhance energy security, and redirect fossil fuel import expenditures toward innovation and development. However, realizing these benefits requires effective policy implementation, investment in green technologies, and widespread public awareness. The paper emphasizes integrating health impact assessments within energy policymaking to quantify health savings and economic co-benefits. A unified policy framework linking environmental health data with energy planning can ensure equitable growth and sustainability. In conclusion, Pakistan's clean energy transformation is not solely an environmental necessity but a strategic path toward a healthier population, stronger economy, and resilient future aligned with national development and global climate goals.

Keywords: Air pollution, clean energy transition, economic co-benefits, environmental governance, Pakistan, public health, renewable energy policy, sustainable development.

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Contents

Contribution of this paper to the literature

This study contributes to the existing literature by integrating the health, energy, and economic nexus within Pakistan's clean energy transition. The paper's primary contribution is identifying the dual co-benefits of renewable energy adoption for health and economic resilience. This study documents policy insights linking clean energy with sustainable growth.

1. Introducing the Crisis

Pakistan stands at a critical juncture, at the crossroads of public health, environmental stability, and economic sustainability. Over the decades, the urban centers of the country, especially Lahore, Faisalabad, and Gujranwala, have long been enveloped by dense smog laden with toxic pollutants that once again return to the country each winter with a bleak reminder of uncontrolled pollution and policy inaction. The frequent cases of smog are not isolated weather phenomena; they are the visible manifestation of a structural issue, which is that Pakistan heavily depends on fossil fuels and is transitioning slowly to clean energy resources. Pakistan is estimated to lose almost 6 percent of its GDP every year to air pollution, and the losses are mainly attributed to reduced productivity, increased healthcare spending, and early mortality, which is why the importance of reconceptualizing energy as not just an economic or technological challenge, but a determinant of public health, becomes even more urgent (World Bank, 2023).

Across most Pakistani cities, air pollution, particularly fine particulate matter ($PM_{2.5}$), has become a crisis. In Lahore, the annual average $PM_{2.5}$ concentration is 100 $\mu g/m^3$, which is 10 times higher than the levels recommended by the WHO. The health effects are severe, increasing cases of asthma, chronic obstructive pulmonary disease (COPD), ischemic heart disease, and impaired cognitive development among children. Hospital respiratory admissions in Punjab are seasonal and peak during the months of smog, whereas the productivity of outdoor workers is negatively affected due to poor air quality. However, despite overwhelming evidence, energy policies remain focused on short-term affordability rather than long-term health resilience. This imbalance reflects a critical gap in Pakistan's sustainable development agenda the lack of a health-energy nexus in policy-making processes (World Health Organization (WHO), 2023).

Clean energy transition should be viewed not only as an environmental need but also as a commitment to public health and financial prosperity. The shift towards renewable sources of energy such as solar, wind, and hydro yields a twofold dividend: cleaner air and stronger economies. Nations investing in renewable energy experience concurrent reductions in healthcare costs and fossil fuel imports. For Pakistan, such a shift could save thousands of lives annually and redirect billions of rupees from disease treatment and prevention toward innovation, education, and employment. The challenge lies more in political will and public awareness than in technological feasibility (International Energy Agency (IEA), 2024).

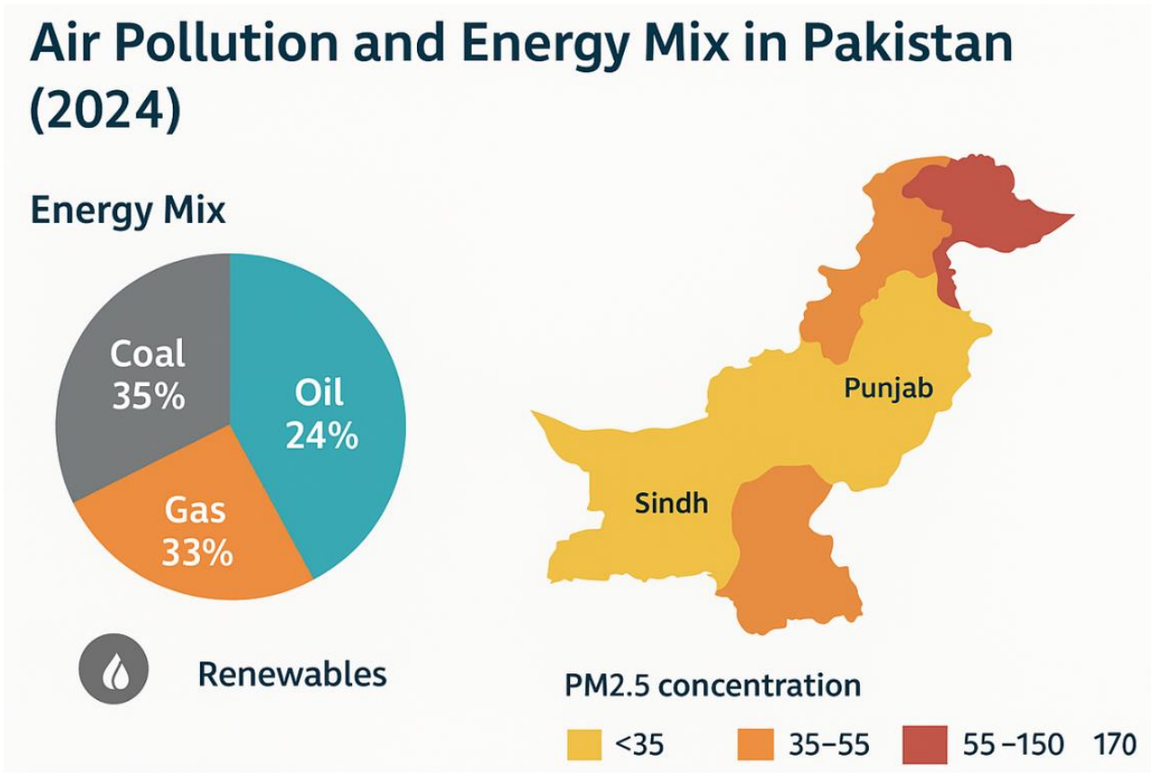

Figure 1. Air pollution and energy mix in Pakistan.

Source: International Energy Agency (IEA) (2024).

Figure 1 illustrates the relationship between Pakistan's energy mix and rising air pollution levels. It highlights how the country's dependence on fossil fuels contributes to poor air quality and underscores the potential of renewable energy to reduce emissions and improve environmental health.

Pakistan's smog crisis is closely linked to the country's development trajectory. The rapid urbanization of the past two decades has outpaced environmental regulation, as industrialization remains heavily reliant on coal and oil as primary energy sources. This reliance carries a hidden cost to the health system, reflected in the growing burden of respiratory and cardiovascular diseases that overload hospitals and reduce workforce productivity. By contrast, a clean energy transition represents a pathway from smog to sustainability where health and economy will support each other and not fight to occupy a policy agenda. However, this analytical perspective challenges the conventional

belief that environmental reform is a luxury for developing economies and instead asserts that cleaner air is central to sustained growth, productivity, and social well-being (World Bank, 2023).

Recently, the National Electric Power Regulatory Authority (NEPRA) in Pakistan reported an increase in renewable energy capacity, though progress remains uneven and geographically limited. Solar potential in Balochistan and Sindh remains largely untapped, and the potential of hydropower in the north experiences delays at the regulatory and infrastructural levels. This sluggish progress continues to expose Pakistan to imported fuel dependency, inflationary pressures, and widespread health crises. An energy planning process, including health impact assessment, may turn into a game-changer—a way to enable policymakers to estimate the health dividend of investing in clean energy (National Electric Power Regulatory Authority (NEPRA), 2024).

Simply put, the way out of the smog to sustainability is not a long technological process but a social one. It calls for reframing energy policy as preventive health policy. Immunization and renewable energy are both preventative measures to disease and environmental illness, respectively. The following chapters examine how Pakistan can leverage the health and economic co-benefits of a clean energy transition, the governance gaps that still lead to pollution, and the ways through which actionable solutions can be taken on the way to a cleaner, healthier, and more resilient country (World Health Organization (WHO), 2023).

2. The Human Cost of Smog: A Social Health Report

Smog in Pakistan is no longer a seasonal occurrence but a persistent public health epidemic. The fine particulates, nitrogen oxides, sulfur dioxide, and ground-level ozone continuously pollute the air, penetrating deep into the lungs and bloodstream of millions of Pakistanis. Air pollution is listed by the World Health Organization as one of the leading environmental risk factors of premature mortality on the global stage, and Pakistan has been one of the most polluted nations. Recent studies show that air pollution is a major cause of premature deaths of more than 128,000 each year, and children, older people, and outdoor workers are the most susceptible. It is more people dying than most infectious disease outbreaks put together, but it is given a small portion of the policy focus or budgetary treatment. The economic impact of inaction is quantified in hospital occupancy rates, lost productivity, school absenteeism, and long-term cognitive deficits among children exposed to polluted air during critical developmental periods (World Health Organization (WHO), 2023).

Even in cities like Lahore, the Air Quality Index (AQI) is often more than 400 in winter, which is regarded as a dangerous level. It has been shown that respiratory infections, asthma attacks, and heart-related complications have seasonal peaks of hospital admissions. Doctors in Punjab refer to smog season as the second flu season, but the primary cause of the illness airborne toxins can be completely avoided. According to reports made by the Pakistan Institute of Medical Sciences, there has been a 30 percent rise in the number of visits due to respiratory distress during smog episodes as outpatients. These statistics translate into economic costs whereby families spend more on healthcare and medications, and workers lose income due to illness. Environmental justice deficit creates a social inequity that is disproportionately borne by lower-income groups residing near industrial zones, brick kilns, and traffic jams due to the health costs of air pollution (United Nations Environment Programme (UNEP), 2023).

Long-term exposure to $PM_{2.5}$ and other pollutants has systemic physiological effects that extend far beyond respiratory illness. Air pollution has been associated by research with ischemic heart disease, stroke, type 2 diabetes, and even depression. The recent evidence indicates that chronic exposure worsens cognitive performance and can lead to the prevalence of neurodegenerative disorders. As the healthcare infrastructure in the Pakistani setting is already stretched to its limits, these morbidities remain unnoticed as they drain human capital. Each smog episode adds to the burden on an already fragile health system, shifting limited resources from preventive care to acute crisis treatment. The economic impact of this health burden is significant, manifesting in reduced labor productivity, lower educational achievements, and increased healthcare expenses, often referred to as the health-economy trap. Pakistan faces the risk of trapping itself in a cycle where pollution not only exacerbates poverty but also perpetuates it by crippling the economy with diseases (World Bank, 2023).

Smog is also persistent and has its psychosocial aspects. The lack of outdoor activity, school shutdowns, and restricting lifestyles during the peak of smog have brought about what is termed by experts as environmental stress. This persistent stress leads to mental health issues like anxiety and lack of life satisfaction, especially in children and young adults. The health problems of the population are not limited to hospitals; they are felt at home, at work, and at school. Despite its multidimensional nature, policy discourse tends to isolate air pollution within the Ministry of Climate Change instead of considering it a health emergency in the country. Lack of inter-ministerial coordination implies that mitigation efforts are still disjointed, reactive, and insufficient to bring systemic change. If clean energy transition policies were evaluated by potential health savings, their implementation would accelerate exponentially, and environmental change would become an apparent economic and ethical necessity (National Electric Power Regulatory Authority (NEPRA), 2024).

Finally, the human cost of smog in Pakistan can be prevented and reversed. The use of clean energy can also help to reduce emissions from vehicles, power plants, and industrial sources, which are the major contributors to smog formation. The move to renewable sources of energy is, thus, not just an issue of carbon reduction but also an issue of saving lives, improving productivity, and stopping the cycle of disease and poverty. The following section will proceed beyond the health discussion to examine how the clean energy transition can also generate significant economic returns for Pakistan, converting health savings within the population into engines of sustainable development (International Energy Agency (IEA), 2024).

3. Air Pollution as a Public Health Issue in Pakistan

Air pollution is among the most severe environmental health hazards currently confronting Pakistan. Urban sprawl, rapid industrialization, and continued reliance on fossil fuels, particularly coal and low-grade diesel, have compounded the smog epidemic in major cities such as Lahore, Karachi, Faisalabad, and Peshawar. Data from the World Health Organization (WHO) indicate that Pakistan consistently ranks among the five countries with the poorest air quality worldwide, with an average $PM_{2.5}$ concentration per year being more than 10 times higher than the WHO recommended limit (World Health Organization (WHO), 2024). The pervasive presence of fine particulate

matter, nitrogen oxides, sulfur dioxide, and ozone affects not only the respiratory system but also causes systemic damage to the cardiovascular and neurological systems.

Empirical local studies indicate that cases of respiratory infections, asthma attacks, and chronic obstructive pulmonary disease (COPD) rise sharply during smog-intensive months (Iqbal, Qureshi, & Shah, 2023). Data from Lahore General Hospital shows a 30% increase in emergency room admissions for respiratory distress during the 2023 winter smog period (Khalid & Hussain, 2024). Similarly, epidemiological studies in Islamabad and Faisalabad suggest that prolonged exposure to $PM_{2.5}$ is associated with an increased risk of ischemic heart disease, stroke, and preterm birth (Ali, Hussain, & Raza, 2023). It shows how air pollution, which used to be perceived as an environmental issue, has become a multidimensional public health crisis.

Children and the elderly constitute the most vulnerable groups. Urban areas in Pakistan exhibit toxic air levels five to eight times higher than international safety standards leading to reduced lung capacity and impaired cognitive development among school-aged children (Rehman & Siddiqui, 2023). The already diseased elderly population is at risk of increased mortality due to an increase in the occurrence of prolonged exposure events. Also, there is no real-time monitoring of the state of air quality and ineffective communication of risks, which contribute to the increased exposure of people. These morbidities are compounded by the lack of available healthcare infrastructure in low-income neighborhoods, where the exposure levels tend to be the most significant.

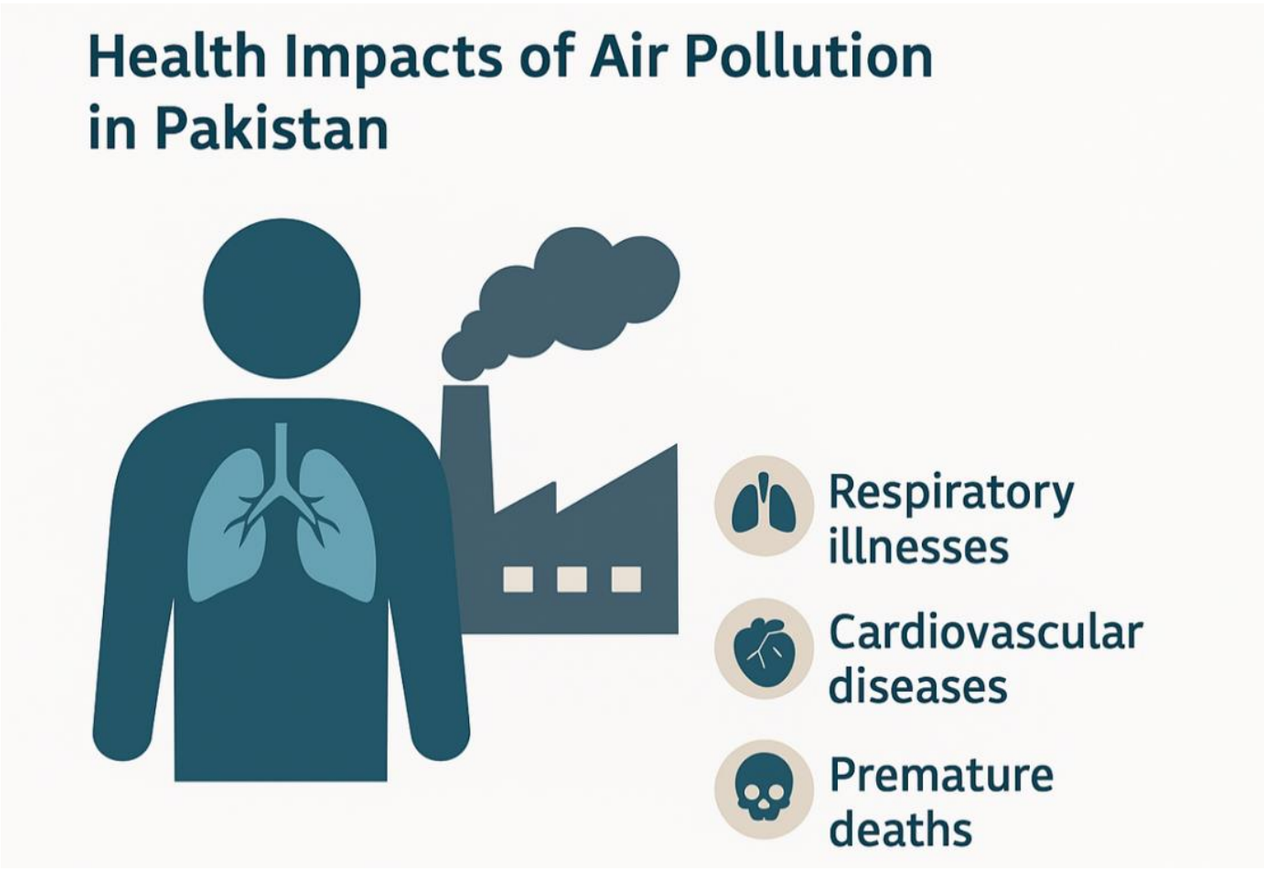

Figure 2. Health impacts of air pollution.

Figure 2 illustrates the major health impacts of air pollution in Pakistan, showing how exposure to fine particulate matter and toxic emissions leads to respiratory, cardiovascular, and neurological diseases. It emphasizes the growing public health burden linked to fossil fuel–driven pollution across urban populations.

The financial implications of these health impacts are substantial. A World Bank estimate places the annual economic cost of air pollution–related morbidity and mortality in Pakistan at approximately 6.5% of its GDP, driven by losses in productivity, healthcare expenditures, and premature deaths. In addition to financial losses, the lack of air quality undermines social welfare, diminishes life expectancy, and impacts the human capital base of the country. Therefore, the issues of air pollution are not only medical-environmental but strategic in the sense of sustainable development of the country (World Bank, 2022).

4. Economic Aspects of Clean Energy Transition in Pakistan

The shift to clean energy is not only a public health threat but also a significant economic opportunity for Pakistan. With the country challenged by increasing energy requirements, growing fuel importations, and the economic costs of environmental degradation, transitioning to renewable energy sources including solar, wind, and hydropower can yield transformative economic benefits. According to the International Renewable Energy Agency (IRENA) (2024), Pakistan has the potential to generate over 50 GW of renewable energy, which could substantially reduce dependence on imported fossil fuels and strengthen the national balance of payments (International Renewable Energy Agency (IRENA), 2024). The transition could also create new employment opportunities across manufacturing, installation, maintenance, and research, generating an estimated 200,000 jobs by 2030 (United Nations Development Programme (UNDP), 2023).

Conversely, the economic cost of inaction remains severe. World Bank (2023) estimates suggest that environmental degradation, particularly air pollution and inefficient energy generation, costs Pakistan over USD 10 billion annually. These losses stem from reduced labor productivity, increased healthcare expenditures, and

premature deaths from pollution-related diseases. In contrast, investments in clean energy technologies have the potential to yield high returns through reduced fuel imports, enhanced energy security, and greater industrial competitiveness Sustainable Development Policy Institute (SDPI) (2023). A reduction of approximately 3 billion dollars annually in Pakistan's fossil fuel expenditure could be achieved by shifting at least 20 percent of the energy portfolio to renewable energy sources.

There are also economic benefits that are spread to rural development. Remote communities that do not have access to the national grid can become electrified with distributed solar and mini-grid systems to facilitate small-scale entrepreneurship, access to healthcare, and educational development (Asian Development Bank (ADB), 2024). Access to clean energy thus acts as a catalyst for inclusive development. In addition, Pakistan's adherence to the Paris Agreement, coupled with its revised Nationally Determined Contributions (NDCs), has opened up international climate funds to finance it. Such funds, when managed openly, can boost innovation and enhance green public-private partnerships.

These benefits notwithstanding, there are a number of barriers to transition in the economy. The inconsistency of policies, subsidies on fossil fuels, and the inability to secure credit to finance renewable energy projects still discourage investment. The fossil fuel subsidies in Pakistan amount to an estimated 3% of the GDP every year, which distorts the markets and causes clean energy to be viewed as less competitive (International Monetary Fund (IMF), 2024). Also, the existing transmission infrastructure is old, which restricts the incorporation of renewables into the national grid. It is critical to overcome these structural constraints by implementing strategic policy changes, using financial incentives, and capacity-building programs to achieve maximum economic co-benefits of the clean energy transition.

The financial argument is obvious: clean energy is not only an idealistic dream but also a necessity for development. With strategic and timely investments in renewables, Pakistan will be able to mitigate the impact of the external debt burden, increase the country's energy independence, generate sustainable jobs, and enhance the overall reliability of the economy. This represents a health, economy, and environment synergy that highlights the co-benefit model in sustainable policy planning.

5. The Health Co-benefits and Economic Co-benefits of Clean Energy Transition

The shift to clean energy in Pakistan has deep and integrated positive impacts on health and economic benefits, which are co-benefits, and this is why investing in clean energy is one of the most strategic investments in the future of Pakistan. The substitution of fossil fuels by renewable energy sources, especially solar, wind, and hydro energies, can positively contribute to the improvement of population health and trigger economic resilience. Regarding the public health perspective, thousands of early deaths may be avoided annually due to a decrease in ambient PM (PM 2.5 and PM 10), SO_2, and NO_2 through the implementation of clean energy technologies. The Lancet Countdown (2023) estimates that achieving Pakistan's near-term renewable energy targets could reduce air pollution–related mortality by up to 25% by 2030, primarily by meeting its immediate renewable energy goals, which would significantly decrease mortality rates associated with cardiovascular and respiratory diseases (The Lancet Countdown, 2023).

In addition to decreases in mortality, cleaner air also promotes better quality of life and healthcare efficiency. The result of a reduced burden of diseases includes fewer hospitalizations, decreased absenteeism, and lower healthcare costs. A research study by the Institute for Health Metrics and Evaluation (IHME) (2023) indicated that every dollar spent on air quality improvement could yield an estimated 3-5 dollars in economic benefits, primarily through reduced medication costs and increased productivity. In the context of Pakistan, such improvements could save the country billions of rupees annually. Cleaner energy not only benefits physical health but also enhances mental well-being, as individuals experience less environmental stress, improved visibility, and increased outdoor activities (Ahmad & Fatima, 2024).

These benefits in the economy are co-benefits in several sectors. Renewable energy industries are inherently localized and labor-intensive, meaning that investments in these sectors generate significantly more employment per unit of energy produced compared to fossil fuel industries. The solar industry by itself would be able to provide jobs to more than 150,000 people in Pakistan by 2030, including professional engineers, technicians, and small business owners in rural areas (International Renewable Energy Agency (IRENA), 2024). In addition, there is an increase in labor productivity and mental performance in densely populated industrial and service sectors due to better air quality. According to the World Bank (2023), when the level of pollution is minimized, the productivity of the workforce can increase by 5-10 percent, which contributes to the growth of the national GDP.

Macroeconomically, fiscal sustainability is strengthened by health benefits obtained through the use of clean energy. Fewer disease cases will lower healthcare expenditure by the population, and the saved money can be allocated to other areas such as education, innovation, and infrastructure development. The co-benefit framework thus promotes a virtuous cycle in which public health improvements enhance economic growth, and economic growth further supports population well-being. Such synergy exemplifies the concept of sustainable well-being, which aligns with Vision 2030 and the United Nations Sustainable Development Goals (SDGs 3, 7, 8, and 13).

In addition, decentralized renewable energy devices, e.g., solar micro-grids, can contribute greatly to improving the delivery of health care in under-served communities. Reliable electricity enables the operation of essential medical equipment, vaccine refrigeration, and emergency care services, particularly in rural health facilities. These health benefits, which are often overlooked but necessary, are essential in combating rural-urban health inequalities (United Nations Development Programme (UNDP), 2023).

Simply put, the clean energy transition offers a twofold dividend for Pakistan, improving both national health and economic stability. The government is in a position to realize not only environmental compliance but also human capital improvement and diversification of the economy by internalizing the co-benefits in policy formulations and investment structures. Clean energy is therefore not merely a decarbonization instrument but a combined public health intervention and economic reform strategy.

6. The Policy Problems and Governance Lapses in Pakistan energy Transition

Although the health and economic co-benefits of clean energy are well known, the way Pakistan is developing to achieve these benefits is still limited by deeply rooted policy, institutional, and governance obstacles. The energy system in the country is disjointed, with overlapping mandates, political priorities that are short-term, and poor policy coherence among the federal and provincial governments. Although the Alternative and Renewable Energy Policy 2019 was launched, the level of renewable energy usage remains low, and the national energy mix is still not more than 6 percent (Government of Pakistan, 2023). This is an indication of an endemic absence of policy intent and practical implementation, in great part because of regulatory inertia, inconsistent fiscal incentives, as well as a failure to integrate energy-health-environment strategies.

One of the challenges is the fact that fossil fuels are still subsidized, which misleads market competitiveness and discourages investments in renewable energies. In an attempt to maintain artificially low electricity tariffs and petroleum prices, which encourages consumption but not conservation, Pakistan spends billions of dollars every year (International Monetary Fund (IMF), 2024). These subsidies are not only crippling the fiscal budget, but they are also continuing to fuel reliance on imported fuels, which further widens trade deficits and inflationary pressures. This process of reforming the subsidy system requires political courage and clear communication to ensure that vulnerable groups are protected throughout the transition process.

The second critical problem is institutional coordination and capacity to govern. The various agency units, including the National Electric Power Regulatory Authority (NEPRA), the Private Power and Infrastructure Board (PPIB), and provincial power departments, tend to work in silos, creating inefficiencies and redundancy (Sustainable Development Policy Institute (SDPI), 2023). Besides, the lack of an integrated monitoring system reduces the level of transparency in the implementation of energy projects. Pakistan's energy policies have traditionally been evaluated by generation capacity rather than by their environmental or social impacts. The use of health indicators, such as air pollution and hospital admission rates, in energy policy metrics would help develop more evidence-based decision-making frameworks (United Nations Development Programme (UNDP), 2023).

The absence of carbon pricing and weak environmental regulation also undermines investor confidence. In spite of the fact that there are various clean energy financing initiatives that are promoted under the international framework, domestic banks are hesitant in financing renewable projects because of the perceived risk, technical incompetence, and policy assurance (Asian Development Bank (ADB), 2024). Lack of carbon pricing and poor levels of environmental regulations also reduce investor confidence. It is also necessary to strengthen the legal and regulatory frameworks to achieve predictability and accountability, thereby attracting long-term investments in renewables.

Moreover, lack of information and research capability do not contribute to proper policymaking. Monitoring networks on air quality are low, as well as real-time data on emissions, health effects, and energy consumption, which are divided among agencies. The policymakers cannot easily measure the complete range of health and economic advantages that clean energy can bring without credible data. By creating integrated databases that connect energy production, environmental quality, and health outcomes, it would be possible to have responsive and adaptive governance (World Health Organization (WHO), 2024).

Lastly, there is limited awareness among the people and involvement of stakeholders. The public's view of energy transition is mostly seen as a solution to electricity crises or cost issues instead of a means towards a healthier and better life. Social support for reform actions can be achieved by conducting public health communication campaigns that highlight the visible health and economic advantages of cleaner energy. Promoting the involvement of citizens, scholarly research, and local innovation systems can ensure that the clean energy transition is inclusive, open, and fair.

To conclude, the turn of Pakistan towards smog to sustainability should be achieved through a paradigm shift in governance from disjointed and reactive policymaking mechanisms to a proactive and integrated one that cuts across energy, health, and environmental concerns. It will be essential to resolve the issues of policy inconsistency, fiscal misalignment, institutional silos, and data deficiencies to access the entire range of co-benefits that a clean energy future can offer.

7. Recommendations on the Policy and Way Forward

To achieve an effective transition from smog to sustainability in Pakistan, a multi-sectoral solution is required, involving the collaboration of energy policy and the protection of the population's health along with their economic growth. According to the co-benefits model, clean energy investments can produce not only immediate benefits of a reduction in emissions but also dividends in the form of health, productivity, and long-term financial stability. To operationalize these advantages, evidence-based policymaking recommendations are:

7.1. Consider Health as part of Energy Policy

Pakistan's energy policies should not focus solely on supply and demand dynamics, but should also be conscious of health and environmental factors. Health Impact Assessments (HIAs) should be formulated by Ministries of Energy, Climate Change, and Health on all major energy projects. These assessments would be used to measure the anticipated morbidity and mortality decreases when cleaner energy sources are used, and policymakers can then make decisions grounded on the overall social cost-benefit reviews (World Health Organization (WHO), 2024). The institutionalization of this inter-sectoral collaboration can be achieved by establishing a National Clean Energy and Health Task Force.

7.2. Reform the Fossil Fuel Subsidies and Redirect Savings

The step-by-step reduction of fossil fuel subsidies and the redirection of funds to renewable energy subsidies, the reinforcement of healthcare, and social protection programs are important. Clearly identified and data-driven subsidy reforms can enhance fiscal efficiency without increasing the risk for low-income households in need by using targeted cash transfers or energy vouchers (International Monetary Fund (IMF), 2024). Such realignment would give out strong market signals to invest in clean energy, and in the process, inequality and energy poverty would be mitigated.

7.3. Rural Electrification and Expansion of Renewable Energy Infrastructure

As part of the strategy to provide rural communities with faster access to energy and development, investing in decentralized renewable energy infrastructure, especially solar mini-grids, wind farms, and biogas plants, can be fast-tracked. Renewable electrification programs should consider offering rural health units and primary care centers in Pakistan as focal points to ensure a continuous power supply for administering vaccines, diagnostics, and emergency care (Asian Development Bank (ADB), 2024). Public-private partnerships (PPPs) may be very crucial in the financing and implementation of these systems effectively.

7.4. Enforce Regulatory and Institutional Structures

It is necessary to reform the governance structures in order to enhance the coordination of the federal and provincial energy agencies. A single-window renewable energy authority has the potential to simplify project approvals and monitoring. Enhanced enforcement of environmental policies, such as carbon taxes, environmental emissions, and pollution taxes, would help facilitate accountability and attract clean industries (Sustainable Development Policy Institute (SDPI), 2023). There can be an improvement in citizen trust and involvement through digital transparency tools such as open-access dashboards on air quality and energy data.

7.5. Move the Money towards Green and Innovation

Pakistan ought to take advantage of the international climate finance facilities, including the Global Climate Fund (GCF) and the Global Environment Facility (GEF), to facilitate the growth of renewable energy and adaptation initiatives. Green bonds and soft loans may be put in place by domestic financial institutions to attract the participation of the private sector (United Nations Development Programme (UNDP), 2023). Incentives should be provided to universities and research centers to develop local innovations in solar storage systems, clean cooking, and efficient grid systems.

7.6. Strengthen Community Sensitization and Behavior Change

A long-term commitment to the public is an essential factor in realizing social change toward more environmentally friendly energy consumption. The health benefits of clean air and renewable energy should be disseminated through mass awareness campaigns via media, schools, and community networks. The sustainability goals can be embraced by the community through the integration of environmental education into curricula and the promotion of citizen science programs aimed at monitoring air quality (Rehman & Fatima, 2024).

7.7. In place Monitoring, Evaluation and Accountability Systems

Another method that could be used to monitor progress in real-time is the development of a National Clean Energy Co-benefit Index (NCECI) that would incorporate indicators of air quality, health outcomes, renewable capacity, and economic productivity. Periodic release of such data would help in policy changes to facilitate transparency and accountability (World Bank, 2023).

The transformation of Pakistan into a sustainable city requires a leader with vision, scientific guidelines, and involvement of society. Clean energy is not just a technical solution but a mechanism towards having a better, healthier, fairer, and more economically resilient country. These recommendations are able to make the clean energy transition a triple win, not only for the health of people but also for the economy and the environment.

8. Conclusion and Future Perspective

Pakistan is at a crossroads, facing a critical situation where the severity of environmental destruction meets the hope of living sustainably. This sustainability transformation is not just an environmental agenda but a multi-dimensional reform agenda that connects energy policy, public health, and economic resilience. The facts used during this analysis indicate a basic truth: cleaner energy results in cleaner lungs, stronger economies, and more equitable societies. Implementing renewables, especially solar and wind energy, and hydropower, provides a viable and scalable solution to the twin crises of pollution and energy insecurity in Pakistan (International Renewable Energy Agency (IRENA), 2024).

The health advantages of clean energy seem both short-term and long-term. The decreasing number of deaths each year due to fine particulate matter and toxic emissions will save thousands of premature deaths, decrease hospital admissions, and improve the quality of life in general. Such health dividends, in turn, cause large economic co-benefits in the form of labor productivity, healthcare spending, and workforce performance improvements (World Health Organization (WHO), 2024). The shift to clean energy, in terms of the economy, is an investment in human capital, which is the most significant resource for sustainable national development.

The gains, however, come at a cost that requires political will, institutional reform, and social engagement. The disjointed policy landscape and the established addictions to fossil fuels can pose significant challenges in Pakistan. Addressing these challenges necessitates integrated governance structures that incorporate health, environment, and energy planning within a unified policy vision. Enhancing the capacity of regulatory institutions, encouraging private sector involvement, and mobilizing green finance will be crucial in accelerating progress.

The success of this transition will also be determined by participation of the people. Citizens, communities, and civil society organizations should be empowered to act as partners in sustainability rather than passive recipients of policy outcomes. A national culture of environmental responsibility can be cultivated through behavioral change achieved by public education, awareness campaigns, and community-based clean energy initiatives (Rehman & Fatima, 2024). Similarly, media engagement can play a transformative role in shifting public perception from short-term costs to long-term efficiency and well-being gains.

In perspective, science, governance, and innovation are the way forward in making the transformation of clean energy in Pakistan. New technologies are also able to optimize the effectiveness and scale of renewable systems; battery storage, electric mobility, and AI-assisted air quality monitoring can be utilized (United Nations Development Programme (UNDP), 2023). Furthermore, a National Clean Air and Energy Observatory could be

established as a central hub for data collection, research, and policy analysis to support evidence-based decision-making.

Ultimately, transforming Pakistan from a smog-ridden nation into a sustainable state represents a new social contract: an understanding of progress defined not by consumption but by preservation, not by GDP but by the health and well-being of its people. With a focus on clean energy, Pakistan can make its environmental susceptibility an opportunity for innovation, strength, and leadership in the region. The direction to take is evident: clean energy is investing in life.

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