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Day: _____

Imbalance of Energy mix in Pakistan and its Consequences

1 Introduction

Thesis Statement: The imbalance of Pakistan's energy mix, characterized by a disproportionate reliance on hydrocarbons, lack of energy infrastructure and inconsistent government policies pose significant consequences for the nation's sustainability and development. This energy asymmetry hinders environmental progress, exacerbates geopolitical vulnerabilities, and limits the potential for economic diversification. Addressing these challenges is crucial for charting a sustainable path for nation's future.

2 The importance of Energy mix for Pakistan

- Diversification for resilience
- Environmental sustainability
- Energy security and Independence

3 Exploring the reasons behind the imbalance of Energy Mix in Pakistan

- Pakistan's overdependence on hydrocarbons for energy production; \$518M in hydrocarbon imports FY2021.

- (b) Infrastructure Challenges in Energy Diversification; Lack of grid infrastructure and transmission lines for distribution of power generated from renewable sources.
- (c) Policy and Regulatory Impediments in energy transition; Circular debt crisis due to flawed agreements with IPPs
- (d) Financial constraints impacting renewable investments
- (e) Geopolitical tensions affecting energy cooperation, War in Ukraine, Iran Suez gas Pipeline
- (f) Public Awareness and participation in energy transition

Irrelevant portion
Not the asked part

Consequences of the Imbalance for Pakistan

- (a) Economic vulnerability due to limited energy sources; global hydrocarbon price fluctuations
- (b) Environmental degradation resulting from non renewable energy dependency; Alarming levels of smog in the metropolitan cities.
- (c) Energy insecurity arising from lack of diverse sources; 90% of the Toqhar district without electricity supply causing social unrest.
- (d) Technological stagnation, hindering adoption of sustainable energy solutions; Solar power capacity remains underutilized due to lack of cutting edge solar technologies
- (e) Pakistan's global standing affected by imbalanced

energy portfolio; as of 2021, Pakistan ranked 104 out of 115 countries on WEF Energy Transition Index.

Approaches to attain a well-balanced Energy Mix for Pakistan:

- a) Diversification strategies for a resilient energy portfolio,
- b) Strategic policy reforms to ensure balanced energy sources.
- c) Investment in innovative technologies for sustainable energy.
- e) International cooperation for sustainable energy development.
- d) Investment in research and capacity building.

In the intricate tapestry of a nation's development, the balance of energy sources plays a pivotal role, determining not only the trajectory of its economic growth, but also the well-being of its citizens and the sustainability of its environment. Pakistan, a country at the crossroads of progress, grapples with a profound challenge—the glaring imbalance of its energy mix. This disarray, a consequence of historical policy decisions, economic complexities, and environmental exigencies, casts a shadow over the nation's present and future. As the global community ardently embraces the transition toward sustainable energy policies and practices, Pakistan finds itself entangled in a web where fossil fuels, hydroelectricity and renewable resources jostle for dominance. The repercussions

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If this energy imbalance extend beyond the mere flicker of lights, they seep into the core of Pakistan's socio-economic landscape, influencing industrial productivity, exacerbating geo-political vulnerabilities and limiting the country's potential for economic diversification. Thus, addressing these myriad of challenges is crucial for gaining resilience, energy security and charting a sustainable path for the nation's future.

The importance of a balanced energy mix for Pakistan can be asessed from the factors such as an evergrowing population rate and an increasing demand for energy for both private and industrial use. The successive discoveries of natural gas reserves shaped Pakistan's energy history since the 1950s. However, since 2005 the absence of major gas field additions saw a decline in gas production and imported oil began to take on a greater burden of the energy demand. Relying on a diverse sources of energy reduces the vulnerability to supply disruptions and price fluctuations. Apart from hydrocarbons a balanced energy mix constitutes of indigenous coal resources, nuclear and hydropower and other renewables such as solar, wind and baggase-based power. Moreover, it enhances the energy security and reduces the environmental impact through cleaner alternatives, and promotes economic stability by preventing overdependence.

on specific resources. This balance is quite vital for the already struggling Pakistani economy, as it can provide some immunity against global price hikes, external shocks and also aligns with the international efforts to transition to greener energy solutions. Ultimately, a well-rounded energy mix contributes to Pakistan's long term stability, meeting the nation's needs while fostering environmental responsibility.

However, various factors contribute to the existing imbalance in Pakistan's energy mix. Firstly, the heavy dependence of the country on the imported fossil fuels and hydrocarbons leads to rising energy prices, not only disrupting the balance of payments, but also posing a substantial challenge to the competitiveness of Pakistani products in the global market.

In FY 2021 the total hydrocarbon imports stood at a staggering rate of \$518M. According to the Ministry of Planning, development and special initiatives, gas accounts for 48 percent, followed by oil 33%, hydel 11%, coal six percent and nuclear at two percent.

A disproportionate reliance of on the imported oils, that is 85% of the total supply, is exerting a strain on the balance of payments besides making the energy mix unfavourable.

Secondly, in order to make an effective transition towards the renewable energy sources, the country requires a robust energy infrastructure. Pakistan has a significant renewable energy potential but it needs a modern infrastructure to capitalize

on this potential. The country has abundant solar and wind resources, but needs more transmission capacity to move these resources to market.

Additionally, the Pakistani government is often reluctant to invest in renewable energy due to concerns about grid reliability.

Thirdly, another major obstacle to achieving the desired energy mix for the country has been the flawed policies and counterproductive agreements signed by the government. The (PPA) 'Power purchase agreements' signed with Independent Power Producers (IPPs) has resulted in rising circular debt and energy shortages in the country. The tariff structure of these IPP contracts and lack of the awarding transparency in negotiation and awarding process is one of the leading causes behind the failure of such contracts.

These IPPs are dependent on hydro carbons for energy production instead of renewable energy, thus further widening the gap in existing energy mix.

Fourthly, Pakistan is currently facing a severe economic crisis. There is a lack of adequate financing for the renewable energy projects, particularly for small scale projects. Part of this difficulty also stems from a lack of awareness regarding RETs (Renewable Energy Technologies), a high risk perception of investment and also uncertainty about the reliability of resource assessments.

Currently, the government is not in a position to provide the required funds for power projects because of its limited fiscal space, and competing needs

of social and other sectors. Furthermore, due to high regulatory and security risks, local and international commercial banks offer loans on high interest rates, thus increasing the cost of financing.

Fifthly, the geo political tensions in the region have acted as a deadlock for the international cooperation on energy projects.

The Iran-Pakistan Gas Pipeline includes laying a 42-inch diameter 1800 km pipeline with capacity of 750 million cubic feet of natural gas per day. Due to the ongoing geo political complications the Pakistan portion of 1800 kms is still under active consideration. Similarly, the war in Ukraine further exacerbated the energy insecurity in the country leading to mass gas shortages and rampant loadshedding in households. The security challenges including terrorism further caused unavoidable delays in clean energy projects under CPEC. Therefore, the geo political tensions in the region have been a leading cause of imbalance of energy mix in Pakistan.

Lastly, there is an obvious gap in public awareness and participation in the energy transition efforts. As Yuval Noah Harari writes in his book '21 lessons for the 21st Century', that people are so invested in their own daily struggles that they rarely see the impact of global crisis around them. It is very true in the case of a struggling economy like Pakistan, where people are more interested

in achieving the bare basic necessities of life and less ^{concerned} about the source of such a necessity.

This in turn only increases the dependency of population on the traditional sources of energy production.

A lack of awareness ~~ent~~ ^{not} also leads to a transition towards cleaner and more sustainable energy resources.

Thus, the internal resistance and a lack of will for adapting to cleaner and renewable sources leads to results in the disproportional energy mix in Pakistan.

After delving into the challenges to the energy mix in Pakistan, it is imperative to expound on the consequences of these challenges on the various aspects of the country's development. One of the most notable consequences of such an energy imbalance is the economic vulnerability it causes. Due to limited energy resources, the country is dependent for most of its energy or power production on the international markets. Any fluctuation in prices or shortages of supply pose a serious threat to the economic stability of the country. During the ongoing

Russia's invasion of Ukraine, oil prices soared to a 14 year high of USD 140 a barrel on 1 March, 2022. Moreover, Pakistan's import bill inflated substantially and increased the cost of production which triggered huge inflationary pressure in the country. — Dr Sajid, Deputy director (SDPI).

Thus, a lack of diversification of energy sources puts Pakistan on the list of most vulnerable countries to external economic ex forces.

Moreover, the excessive use of non renewable energy resources is proving to be a direct contributor to the environmental degradation in the country. The use of firewood and dung cakes in Pakistan are major sources of CO_2 and sulphur oxide emissions, that have a green house effect on the environment and severe health complications for exposed households. World Air Quality Report (IQ Air, 2021) ranked the air quality of Pakistan as the second most polluted. The staggering levels of smog in Lahore rendered it as the most polluted city in 2021. Nitrogen oxide and VOCs are emitted by automobiles, coal power stations and gasoline etc.

Turning towards more clean energy sources and replacing the traditional energy sources with the renewable ones is the first step towards achieving both a balanced energy mix and a better air quality and environment overall.

Due to the prevailing imbalance, Pakistan is witnessing the crisis of energy insecurity. The remote parts of the country have next to no access to electricity or gas. This is not only resulting in the phenomena of 'energy poverty' but is also a leading factor behind social fragmentation and feelings of distrust towards the government. A jirga ex in Torghar district complained that 90% of the areas in district didnot have electricity supply. In 2011 the residents rendered their land and even graveyards for the Tarbela Dam, in hopes of provision of basic facilities of life, including electricity supply.

The jirga concluded that the matter if not resolved will lead to protests and civil unrest in the area.

Thus, energy insecurity is also a direct threat to the national security and peace within the state.

Without a diversification in the energy portfolio the country cannot expect to achieve the desired energy security.

Pakistan's disproportionate energy mix has also impacted the technological progress in the area.

It is evident in the limited adoption and development of renewable energy technologies. Despite having substantial solar energy potential, Pakistan's solar power capacity remains underutilized.

The energy sector's focus on traditional sources has resulted in a delayed exploration and implementation of cutting-edge solar technologies. This imbalance has hindered the nation's ability to leverage its renewable energy resources effectively. In contrast, countries with a more diversified energy mix have been quicker to embrace and invest in renewable technologies, fostering innovation and technological advancements in solar, wind and other sustainable energy sources.

Unlike these countries, Pakistan has lagged behind on transitioning to the use of cleaner and renewable energy resources. This in turn has affected the global standing of Pakistan. As of 2021, Pakistan ranked 104 out of 115 countries on World Economic Forum's Energy transition index.

Such a global position of Pakistan discourages the energy investors and even the lending institutes such as IMF and world bank. Lately IMF has

pushed Pakistan for integrating cleaner energy sources and climate sustainable infrastructure in its budget for FY 2024-2025. Therefore, achieving a balanced energy mix is no longer a desire, but a priority for the survival of the country.

However, despite the challenges and the ramifications of an imbalance in energy mix, Pakistan has a great potential

However, despite these challenges and their ramifications, Pakistan has a great potential to still achieve a balanced energy mix. In order to manifest this, the country will have to build diversification strategies for a resilient energy portfolio. According to World Bank, utilizing just 0.01 percent of the country's area for solar photovoltaic (solar PV) power generation would meet Pakistan's current electricity demand. Moreover, it will also have to improve the existing energy infrastructure and complete the development projects underway. An effective energy mix will comprise of both the traditional and modern sources of energy production.

Apart from newer strategies the government will also have to reform and overhaul the existing policies. Reviewing the policies and agreements for probable discrepancies is a vital step towards ensuring the long term sustainability of energy projects. Government's Alternative and Renewable Energy policy 2019 and the indicative generation capacity expansion plan ^{is} a positive

step in this direction. Moreover, restructuring the existing tariff structure of IPPs and making the bidding process more transparent are some of the measures that can further facilitate the energy mix.

Additionally, expanding the investment in the renewable energy can make electricity cheaper, achieve greater energy security, reduce carbon emissions and help Pakistan save upto \$5 Billion over the next 20 years according to World Bank. According to a study by global consulting firm Ernst & Young (EY), Pakistan has the potential to become one of world's leading renewable energy markets with an annual installed capacity of 245 gigawatts (GW). These figures represent an estimated increase of 134% from 2017 levels.

Lastly, Pakistan can effectively address its energy mix imbalance by investing more in research and exploration of newer energy resources and capacity building programs. Introduction of energy management programs, funding relevant research studies in universities will prove to be a proactive measure which will also decrease the country's dependency on international experts. Moreover, capacity building programs are vital to train the human resource in management of renewable energy projects and an efficient construction of energy infrastructure.

As the world transitions towards a more balanced energy mix with an inclination towards cleaner energy, Pakistan will be at a disadvantage if it does not diversify its energy mix. Growing energy demands due to population growth, rapid urbanization and industrialization always outpace supply. Governance and regulation shortcomings are further challenges which hinder performance, accountability and transparency. A disproportionate reliance on fossil fuels and lack of innovation and investment in renewable energy also worsens the situation. The ramifications of these challenges include energy insecurity, stagnant economic growth, environmental degradation and the tarnishing of Pakistan's image on the global fronts. Pakistan needs to adopt a comprehensive and holistic approach to address the issue of its disproportionate energy mix. It has abundant potential for solar, wind, hydro and biomass resources that could be harnessed through various technologies.

Moreover, Pakistan should also explore other indigenous options of energy production and invest in research and capacity building of its human resource to further strengthen its energy sector. In a nutshell, despite the numerous challenges facing the attainment of a balanced energy mix in Pakistan, many opportunities can be taken to develop the sector further and create a more sustainable energy future for the country. In words of Tim Wirth, Barack Obama "A nation that cannot control its energy sources, cannot control its future."