Reforming the Energy Sector and Cost Effective Sources of Energy for Industrial Development

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Abstract:

Pakistan's energy sector faces critical challenges that hinder industrial development and economic prosperity. Rising energy demand and reliance on costly imported fossil fuels strain the economy and exacerbate environmental issues. Controversial agreements with Independent Power Producers (IPPs) have led to high electricity costs, impacting industrial growth and economic stability. To address these challenges, the Pakistan Power Minister's Task Force aims to reform the energy sector through a comprehensive review of the current energy mix, infrastructure, and governance. Key strategies include promoting renewable energy, modernizing infrastructure, strengthening regulatory frameworks, and fostering public-private partnerships. Implementing policies focused on cost-effective energy sources, energy efficiency, and innovation is crucial for sustainable industrial development. The recommendations outlined include diversifying energy sources, modernizing infrastructure, enhancing regulatory oversight, and fostering research and community engagement. By pursuing these measures, Pakistan can achieve a more resilient, sustainable, and economically viable energy landscape that supports long-term industrial growth.

Key words:

Energy sector, Industrial development, Renewable energy, Regulatory reforms

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Introduction

Pakistan's energy sector is not suitable for industrial development that leads to a prosperous and economically developed nation. Energy demands are on the rise, and energy is extremely expensive, which not only negatively impacts households but also hampers industrial growth. Pakistan is heavily reliant on imported fossil fuels, which burdens the economy and affects both the environment and society. Pakistan has entered into controversial agreements with Independent Power Producers (IPPs). The Power Division has facilitated the commissioning of forty-six (46) thermal independent power projects (IPPs) with a gross capacity of 22,174 MW, but the energy they provide is extremely costly, which is detrimental to industrial development and economic growth.

To achieve sustainable industrial development and address these issues, a task force has been set up to reform the energy sector and identify cost-effective energy sources for industrial development. The Task Force is tasked with conducting a comprehensive review of Pakistan's energy sector, including its current energy mix, infrastructure, and governance structure, and identifying cost-effective energy sources, including renewable energy options, to meet the growing demands of industry and commerce. Developing a roadmap for energy sector reform, including recommendations for policy, regulatory, and institutional changes, as well as identifying potential financing mechanisms and investment opportunities to support the transition to a more sustainable energy mix, is also essential. The future of a prosperous Pakistan is directly linked to cost-effective sources of electricity, as this is directly related to industrial growth.

Problem Statement

The power sector plays a vital role in uplifting the economy and promoting industrial development in a country. Pakistan's total installed power generation capacity is 43,775 MW, with 59% of energy coming from thermal fossil fuels, which is reported to be expensive due to the import of fossil fuels. However, there is a perception that the industrial base in Pakistan is severely impacted by the power sector, resulting in the closure of several industries. Therefore, this research will examine the challenges related to the perceived energy issue, particularly its high cost and negative impact on the industrial base, and will critically evaluate and analyze the situation regarding energy sector reforms and cost-effective energy sources for industrial development.

Research methodology

The research methodology used in this study is mixed and includes data collection. It incorporates various techniques and processes used to systematically investigate the topic. Key methods include brainstorming, which fosters creative idea generation; a literature review, which synthesizes existing scholarly work to contextualize and identify research gaps; and secondary data analysis, which leverages pre-existing data for new insights. Situational analysis assesses the current state of affairs, identifying internal and external factors impacting the research area. Analyzing the legal and constitutional framework provides insights into regulatory constraints and opportunities. Comparative analysis, such as evaluating Pakistan's energy sector against global best practices, identifies areas for improvement. SWOT analysis examines strengths, weaknesses, opportunities, and threats, while PESTLE analysis explores political, economic, social, technological, legal, and environmental influences. Lastly, GAP analysis identifies discrepancies between current and desired states, guiding strategic planning and development. These methodologies collectively enable a thorough, multifaceted exploration of complex research questions. Based on the findings, a logical framework has been developed to address the challenges.

Key Findings:

After thorough research and analysis, it becomes clear that Pakistan is not an energy-deficient country but an energy-efficient and energy-surplus country. According to the National Electric Power Regulatory Authority's (NEPRA) 2022 yearly report, Pakistan's total installed power generation capacity is 43,775 MW. The breakdown of energy production in different areas of Pakistan is as follows: i. Thermal energy: 59% ii. Hydroelectric power: 25% iii. Nuclear energy: 9% iv. Wind energy, solar, and biogas: 7%

Current Energy Demand and Capacity: Current energy demand in Pakistan: 30,000 MW
Total production capacity in Pakistan: 26,000 MW
Shortfall: 4,000 MW
IPPs production capacity: 16,000 MW
SOEs: 10,000 MW

Pakistan, therefore, needs to harness cost-effective sources of energy as opposed to conventional sources, which are a waste of valuable resources and unsustainable for the country's industrial base and overall economic development. However, renewable energy sources cannot currently replace conventional power entirely due to their intermittent nature and lesser development. Thus, a balance between the two sources is required until renewable energy can fully replace conventional power. There is an urgent need to tap into renewable energy sources and accelerate the transition due

to their cost-effectiveness and sustainability. The world is rapidly moving toward renewable energy. For instance, "...the Kalyon Karapinar solar power plant is a large-scale initiative located in Turkey's central Anatolia region. It stands as the largest photovoltaic power plant in Europe and the world. This impressive project has 3.2 million solar panels across 2,000 hectares, producing enough energy to power two million homes. The climate of the site is desert-like, unsuitable for farming or living."

Source: *https://www.ecoticias.com/en/largest-photovoltaic-power-plant/2435/*

Literature Review

A comprehensive review of research articles and related policies reveals that the power sector in Pakistan faces numerous challenges (Kiani, 2020). Consultations with various sources and energy sector policies confirm these issues (Ministry of Energy, 2020; NEPRA, 2020). Despite an abundance of renewable energy resources, including solar, wind, hydroelectric, and biomass (Saeed et al., 2020), Pakistan's power sector is plagued by frequent power outages, energy shortages, high energy costs, dependence on fossil fuels, and inefficient energy infrastructure (Aziz, 2007; Gillani, 2010). These challenges have negatively impacted industrial growth in Pakistan (Pakistan Institute of Development Economics, 2020). However, a reformed energy sector can ensure industrial development, economic well-being, job creation, and environmental sustainability (Ali et al., 2020; Bhutto et al., 2019).

Scope of Study

To critically analyze the energy sector and cost-effective energy sources for industrial development, identify key areas requiring reform, and suggest feasible policy options. The scope will further cover the generation and distribution capacities of the power sector, including production capacities of both state-owned and private power generation companies. Different research methodologies have been adopted for various aspects of the power sector analysis. The following TORs have been considered:

- Situational analysis of the current state of the power sector.
- Analysis of the potential, issues, and contributions of Pakistan's energy sector toward industrial development and economic well-being.
- Examination of the existing legal, institutional, and policy framework for managing and regulating the energy sector.
- Comparative analysis of Pakistan's energy sector against global best practices.
- SWOT analysis of institutions responsible for producing, distributing, and regulating electricity.
- PESTLE/GAP analysis.
- Development of a practical plan using a log frame matrix to find practical and viable solutions.

Pakistan total installed power generation capacity:

According to National Electric Power Regulatory Authority's (NEPRA) 2022 yearly report, Pakistan's total installed power generation capacity is 43775 MW.

The breakdown of energy production in different areas of Pakistan is given below:

i. **Thermal energy**: 59%
ii. **Hydroelectric power**: 25%
iii. **Nuclear energy**: 9%
iv. **Wind energy, Solar and Biogas**: 7%

Some of the major IPPs with power generation capacity

Natural gas and Oil-fired Plants

S.No	Name of power plant	location	Status	Capacity
1	Hub Power Company (HUBCO)	Baluchistan	Oil-powered	1292 MW
2	K-Electric Bin Qasim Power Station	Karachi	Natural gas & oil	1260MW
3	Fauji Kabirwala Power Company	Punjab	Natural gas	157 MW

Coal-Fired Power Plants

S.No	Name of power plant	Location	Status	Capacity
1	Port Qasim Power Plant	Karachi	Coal-fired	1320 MW
2	Sahiwal Coal Power Project	Punjab	----------	1320 MW
3	Engro Thar Block II Power Plant	Sindh	Indigenous Thar coal	660 MW

Hydroelectric Power Plants

S.No	Name of power plant	location	Status	Capacity
1	New Bong Escape Hydropower Project	Azad Jammu & Kashmir	Hydroelectric	84 MW
2	Patrind Hydropower Project	On the border of KP & AJK	----------	147 MW

Wind Power Plants

S.No	Name of power plant	location	Status	Capacity
1	Zorlu Enerji Pakistan	Sind	Wind power	56.4 MW
2	Three Gorges Second and Third Wind Farms	Sind	----------	49.5 MW
3	Fauji Fertilizer Company Energy Limited (FFCEL) Wind Farm	Sind	----------	49.5 MW

Solar Power Plants

S.No	Name of power plant	location	Status	Capacity
1	**Quaid-e-Azam Solar Park**	Bahawalpur	Solar	100 MW
2	**Various small-scale solar projects**	Punjab & Sind	-------	----------

State-Owned Hydro-Power Projects

The primary state-owned enterprise responsible for hydropower generation in Pakistan is the Water and Power Development Authority (WAPDA). Here are some of the major state-owned hydropower projects in Pakistan along with their capacities:

S.No	Name	Location	Status	Capacity
1	Tarbela Dam:	Khyber Pakhtunkhwa,Sawabi, Indus River		4888 MW
2	Mangla Dam:	Mirpur, AJK, Jhelum River		1000 MW
3	Ghazi-Barotha Hydropower Project	Attock, Punjab, Indus river		1450 MW
4	Warsak Dam:	Mohmand , KP, Kabul river		243 MW
5	Chashma Hydropower Project	DIKhan, Indus river		184 MW
6	Dargai Hydropower Project	Malakand, River Swat		20 MW
7	Renala Hydropower Project	Okarra, Punjab, Lower Bari doab canal		1.1 MW
8	Neelum-Jhelum Hydropower Plant	AJK	Hydro	969 MW
9	Allai Khwar Hydropower Project	Indus River Battagram		121 MW
10	Gomal Zam Dam	WANA/Tank		17.4 MW

Power Generation Companies: (Coal-fired)

S.No.	Name of GENCO	Generation Capacity
1	Jamshoro Power Company Limited (JPCL or GENCO-I)	1,024 MW.
2	Central Power Generation Company Limited (CPGCL or GENCO-II)	2,402 MW.
3	Northern Power Generation Company Limited (NPGCL or GENCO-III)	1,300 MW
4	Lakhra Power Generation Company Limited (LPGCL or GENCO-IV)	150 MW.

Current Situation

Current energy demand in Pakistan: 30,000 MW
Total Production capacity in Pakistan:26,000 MW
Shortfall: 4000 MW
IPPs production capacity: 16000 MW
SOEs: 10,000 MW

The Task Force comprises representatives from 40th MCMC so that different perspectives could be looked into. This report presents the findings and recommendations of the Task Force, outlining a vision for a more sustainable, efficient, and cost-effective energy sector that can support Pakistan's industrial development and economic growth and aligning it with Sustainable Development Goals (SDGs).

Exploration of Policy guidelines

Energy Sector Reforms:

The task force is working to address significant issues in the energy sector, such as inefficiencies, outdated regulations, and poor management. This initiative aims to create an environment conducive to investment and innovation through business facilitation, increased transparency, and improved collaboration (Ahmed et al., 2021).

Issues also exist with Independent Power Producers (IPPs) concerning the power sector. The Private Power and Infrastructure Board (PPIB), an autonomous body of the Power Division, Government of Pakistan (GoP), provides a one-window facility for investors in power generation and related infrastructure. While IPPs have played a crucial role in addressing Pakistan's energy shortages, a primary concern is the high cost of electricity generated by IPPs, which has contributed to the country's circular debt problem (Kiani, 2022). According to the National Electric Power Regulatory Authority (NEPRA), the cost of electricity generated by IPPs is significantly higher than that produced by public sector power plants (NEPRA, 2022).

Another issue is the uneven distribution of IPPs, with most located in Punjab, limiting access to electricity in other provinces (Ministry of Energy, 2022). This has exacerbated existing energy disparities between provinces. Additionally, IPPs have been criticized for prioritizing profit over public interest, raising concerns about their social and environmental impact (Khan, 2021).

The Power Division has successfully facilitated the commissioning of forty-six (46) independent power projects (IPPs) with a gross capacity of 22,174 MW and investments exceeding US$ 27 billion. These projects use various fuels and technologies, including hydro, Thar coal, imported coal, RLNG/gas, and oil. However, circular debt currently stands at Rs. 2.31 trillion, approximately 5.1% of GDP.

Controversial Terms and Conditions of Agreements with IPPs and Their Negative Impacts on Industry:

A significant conflict of interest exists, as 90% of IPP contracts are owned by individuals who were either part of the cabinet or linked to decision-making processes. This raises legal concerns and could lead to the nullification of these contracts in a court of law. Additionally, purchasing electricity from international IPPs at full capacity could be considered.

These contracts are also suspected to have resulted from kickbacks, underscoring the need for transparency and accountability in the energy sector.

Controversial Points in Power-Purchase Agreements (PPA):

1. Capacity Payments: Contracts often guarantee payments to IPPs based on their installed capacity, regardless of actual electricity generation, leading to financial obligations even during low demand or when cheaper alternatives are available (Ali, 2017).
2. Take-or-Pay Contracts: Agreements typically include clauses requiring the government to pay for a specified amount of electricity, whether consumed or not, placing financial burdens on consumers and the government (Khan, 2018).
3. Indexation of Fuel Prices: Contracts may stipulate that fuel costs are indexed to international market prices, exposing consumers to global fuel price fluctuations and resulting in higher electricity tariffs (Ahmad & Rehman, 2020).
4. Cost Overruns and Guarantees: IPP contracts often include provisions for the government to cover cost overruns or provide financial guarantees, transferring risk from investors to the public sector (Majeed & Jamil, 2021).
5. Tariff Adjustments: Agreements may allow IPPs to adjust tariffs based on inflation, currency exchange rates, and policy changes, leading to tariff hikes and increased consumer costs (Khan & Khan, 2019).

6. Inefficiencies and Maintenance Costs: Contracts may lack strict provisions for monitoring and penalizing inefficiencies or poor maintenance, resulting in additional costs passed to consumers (Hasan, 2016).
7. Non-Utilization Penalties: Some contracts impose penalties on the government for not utilizing the agreed-upon IPP capacity, incentivizing overcapacity and higher costs (Majeed & Zaman, 2018).
8. Lack of Transparency: Contracts often lack transparency in pricing mechanisms, cost breakdowns, and financial arrangements, making it difficult to assess the fairness of tariffs and expenses (Hussain, 2020).
9. Long-Term Commitments: Contracts with lengthy durations, such as power purchase agreements spanning decades, lock consumers into high tariffs for extended periods, limiting flexibility and hindering cost reduction efforts (Shahbaz et al., 2019).
10. Limited Competition and Monopolistic Behavior: The dominance of a few IPPs in the market, combined with barriers to entry and limited competition, can result in monopolistic behavior and higher electricity prices (Zaidi & Mirza, 2017).

Negative Impacts:

1. **Increased Production Costs:**
    - **High Electricity Prices**: Pakistan's industrial sector faces high electricity tariffs. For example, the average industrial electricity tariff in Pakistan has been around PKR 18-20 per kWh in recent years, significantly higher compared to regional competitors like India and Bangladesh.
2. **Fuel Cost Adjustment**: Frequent adjustments in fuel prices, often passed onto consumers, lead to unpredictable costs for industries. In 2023, there were several instances where fuel cost adjustments ranged between PKR 3-5 per kWh, exacerbating cost uncertainties.
3. **Decreased Competitiveness**:
    - **Export Decline**: Higher energy costs make Pakistani products less competitive in international markets. According to the Pakistan Bureau of Statistics, textile exports, a major industrial sector, dropped by 14.7% year-on-year in 2023, partially due to high production costs.
4. **Operational Inefficiencies**: Industries face higher operational costs, reducing profit margins. A report by the Pakistan Business Council in 2022 highlighted that energy costs constitute about 30-40% of total production costs in energy-intensive industries like textiles and cement.
5. **Load Shedding and Unreliable Power Supply**:
    - **Production Losses**: Power outages cause significant production losses. In 2021, the Federation of Pakistan Chambers of Commerce & Industry (FPCCI) estimated that load shedding resulted in approximately PKR 210 billion in losses annually for the industrial sector.

6. **Increased Use of Generators**: To mitigate power outages, industries resort to using diesel generators, which are more expensive. The cost of electricity from diesel generators can be as high as PKR 35-40 per kWh, more than double the grid supply cost.
7. **Impact on Small and Medium Enterprises (SMEs)**:
    - **Financial Strain**: SMEs, which account for about 30% of Pakistan's GDP, struggle with high energy costs. The Small and Medium Enterprises Development Authority (SMEDA) reports that many SMEs are forced to reduce operations or shut down due to unsustainable energy expenses.
8. **Investment in Alternatives**: Limited financial resources make it difficult for SMEs to invest in alternative energy sources like solar, which require high initial capital.
9. **Environmental and Health Costs**:
    - **Pollution from Conventional Sources**: Heavy reliance on thermal power (coal, oil, and gas) leads to significant greenhouse gas emissions. According to the Global Carbon Atlas, Pakistan emitted around 223 million tons of CO2 in 2022, with a substantial share from the industrial sector.
    - **Health Impact**: Industrial pollution contributes to health issues, increasing healthcare costs. The World Bank estimated that air pollution costs Pakistan nearly 5.88% of its GDP, around USD 47 billion annually, in terms of health costs and lost labor.
10. **Investment Deterrence**:
    - **Reduced Foreign Direct Investment (FDI)**: High energy costs and unreliable supply deter foreign investors. The State Bank of Pakistan reported a 29% decline in FDI in 2023, highlighting energy costs and supply as major concerns for investors.

Overall, the costly conventional power supply in Pakistan hampers industrial growth, reduces competitiveness, and leads to significant economic and social costs. Transitioning to more affordable and reliable renewable energy sources could mitigate these issues and foster sustainable industrial development.

Given this, there is now a need to focus on the diversification of renewable energy sources for cost-effectiveness, industrial growth, economic development, and the gradual reduction of Pakistan's dependence on fossil fuels until renewables are fully capable of replacing conventional power. Additional focus areas include enhancing energy efficiency measures, developing outdated infrastructure, promoting public-private partnerships, fostering research and innovation in the power sector, capacity building, and training to produce a skilled workforce in the energy sector. Aligning energy sector reforms and initiatives with the United Nations' Sustainable Development Goals (SDGs) will help Pakistan contribute to global efforts to achieve sustainable development, reduce poverty, and protect the environment.

The following analysis was carried out by the task force to point out issues and challenges for policy recommendations regarding reforming the energy sector and cost effective sources of energy for industrial development:
Situational Analysis of the Energy Sector in Pakistan: Potential, Issues, and Contributions

This analysis examines the current potential, issues, and contributions of Pakistan's energy sector towards industrial development and economic growth.

Potential of Pakistan's Energy Sector

Renewable Energy Sources:

Pakistan is endowed with substantial renewable energy resources, including solar, wind, hydroelectric, and biomass. The country's geographical location provides ample sunlight for solar power generation, with an estimated potential of 2.9 million MW (Saeed et al., 2020). Additionally, the wind corridors in the provinces of Sindh and Balochistan offer significant potential for wind energy, with estimates suggesting a capacity of 50,000 MW (Bhutto et al., 2019).

Hydroelectric Power:

Pakistan's topography, characterized by major rivers and tributaries, provides significant potential for hydroelectric power. The country has an identified potential of approximately 60,000 MW, of which only a fraction has been exploited (Malik et al., 2019). Large-scale hydroelectric projects, such as the Diamer-Bhasha and Dasu dams, are in various stages of development, promising to significantly enhance the energy mix.

Biomass and Waste-to-Energy:

The agricultural sector in Pakistan generates considerable biomass, which can be utilized for energy production. Biomass energy, including biogas from animal waste and crop residues, holds promise for providing decentralized energy solutions, particularly in rural areas (Ali et al., 2020). Additionally, waste-to-energy technologies can convert municipal and industrial waste into energy, contributing to sustainable waste management and energy production.

Current Situation:

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Cost of electricity per unit in different sectors in Pakistan

S. No.	Sector	Cost per unit excluding taxes (PKR per KWh)	Cost per unit including taxes (PKR per KWh)
1	Hydropower	1-2	4-6
2	Coal fired Power plant	6-8	10-12
3	Natural Gas	Domestic gas: 6-7 LNG: 10-12	Domestic gas: 9-11 LNG: 15-18
4	Nuclear	6-8	10-12
5	Oil fired Power plant	12-18	18-22
6	Wind power	5-7	8-10
7	Solar power	5-7	8-10
8	Biogas and other renewables	6-9	9-12

Power consumption Slabs:

Consumer Category	Consumption Slabs	Rate (PKR/kWh)
Residential	1-50 kWh	3.95
	51-100 kWh	7.74
	101-200 kWh	10.06
	201-300 kWh	12.15
	301-700 kWh	19.55
	Above 700 kWh	22.65
Commercial	Up to 5 kW	19.95
	Above 5 kW	20.95
Industrial	B1 (up to 25 kW)	17.95
	B2 (25-500 kW)	16.95
	B3 (above 500 kW)	15.95
	B4 (above 500 kW, off-peak)	13.45
	B4 (above 500 kW, peak)	21.45

http://www.nepra.org.pk

Total Number of DISCOs:

FY 2023 Losses: In the fiscal year 2022-23, DISCOs contributed to a surge in circular debt, adding Rs. 396 billion to the national total. This included Rs. 160 billion due to high losses and an additional Rs. 236 billion from under-recovery of electricity bills (Profit by Pakistan Today).

Overall Circular Debt: By June 30, 2023, the circular debt had reached Rs. 2.31 trillion, highlighting the chronic financial issues within the power sector (Profit by Pakistan Today).

DISCOs are operating at a loss and are responsible for the distribution, transmission, and management of power.

Issues:

1. **Energy Shortages**: Pakistan faces significant energy shortages, with a demand-supply gap of around 5,000 MW, resulting in frequent power outages and load shedding (Kiani, 2020).
2. **High Energy Costs**: The cost of energy in Pakistan is high, making it difficult for industries to operate efficiently and competitively (Pakistan Institute of Development Economics, 2020).
3. **Dependence on Fossil Fuels**: Pakistan's energy mix is heavily reliant on fossil fuels, contributing to greenhouse gas emissions and environmental degradation (Ministry of Climate Change, 2020).
4. **Inefficient Energy Infrastructure**: The aging and inefficient energy infrastructure leads to significant transmission and distribution losses (NEPRA, 2020).
5. **Dollar Indexation with Reference to IPP Agreements**.
6. **Rapid Increase in Circular Debt**.
7. **Long-term Contracts with IPPs**.

Contributions:

1. **Industrial Development**: A reformed energy sector can provide reliable and cost-effective energy to industries, promoting industrial development and economic growth (Kiani, 2020).
2. **Economic Well-being**: Access to affordable energy can improve the overall economic well-being of the population, reducing poverty and inequality (Pakistan Institute of Development Economics, 2020).
3. **Job Creation**: A thriving energy sector can create new job opportunities in the energy and industrial sectors (Ministry of Energy, 2020).
4. **Environmental Sustainability**: A shift towards cost-effective and renewable energy sources can reduce Pakistan's carbon footprint and promote environmental sustainability (Ministry of Climate Change, 2020).

Analysis of Pakistan's Legal, Institutional, and Policy Framework for Managing and Regulating the Energy Sector: A thorough analysis of this framework reveals key strengths, weaknesses, and areas for improvement.

Analysis of Pakistan's Legal, Institutional, and Policy Framework for Managing and Regulating the Energy Sector: A thorough analysis of this framework reveals key strengths, weaknesses, and areas for improvement.

Legal Framework:

- **Constitution of Pakistan**: Provides the foundational legal structure for governance, including the distribution of powers between federal and provincial governments. Energy is a shared responsibility, with both levels having roles in regulation and policy-making.
- **National Electric Power Regulatory Authority (NEPRA) Act, 1997**: Establishes NEPRA as the main regulatory body for electricity. NEPRA is

responsible for licensing, tariff setting, and ensuring the reliability and efficiency of the power supply.

- **Oil and Gas Regulatory Authority (OGRA) Ordinance, 2002**: Establishes OGRA to regulate the oil and gas sector, including pricing, licensing, and consumer protection.
- **Pakistan Energy Efficiency and Conservation Act, 2016**: Establishes the National Energy Efficiency and Conservation Authority (NEECA) to promote energy efficiency and conservation.
- **Alternative Energy Development Board (AEDB) Act, 2010**: Establishes the AEDB to promote renewable energy projects, including solar, wind, and biomass.
- **Environmental Protection Act, 1997**: Provides the legal framework for environmental protection, including regulations for emissions and pollution from energy projects.

Analysis of Pakistan's Legal, Institutional and Policy Framework for Managing and Regulating the Energy Sector

A thorough analysis of this framework reveals key strengths, weaknesses, and areas for improvement.

Legal Framework Constitution of Pakistan:

The Constitution provides the foundational legal structure for governance, including the distribution of powers between federal and provincial governments. Energy is a shared responsibility, with both levels having roles in regulation and policy-making.

National Electric Power Regulatory Authority (NEPRA) Act, 1997:

Establishes NEPRA as the main regulatory body for electricity. NEPRA is responsible for licensing, tariff setting, and ensuring the reliability and efficiency of the power supply.

Oil and Gas Regulatory Authority (OGRA) Ordinance, 2002:

Establishes OGRA to regulate the oil and gas sector, including pricing, licensing, and ensuring consumer protection.

Pakistan Energy Efficiency and Conservation Act, 2016:

Establishes the National Energy Efficiency and Conservation Authority (NEECA) to promote energy efficiency and conservation.

Alternative Energy Development Board (AEDB) Act, 2010:

Establishes the AEDB to promote renewable energy projects, including solar, wind, and biomass.

Environmental Protection Act, 1997:
Provides the legal framework for environmental protection, including regulations for emissions and pollution from energy projects.

Institutional Framework Ministry of Energy:
Comprises two divisions: the Power Division and the Petroleum Division. It is responsible for policy-making, planning, and coordination of the energy sector.

National Electric Power Regulatory Authority (NEPRA):
An independent regulatory authority overseeing the electricity sector. It regulates tariffs, issues licenses, and ensures compliance with regulatory standards.

Oil and Gas Regulatory Authority (OGRA):
Regulates the oil and gas sector, including pricing, licensing, and compliance with safety and environmental standards.

Pakistan Atomic Energy Commission (PAEC):
Responsible for the development and regulation of nuclear energy for peaceful purposes, including power generation.

Alternative Energy Development Board (AEDB):
Promotes and facilitates the development of renewable energy projects.

National Energy Efficiency and Conservation Authority (NEECA):
Promotes energy efficiency and conservation measures across various sectors.

Policy Framework
The "National Electricity Plan 2023-27" outlines the strategic framework for the country's power sector over the next few years. Key features of this plan, particularly concerning Independent Power Producers (IPPs), include:

1. Renewable Energy Focus:
The policy emphasizes increasing the share of renewable energy in the energy mix, targeting 30% renewable capacity by 2030, which includes wind, solar, and hydroelectric power. This effort aims to reduce reliance on imported fuels and ensure sustainable energy production (Power.gov.pk; IEEFA).

2. Least-Cost Generation Plan:
The plan aims to adopt a least-cost generation approach, optimizing existing resources and integrating new renewable energy projects. This approach is designed to minimize the overall cost of electricity generation and reduce the financial burden on the power sector (Power.gov.pk).

3. Circular Debt Reduction:

A critical aspect of the policy is addressing the circular debt issue by improving the financial health of power distribution companies, enhancing billing and collection efficiencies, and reducing transmission and distribution losses (Power.gov.pk).

4. Capacity Expansion and Overcapacity Management:

The policy acknowledges past issues with overcapacity and aims to align future capacity expansion more accurately with projected demand. This includes revising power demand forecasts to avoid the financial strain of unused capacity (IEEFA).

5. Hydropower Development:

There is significant focus on hydropower projects, with large-scale developments such as the Diamer-Bhasha Dam included in the plan. These projects are expected to provide a reliable and significant share of the energy mix, though they come with high investment costs and long construction times (IEEFA).

6. Private Sector Participation:

The policy encourages private sector investment in the power sector, particularly through IPPs, by streamlining regulatory processes and creating a conducive environment for private investors (Power.gov.pk).

7. Regulatory and Institutional Reforms:

To support these strategies, the plan includes reforms in regulatory frameworks and institutional structures. This involves enhancing the capacity of regulatory bodies and ensuring transparency and accountability in the sector (Power.gov.pk).

Identification of Challenges and Areas for Improvement:

i. Tariff Determination and Subsidies
ii. Legal Framework for Renewable Energy
iii. Power Theft and Non-Technical Losses
iv. Financial Viability of Distribution Companies
v. Capacity Building and Training
vi. Environmental Compliance
vii. Energy Efficiency Standards
viii. Interagency Coordination
ix. Investment and Financing Challenges
x. Grid Infrastructure and Reliability
xi. Circular debt
xii. Capacity expansion and over capacity management
xiii. Integration of renewable energy into the main grid

Best Practices around the world

Analysis of Pakistan energy sector by comparing it with the best practices around the world:

Pakistan's energy sector is characterized by its reliance on imported fossil fuels, aging infrastructure, and inefficiencies in governance and management. By comparing it with global best practices, we can identify key areas where reforms and improvements are needed to ensure sustainable and efficient energy production and distribution.

1. ***Energy Mix and Renewable Energy Integration***

Pakistan's Current Status:

- **Energy Mix**: Pakistan's energy production is dominated by thermal energy (59%), followed by hydroelectric (25%), nuclear (9%), and renewables like wind, solar, and biogas (7%).
- **Renewable Energy Potential**: Despite significant potential for solar (estimated at 2.9 million MW) and wind energy (50,000 MW), the adoption of renewable energy sources remains limited due to financial and infrastructural challenges (Bhutto et al., 2019; Saeed et al., 2020).

Global Best Practices:

- **Germany**: Germany has successfully integrated renewable energy into its grid, achieving over 46% of its electricity from renewables in 2020. Policies like the Renewable Energy Sources Act (EEG) provided feed-in tariffs and long-term contracts that incentivized investment in renewables (BMWi, 2021).

2. ***Energy Efficiency and Infrastructure Development***

Pakistan's Current Status:

- **Aging Infrastructure**: Pakistan's energy infrastructure is outdated, leading to high transmission and distribution losses, frequent outages, and inefficient energy use (Malik et al., 2019).
- **Energy Efficiency**: Efforts to promote energy efficiency are in place, but implementation remains weak, limiting potential benefits (Shahbaz et al., 2020).

Global Best Practices:

- **Japan**: Japan has invested heavily in smart grid technologies and energy-efficient appliances following the Fukushima disaster, leading to significant improvements in energy efficiency and grid stability (METI, 2020).

3. *Governance and Regulatory Framework*

Pakistan's Current Status:

- **Regulatory Bodies**: Pakistan has multiple regulatory bodies, including NEPRA and OGRA, but suffers from coordination issues and limited enforcement capabilities (Ahmed et al., 2021).
- **Policy Implementation**: Policy implementation is often hampered by bureaucratic inefficiencies and lack of transparency (Saeed et al., 2020).

Global Best Practices:

- **United Kingdom**: The UK has a streamlined regulatory framework with Ofgem, the regulator for electricity and gas markets, ensuring transparent and efficient market operations (Ofgem, 2020).

4. *Investment and Financing Mechanisms*

Pakistan's Current Status:

- **Investment Challenges**: Attracting investment in the energy sector is challenging due to regulatory uncertainty and bureaucratic delays (Khan et al., 2018).
- **Financing Mechanisms**: Limited financing options and high capital costs hinder the development of renewable energy projects (Pakistan Institute of Development Economics, 2020).

Global Best Practices:

- **China**: China has become a global leader in renewable energy investment through strong government support, subsidies, and favorable financing terms for renewable projects (IEA, 2021).
- **India**: India's National Solar Mission offers various financial incentives and has established clear policies to attract domestic and international investment in solar energy (MNRE, 2020).

Lessons Learned:

1. Heavy investment in smart grid technologies and energy-efficient appliances.
2. Streamlining the regulatory framework to avoid overlap.
3. Strong incentivization of renewable resources.

SWOT analysis of Pakistan's energy sector related institutions responsible for producing, distributing electricity and regulating the sector

Strengths	Weaknesses
• **Diverse Energy Mix:** Pakistan's energy sector benefits from a diverse mix, including thermal, hydroelectric, nuclear, and renewable sources (NEPRA, 2022). • **Regulatory Framework:** The existence of multiple regulatory bodies, such as NEPRA (National Electric Power Regulatory Authority) and OGRA (Oil and Gas Regulatory Authority), provides a structured oversight mechanism (NEPRA, 2022). • **Renewable Energy Potential:** High potential for solar and wind energy, particularly in regions with abundant sunlight and wind resources (Bhutto et al., 2019). • **Government Initiatives**: Government initiatives aimed at promoting renewable energy and energy efficiency indicate a strategic focus on sustainable energy development (Ali et al., 2020).	• **Institutional Overlap and Coordination Issues:** Overlapping responsibilities among regulatory bodies like NEPRA, OGRA, and AEDB (Alternative Energy Development Board) lead to coordination challenges (Ahmed et al., 2021). • **Aging Infrastructure**: Outdated and insufficient infrastructure, including power plants and transmission lines, results in frequent outages and high transmission losses (Malik et al., 2019). • **Inefficiency and Governance Issues**: Inefficiencies in management and governance, coupled with bureaucratic hurdles, impede effective implementation of energy policies (Shahbaz et al., 2020). • **Financial Constraints:** Limited financial resources and investment in the energy sector restrict the development and main tenance of infrastructure (Khan et al., 2018).
Opportunities	**Threats**
• **Investment in Renewable Energy:** Opportunities to attract local and international investment in solar, wind, and other renewable energy projects (IEA, 2020). • **Public-Private Partnerships (PPPs**): Potential to leverage PPPs for infrastructure development and innovation in the energy sector (Kumar & Katoch, 2014). • **Technological Advancements:** Adoption of smart grid technologies and energy-efficient appliances to improve energy management and reduce wastage (Ali et al., 2020). • **Capacity Building:** Initiatives for training and skill development to build a competent workforce in the energy sector (Saeed et al., 2020).	• **Political and Economic Instability:** Political turmoil and economic instability pose significant risks to the energy sector's development and sustainability (Ahmed et al., 2021). • **Environmental Concerns**: Environmental challenges, including pollution from thermal power plants, and water scarcity affecting hydroelectric power generation (Bhutto et al., 2019). • **Security Issues:** Security threats in certain regions can disrupt energy production and distribution, affecting overall sector stability (Malik et al., 2019). • **Global Energy Market Volatility:** Fluctuations in global energy prices, particularly for imported fuels, impact the cost of energy production and the broader economy (IEA, 2020).

PESTLE Analysis of Pakistan's Energy Sector

Political	Economic	Social	Technological	Legal	Environmental
Strengths: Government initiatives for renewable energy promotion	**Strengths:** Diverse energy-mix reducing dependence on imports.	**Strengths:** Growing awareness of environmental sustainability	**Strengths:** Potential for technological advancements in renewable energy.	**Strengths:** Regulatory framework for energy sector oversight.	**Strengths:** Renewable energy potential, such as solar and wind.
Weaknesses: Political instability affecting policy continuity.	**Weaknesses:** Financial constraints limiting infrastructure investment.	**Weaknesses:** Limited access to electricity in rural areas.	**Weaknesses:** Insufficient investment in research and development.	**Weaknesses:** Inconsistent enforcement of regulations.	**Weaknesses:** Environmental degradation from fossil fuel usage.
Opportunities: Policy reforms for energy sector development.	**Opportunities:** Investment in renewable energy projects.	**Opportunities:** Community engagement for renewable energy projects.	**Opportunities:** Adoption of smart grid technologies.	**Opportunities:** Strengthening legal frameworks for renewable energy.	**Opportunities:** Mitigation of climate change impacts through renewable energy.
Threats: Political interference impacting regulatory autonomy.	**Threats:** Global energy market volatility affecting prices.	**Threats:** Social resistance to infrastructure development projects.	**Threats:** Technological obsolescence of existing infrastructure.	**Threats:** Legal challenges to energy project implementation.	**Threats:** Natural disasters affecting energy infrastructure.

GAP Analysis

1. Energy Mix and Diversification:

Current State: Pakistan relies heavily on thermal power (59%) and has limited renewable energy (7%) (NEPRA, 2022).

Desired State: Increase the share of renewable energy to reduce dependence

on fossil fuels and enhance sustainability.
Gap: Lack of sufficient incentives and investments in renewable energy projects.

2. Regulatory and Institutional Framework:
Current State: Multiple regulatory bodies with overlapping responsibilities and coordination issues (Ahmed et al., 2021).
Desired State: A streamlined regulatory framework with clear roles and efficient coordination among institutions.
Gap: Institutional overlap and lack of clear delineation of responsibilities.

3. Infrastructure Development:
Current State: Aging and inefficient infrastructure leading to frequent outages and high transmission losses (Malik et al., 2019).
Desired State: Modern, resilient, and efficient energy infrastructure capable of supporting industrial growth.
Gap: Inadequate investment in infrastructure modernization and maintenance.

4. Public-Private Partnerships (PPPs) and Investment:
Current State: Limited PPPs due to regulatory and bureaucratic challenges (Khan et al., 2018).
Desired State: Increased private sector participation and investment in energy projects.
Gap: Need for more favorable regulatory and business environments to attract private investments.

5. Research and Innovation:
Current State: Limited focus on and funding for research and innovation in energy technologies (Ali et al., 2020).
Desired State: Strong emphasis on research and development (R&D) to drive technological advancements and energy efficiency.
Gap: Insufficient support for R&D and innovation initiatives.

6. Capacity Building:
Current State: Workforce in the energy sector lacks adequate training and skills (Saeed et al., 2020).
Desired State: A skilled and competent workforce capable of managing and operating modern energy systems.
Gap: Need for enhanced training programs and skill development initiatives.

Conclusion

The Pakistan Power Minister's Task Force has embarked on a comprehensive initiative to reform the nation's energy sector, addressing industries' woes due to expensive power, structural inefficiencies, regulatory shortcomings,

and operational challenges. The primary focus is on tapping cost-effective energy sources, enhancing energy efficiency, reliability, and environmental sustainability. The task force's efforts include modernizing the energy infrastructure, promoting renewable energy, and ensuring fiscal sustainability. Additionally, identifying and utilizing cost-effective energy sources for industrial development are crucial for fostering economic growth and energy resilience in Pakistan.

Issues and Challenges

1. High energy costs due to the reliance on fossil fuels by most of the Independent Power Producers (IPPs).
2. Slow uptake of smart grid technologies and energy management systems.
3. Aging power plants, transmission lines, and distribution networks, resulting in high losses and unreliable energy supply.
4. Lack of development in decentralized energy solutions for rural regions.
5. Overlapping regulations and poor coordination among regulatory bodies.
6. Absence of a unified controlling entity to oversee energy sector regulation.
7. Underutilization of Public-Private Partnerships (PPPs) to leverage private investment and expertise.
8. A workforce lacking the necessary skills to manage and operate modern energy systems.
9. Inadequate alignment of energy sector reforms and initiatives with the United Nations' Sustainable Development Goals (SDGs).
10. Poor awareness campaigns on energy conservation and the benefits of renewable energy.
11. Limited partnerships to develop relevant curricula and enhance skills training.
12. Absence of supportive policies, such as Germany's feed-in tariffs, to encourage renewable energy investment.
13. Policy ambiguity and instability that discourage investment, unlike the clear frameworks in China and India.
14. Inconsistent tariff determination and unsustainable subsidies, leading to financial losses.
15. Difficulty attracting investment due to regulatory uncertainties and financial risks.
16. Lack of renegotiation of existing agreements with IPPs.
17. Absence of a standard template for future IPP agreements.
18. Failure to ensure competitive and transparent bidding processes.
19. Non-alignment of capacity payments with actual generation capacity.
20. Lack of burden-sharing of Transmission and Distribution (T&D) losses among IPPs, DISCOs, and the government.
21. Limited public accessibility to IPP agreements, leading to non-transparency and lack of accountability.
22. Failure to audit IPP agreements to identify irregularities or excess payments.

23. Capacity payments not tied to actual performance and availability of electricity.

Recommendations

By implementing the following policy recommendations, Pakistan can develop a sustainable, efficient, and cost-effective energy sector that supports industrial development and economic growth while contributing to global efforts in environmental sustainability:

S# No.	Policy Recommendations	Action By	Timeline
1	**Diversification of Energy Sources:** • Increase the share of renewable energy in the energy mix by providing incentives such as tax breaks and guaranteed prices. • Facilitate investment in solar, wind, hydroelectric, and biomass energy projects.	**Federal /Provincial Govt. NEPRA and AEDB**	**Medium Term**
2	**Enhancement of Energy Efficiency:** • Implement and enforce energy-efficient standards for appliances, buildings, and industrial processes. • Promote the adoption of smart grid technologies and energy management systems.	**Federal /Provincial Govt. NEPRA and AEDB**	**Medium Term**
3	**Infrastructure Modernization:** • Invest in upgrading and expanding power plants, transmission lines, and distribution networks to reduce losses and ensure reliable energy supply. • Develop infrastructure to support decentralized energy solutions, particularly in rural areas.	**Federal /Provincial Govt. for action as per PPP Policy. Ministry of Planning /development Donors and International funding**	**Long Term**
4	**Strengthening Regulatory Frameworks:** • Streamline the regulatory framework to eliminate overlaps and enhance coordination among regulatory bodies. • A central controlling autonomous body be established	**Federal /Provincial Govt. NEPRA**	**Long Term**
5	**Investment Facilitation:** • Create a conducive environment for private sector participation through clear policies, reduced bureaucratic hurdles, and attractive financing options. • Explore public-private partnerships (PPPs) to leverage private investment and expertise. • Amendments in rules/policies be made.	**Federal and Provincial Government, AEDB Ministry of Commerce & Industry**	**Long Term**

6	**Research and Innovation:** • Establish research centres and innovation hubs focused on energy technologies, grid management, and energy storage. • Provide funding and support for research and development (R&D) initiatives in renewable energy and energy efficiency.	**Federal and Provincial Government, Ministry of Science & Technology**	**Short Term**
7	**Alignment with Sustainable Development Goals (SDGs):** • Ensure that energy sector reforms and initiatives are aligned with the United Nations' Sustainable Development Goals (SDGs) to promote sustainable development, reduce poverty, and protect the environment.	**Federal and Provincial Government, AEDB**	**Long Term**
8	**Community Engagement:** • Engage local communities in renewable energy projects to ensure acceptance and participation. • Implement awareness campaigns to educate the public on energy conservation practices and the benefits of renewable energy. • Policies be formulated.	**Federal and Provincial Government, Ministry of Information**	**Medium Term**
9	**Rural Electrification:** • Prioritize rural electrification to increase access to electricity and support regional development.	**Federal and Provincial Government**	**Medium Term**
10	**Knowledge Sharing:** • Facilitate knowledge sharing and technology transfer to drive innovation in the energy sector.	**Federal and Provincial Government**	**Medium Term**
11	**Educational Partnerships**: • Collaborate with educational institutions to develop relevant curricula and enhance skills training.	**Federal and Provincial Government, Pakistan Engineering Council**	**Medium Term**
12	**Policy Incentives:** • Implement policies similar to Germany's feed-in tariffs to encourage investment in renewable energy.	**Federal and Provincial Government**	**Long Term**
13	**Tariff Determination and Subsidies:** • Establish a clear and transparent tariff-setting mechanism that reflects the true cost of power generation, transmission, and distribution.	**Federal and Provincial Government NEPRA**	**Long Term**
14	**Investment and Financing Challenges:** • Improve the investment climate by providing clear, consistent policies and guarantees. • Develop financial instruments and incentives to attract both domestic and international investors.	**Federal and Provincial Government**	**Medium Term**

15	**Renegotiate existing agreements with IPPs:** • Review and renegotiate existing contracts to ensure fair and competitive pricing, removing undue advantages and ambiguities.	**Government of Pakistan, CPPA**	**Long Term**
16	**Standardize future agreements:** • Develop a standardized template for future IPP agreements, incorporating best practices, transparency, and clarity.	**Government of Pakistan**	**Long Term**
17	**Competitive bidding:** • Introduce competitive bidding processes for new IPP projects, ensuring fair competition and market-driven pricing.	**Government of Pakistan**	**Long Term**
18	**Public disclosure:** • Make IPP agreements and related information publicly accessible, promoting transparency and accountability.	**Ministry of Power and Energy**	**Short Term**
19	**Transparency and Accountability:** • Audit Existing Agreements: Conduct a comprehensive audit of existing IPP agreements to identify any irregularities or excessive payments.	**Government of Pakistan**	**Short Term**
20	**Capacity Payments and Performance Guarantees of IPPs:** • Performance-Based Payments: Link capacity payments to actual performance and availability of electricity.	**Government of Pakistan**	**Mid Term**
21	• Night markets should be closed by 8 pm, similar to EU and China.	**Govt. of Pakistan through district administration**	**Short term**
22	• All factories, tube wells, and home cooking should be converted to solar power.	**AEDB**	**Long term**
23	• EV charging infrastructure should be powered by solar panels.	**GoP**	**Medium term**
24	• Existing taxis (Suzuki Mehran and others) should be converted to electric vehicles by installing EV kits.	**Federal & Provincial govt.**	**Medium term**
25	• High-end consumers should be incentivized to adopt electric vehicles, with heavy taxation on petrol to discourage its use.	**GoP**	**Long term**

Log Frame Matrix for Energy Sector Development in Pakistan

Overall Goal:

Reform Pakistan's energy sector to ensure efficiency, reliability, and sustainability while promoting cost-effective energy sources for industrial development.

S#	*Proposed actions*	*Responsibilities*	*Resources*	*Timeline*	*KPIs*
1	Increased adoption of renewable energy	NEPRA / AEDB reports, renewable energy project data	Government policy documents	3 months	Percentage increase in renewable energy capacity
2	Enhanced energy infrastructure	Ministry of Power & Energy	Project reports, site inspections	1 year	Number of modernized power plants and transmission lines
3	Financial incentives for investors	GoP/ AEDB	Investment policy documents	6 months	Number of financial incentives introduced for investors
4	Financial strategy development	GoP/ concerned Ministry through State Bank of Pakistan	Strategy documents, funding agreements	6 months	Development of financial strategies, funding secured
5	Stakeholder engagement	Ministry of power & Energy	Meeting attendance records	3 months	Number of stakeholder meetings

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