IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Received August 17, 2020, accepted August 22, 2020, date of publication August 26, 2020, date of current version September 8, 2020.

Digital Object Identifier 10.1109/ACCESS.2020.3019648

Energy Scenario in South Asia: Analytical Assessment and Policy Implications

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ABSTRACT In the South Asian countries, including Bangladesh, India, and Pakistan, the current energy scenario is considered non-sustainable due to diverse issues such as economic, environmental, geopolitical, technological options for energy exploitation, and negligible volume of regional energy trade. Though, within the region, India is leading a phase of energy transition and economic transformation through renewable energy development. The countries need to exhibit well in the development of their renewable sources following the rapid pace of renewable energies worldwide. This article offers an overview of the energy scenario, growth of renewable energies, evolution, and approach for energy policy by highlighting key challenges and barriers for the ecological energy mix of the countries. Importantly, the paper assesses the current energy mix in South Asia, highlighting the anomaly of its fossil fuel-based future outlook, its ambitions to move towards less environmental pollution, and sustainable energy mix through a strategic tool SWOT analysis; strengths, weaknesses, opportunities, and threats (SWOT). In particular, this study examines the government policies to expand the implementation of renewable sources with an insight into the existing regulatory structure of the energy sector. The presented research findings suggest that to achieve the ambitious target to reduce emission discharge by up to 30% by the year 2030 under Intended Nationally Determined Contributions (INDCs), the Governments of the three countries must take preemptive measures. It includes the stage-wise reduction of subsidies on fossil fuels, market integration within the region, and swift realization of the existing initiatives through strong political will, good governance, adoption of the latest technologies, and a pragmatic action plan, and energy cooperation across the region.

INDEX TERMS Energy mix, SWOT analysis, regional trade, and policy.

I. INTRODUCTION

Energy plays a very vital role in the cultural, economic, political, and social sectors running the whirl of development by maintaining all the requirements of a society. Rapidly increasing energy needs of humans are not supported by the current landscape of energy resources as the conventional energy sources have already been immensely exploited to meet the daily-life necessities [1]. South Asia consists of the present territories of Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, India, Pakistan, and Sri Lanka. The South Asian countries are included in the list of rapidly growing and developing nations in the entire world. These are also considered to be a center for a rising middle-class population, which has observed major growth in the prime energy utilization by improving economic circumstances and an escalation in per capita revenue. In 2017, the South Asian Association of Regional Cooperation (SAARC), which consists of 8 nations, accounted for 4% of the world's collective GDP of amount USD 79.86 trillion, with the cumulative GDP of ∼$3.31 trillion [2]–[4]. Approximately 24% of the world 's residents, i.e., more than 1.5 billion people are living in these countries.

In terms of volume and mix, the primary energy consumption of South Asian countries changes substantially. Every nation in this region has different usage, reliant on energy accessibility, economic and commercial feasibility, the primary geopolitical situation, degree of energy sector trade, and technologies available for energy survey. It is

The associate editor coordinating the review of this manuscript and approving it for publication was Dwarkadas Pralhaddas Kothari.

also estimated that the trades of diesel dependent vehicles have escalated from 4% to 11% in the recent years. In fact, energy reserves in the developing countries are declining fast [5]. A severe consequence is caused by the emissions and discharges formed by the burning of petroleum-derived fuel with its impact on the both environment and human health [6]–[10]. The region of South Asia is endowed with diverse, rich natural energy resources like coal, wind, thermal, water, gas, solar and geothermal, etc [11]. There is huge presence of natural resources that include estimated coal reserves of 133,237 million tons, hydropower potential of 296,431 MW, natural gas reserves of 85 Tcf (trillion cubic feet) and high renewable potential of solar (365,639 MW), and wind (378,594 MW) [11], [12]. Despite the availability of rich energy resources in the region, many South Asian countries are fronting a severe shortage of electrical power with numerous blackouts [13]. In this wake, the governments of South Asian nations are encouraged to expand renewable energy resources as the region is blessed to have rich and plentiful energy sources, [12], [14], [15]. The nations have commenced numerous steps and actions to appeal a sustainable energy mix, ultimately with some of these plans going sound. However, it necessitates continuous progress to reach the specified targets.

Bangladesh has one of the lower per capita energy consumptions [16]. The country's focus in energy sector is: private sector contribution; fuel diversification; exploiting renewable energies; tariff rationalization; energy efficiency and conservation; regional collaboration for cross-border power trade [16], [17]. The fast growth of India primarily determines the country's energy policy development path, the rise in the energy shortage, and the quest for alternative energy sources. With coal being the significant fuel in the energy mix in India, 6% of the world's primary energy is utilized in India [18], [19]. By 2022, The Jawaharlal Nehru National Solar Mission 2010 predicted 22 GW of grid tied solar power [20]. According to India's Nationally Determined Contributions (INDC) to fight climate change, it plans to develop 100 GW of solar power capacity in the next few years [21], [22]. Energy policy is acute for a developing country like Islamic Republic of Pakistan in view of its development and growth of population. The country had certain plans and various rounds of energy policy such as owner Policy, Energy Conservation and Efficiency Policy and Environment Policy, Petroleum Policy, and Renewable Energy Policy [23], [24]. The Alternative and Renewable Energy Policy 2019 (ARE Policy 2019) sets out plans for more realization of renewables' full potential in Pakistan while encouraging contentious electricity pricing in the energy sector. The Government of Pakistan (GOP) has currently set a goal of almost 20 percent capacity-based renewable energy development by the year 2025, and at least 30 percent by 2030 [25].

This article is limited to the study of three major economies of South Asia, i.e., India, Bangladesh, and Pakistan, termed as SAN-3. The subsequent points will describe the basis for the choice of SAN-3 (three major countries of South Asian region):

- These countries represent more than 94% of the total population of the region, and so is the region's energy consumption.
- The geographical term, i.e. 'Indian subcontinent' for these three countries is alternately used to define South Asia
- The nations are acting as a crossroads for worldwide trade because of their greater population and strongly projected economic boost.

There have been multiple articles available in the literature highlighting the current status, and future prospects of energy sectors in Bangladesh, India and Pakistan [9]–[21]. Nevertheless, it is much needed to analyze the course of the countries towards the evolving policies to accomplish diverse energy mix. This research study is focused on the analysis of the trajectories of the countries towards the evolving policies to accomplish diverse energy mix. Analytical assessment of the chronological trajectory will enable the concerned stakeholders to implement viable energy strategies to diminish the impending energy insecurity issues in the region. The study provides a comprehensive analysis of the South Asian region's energy planning approach involving country-specific energy profile, describing factors that affect the energy sector, such as population, GDP, energy source availability, and in-depth insight into the current regulatory structure. It presents facts and challenges for sustainable development of energy, along with recommendations to encounter the ever-growing demand through analytical assessments of the functions of regulatory bodies and the governments' key energy initiatives. In addition, SWOT analysis is performed, which is prevalent in research studies, to investigate the strengths, weaknesses, opportunities, and threats of energy situation of a country or region.

This study contributes to the literature on the energy evolution strategies for the key South Asian countries with identification of the threats related to the future energy policies for improved energy security. In particular, this article assesses the evolution of energy policy and accessibility of energy sources which intend to facilitate the decision-makers and stakeholders better plan and execute sustainable energy mix in the region. To the Author's knowledge, the strategic analysis of South Asia's energy mix, as presented in this research paper, has not been reported in the literature. Inspecting the irony and its probable resolutions can aid policy planners to apprehend the existing scenario, the basis of discrepancy in their policies, and the likely effects of present strategies and policies.

II. METHODOLOGY

A systematic review of the energy scenario, growth of renewable energies, evolution, and approach for energy policy has been conducted in this research study. Ontological approach

TABLE 1. The demographic and economic scenario of the countries.

Country	Population (million)	GDP growth rate	Growth rate (Industry)	Inflation	Year
Bangladesh	165.6	7.9%	8.2%	5.63%	2019
India	1,369.56	6.8%	6.1%	4.86%	2018/2019
Pakistan	212.2	5.8%	5.5%	3.93%	2018/2019

is adopted to classify the available literature on the topic. The presented content and its analysis are structured using objectivism based on ontological approach. To maintain objectivity, an archive of the related vocabulary and material has been prepared concerning the energy scenario in South Asia. The literature is extensively searched from the past decades to archive articles published on the related topics using a sequence of keywords to pinpoint energy studies in the region. The search keywords are ''energy mix,'' ''overview of energy sector,'' ''energy prospects,'' renewable energy status,'' ''SWOT analysis'' ''politics in energy,'' ''policy study,'' ''renewable energy policy,'' ''climate change'' ''INDC,'' ''energy trade in the region,'' and etc. The literature was searched from Web of Science, Google Scholar, ScienceDirect, and Scopus databases. All the articles found relevant with energy and policy for the three countries have been used in the presented review process and assessment. It was discovered that there is a substantial need of a research study, which should contain chronological information of the region's energy scenario, policy plans and the relevant institutional set-up. In addition, we also collected data from gray literature by institution including Planning Commission, Statistics Bureau, annual reports from various ministries of the governments of countries, news articles, documented statements of incumbent officials of the energy sector.

From the detailed overview of energy sector and its policies, SAN-3 face both merits and demerits in strengthening the region's energy outlook through diversity in the energy mix. Thus, the future outlook of energy sector is not much clear. In this regard, this research study conducts the SWOT analysis to underline the capabilities upon which the region can settle the energy paradox. The SWOT matrix is a well-defined method applied to assess the different aspects i.e. strengths, weaknesses, opportunities, and threats implicated in a project. This tool has also been employed in energy research involving energy policy, and planning of renewable energies [13], [14], with focus on a few analogous issues as presented in this research study but in distinct context. The SWOT matrix illustrates both beneficial and detrimental factors originating from strategic plan. Where, strengths are the internal beneficial resources and weaknesses are impeding factors towards the sustainable energy vision. Opportunities are considered external beneficial avenues and the threats are perceived as risky aspects towards the sustainable energy scenario.

III. ENERGY SCENARIO IN THE REGION

Table 1. shows the macro-economic parameters of the three countries [28]–[30]. Fig. 1 depicts the demand for electrical energy of the three South Asian countries in the year 2018/2019 [13]. The three nations experience net shortfalls in the large traditional fossil-fuel energy sources. The energy mix of three countries are shown in Fig. 2 while comparison of their power generation mix by source is portrayed in Fig. 3.

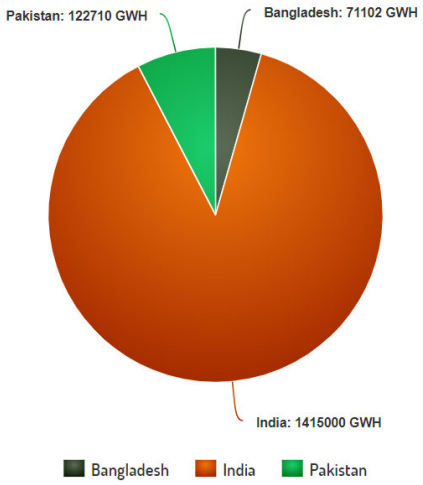

FIGURE 1. The electrical energy demand for the nations in year 2018/2019.

A. ENERGY SCENARIO IN BANGLADESH

Bangladesh is one of South Asia's fast-growing economies. In the country, increasing population and social development have caused an increase in the demand for energy. With GDP recording 6.6 percent Compound Annual Growth Rate (CAGR) over the last five years, Bangladesh has risen sharply [30]. The energy demand for Bangladesh has increased at a CAGR of 7.4% from 25.7 MTOE in 2013 to 37.38 million of tons of oil equivalent (MTOE) in the year 2018 [31]. Due to gas shortages and insufficient capacity acquisitions, uncontrolled demand exceeded power generation capacity a few years ago and prompted the government to enact ambitious generation increase plans. Power generation capacity in the year 2018 was 17,801 MW in Bangladesh [32]. The highest possession was occupied by Bangladesh Power Development Board (BPDB), which is (around 5300 MW).

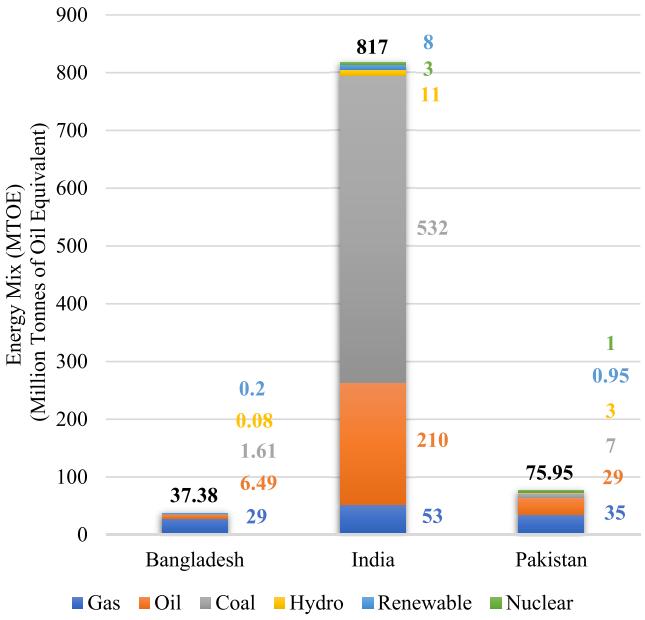

FIGURE 2. Energy Mix of the countries for Year 2018/2019.

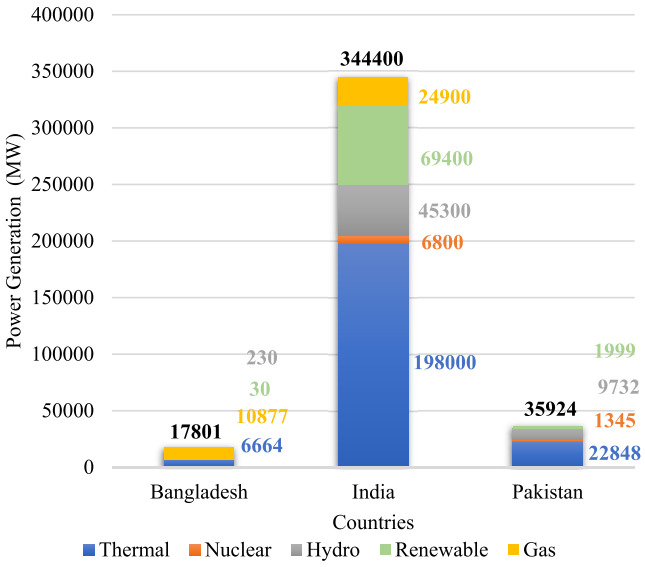

FIGURE 3. Power Generation by Source for Year 2018/2019.

Over 70 percent of power generation comes from gas power plants with thermal power that accounts for just 20 percent of the total capacity. Almost 62,925 GWH (Gigawatt hours) of power was generated in the year of 2018, which was 9.8% more than the last year. By linking Bheramara and Tripura, around 4661 GWH of energy has been imported from India [30], [32]–[34]. By 2021 and 2030, the country 's generation capacity of power would be boosted to 24,000 MW and 40,000 MW conferring to the Power Sector Master Plan of Bangladesh. Taking into account the retirement plans of the current power utilities, the de-rating of the power plants, the implementation of early retirement policy for obsolete power plants, and the construction of modern and effective facilities, energy stations with an extra capacity of 14,500 MW are anticipated to be installed by 2030. Karnafuli Hydro, with an installed capacity of 230 MW, is the only hydropower plant in Bangladesh [35].

1) DEMAND FOR PETROLEUM PRODUCTS IN BANGLADESH

During the years 2013-2018, the demand for Petroleum, Oil, and Lubricants (POL) without LPG did rise at 4.7% CAGR in Bangladesh [30]. Owing to the growing mandate for diesel and petroleum from the thriving transportation industry, in fiscal 2018 the growth remained to 8.7%. Escalated automobile growth joint with low fuel costs, mostly automobiles like motorcycles and cars widened the utilization of high-octane blending component (HOBC) and petrol by 12.4% and 7.6% in turn [30], [36]. In 2018, consumption of diesel escalated by 11.2 percent year-on-year as a result of massive development in the transportation sector driven by robust GDP growth of 7.1 percent. Commercial vehicles, increasing diesel demand, reported a 15 percent growth in fiscal 2018 and a 12.3 percent increase in CAGR over the last five years [37]. Fig. 4. depicts the demand for POL for years 2018/2019.

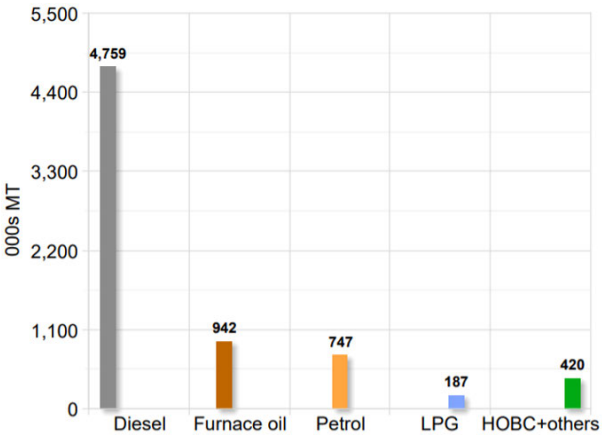

FIGURE 4. POL demand in bangladesh in 2018/2019.

2) RENEWABLE ENERGY DEVELOPMENT IN BANGLADESH

Government of Bangladesh has put special emphasis on the Development Program of Renewable Energy under the Power Sector Development Plan [38]–[40]. Bangladesh Power Development Board (BPDB) plans to leave fossil fuels and look towards renewable energy sources as the future sustainable and reliable generation of power [40]. Although electrification tends to lag behind, the nation had to depend on conventional energy sources, over which they had technical proficiency to boost supply. Now, by 2022, as Bangladesh has planned to put all households to the grid so the main emphasized area will be the rebalancing of the fuel mix. BPDB has mounted 270 kWh of solar systems on the rooftop of its offices, with an additional capacity of 500 kWh in the pipeline [38]. In the Kutubdia Island and Cox's Bazaar, small wind projects have been installed. Eight cities of Bangladesh

have solar streetlights installed, and in Sylhet and Chittagong, solar charging stations are now being established. Electrical power of almost 870 MW will be added to the grid as there are 9 projects of renewable energy in progress [41]. A development financial organization owned by the state is devoted to encouraging or provide financial support to the projects and infrastructure of renewable energies in Bangladesh, which is known as 'Infrastructure Development Company Limited (IDCOL)'.

3) ENERGY POLICY IN BANGLADESH

Bangladesh relies heavily on fossil fuels for its generation of power, and its future energy strategy is geared towards imports of fossil fuels. There are some policy approaches in the energy area, including involvement of private sector, energy efficiency and conservation, regional cooperation on cross border power trade, the variation of fuel mix, and validation of tariff etc. Up to 2030, the country has made a master plan on energy conservation and efficiency, as they are vital ingredients for energy advancement in Bangladesh. In comparison to the base value, it is predicted that the power demand would tumble down by capacity of 8 GW if the energy efficiency of 20% is enhanced by 2030. A cross border policy of trade is being established by India so that the Power Development Board of Bangladesh can get power from any Indian Company. To minimize the manufacturing cost of energy, the subsidy is given for the fuel by proposing electricity tariffs. To boost the country's economy, cheap prices of power are of great importance. Though the cost of power supply per unit has increased over time, the rate of growth is very little. To meet the rising demand for the nation, BPDB has planned to get power from self-governing power manufacturers and by mounting new power plants, which will lead to accelerating the price of power production. In the light of increasing energy prices, the bulk power tariff rate has actually raised from 2.50Tk in 2007 to 3.8 Tk in 2015 to minimize the economic loss of BPDB [42]. Bangladesh's Government has also implemented electricity pricing slabs so those high-end consumers can reduce utilizing the subsidies. It can be minimized more efficiently if the losses of the system somehow are reduced. For this purpose, there is need to train the workforce efficiently and introduce some optimization techniques in the area of transmission, generation, and distribution. Energy conservation, reliability and efficiency are also very important for substantial development and growth in the country.

The Government of Bangladesh has provided a robust push to increase the production of renewable energies in the country. In the years 2015 to 2020, the objective was to produce 5% to 10% power from renewable energy resources. In 2014, for the promotion of energy efficiency and reliability, the government had established a department named Sustainable and Renewable Energy Development Authority (SREDA) [43]–[45]. The Government of Bangladesh is also seeking to follow Bangladesh's 'Private Sector Power Generation Strategy' to draw private investment and guarantee a better cost for projects of power generation. As the cost of RE is reducing with time, a complete road map for binding renewable energy has also been intended in Bangladesh to pay emphasis on solar projects. On the initial stage, projects based on rooftop solar PV would be more attractive as there exists a land scarcity in the country. BPDB is also sectioning wide grid linked solar projects (more than 30MW) to promote further use of solar energy.

4) INSTITUTIONAL FRAMEWORK OF ENERGY SECTOR IN BANGLADESH

The energy sector of Bangladesh is under the regulations of the Ministry of Energy, Power and Mineral Resources. It is responsible for regulations and rules designed to uplift the energy sector in areas like power, coal, gas and other primary fuels. In 1995, the established power cell was aimed to assist the power sector for monitoring, designing, and facilitating reforms in the power division. It plays a significant role in improving, reforming, and facilitating the private sector, starting regulatory commissions, assessing power tariffs and sector participation and contribution. Bangladesh Energy Regulatory Commission (BERC) was established in 2004, which aimed to frame the necessary standards, and codes to continue the transparency, efficiency and submission to management, and operations in the sectors of petroleum, gas and electricity [46], [47]. In 1972, to boost the power sector in the country, a public sector organization was created as Bangladesh Power Development Board (BPDB), which is an authoritative body that has all the rights to construct, plan, and operate and run power generation units all over the country as well as power distribution in the urban areas. It sells power to customers and distribution companies after purchasing from generating companies as a single consumer. The institutional set-up of the energy area of Bangladesh is shown in Fig. 5.

The central body: i.e., Energy and Mineral Resources, and Power ministry (MoPEMR) is also responsible and accountable for all the development, planning and different types of commercial energy resources management, including power. Power Division and Resource Division (EMRD) are two divisions under the control of Mineral and Energy Resource. EMRD is the administrative authority and is responsible for the administration of all the mineral resources and energy resources containing gas, oil, coal, and other minerals of Bangladesh [48]–[50]. Petrobangla, a Bangladeshi Oil, Gas and Mineral Corporation (BOGMC), is a shareholder of companies who is playing a role in the development and growth of gas and oil on behalf of the EMRD. Bangladesh Petroleum Corporation (BPC) is responsible for all the measures which are required to be taken in order to uplift the petroleum industry such as, crude oil processing, refining, lubricants blending, export, import, and advertising and marketing of products containing lubricants, and by-products. Bangladesh Petroleum Corporation (BPC) has 8 divisions –three distributions, one oil refinery and two lubricant blending plants, marketing companies, an LPG bottling and distribution plant.

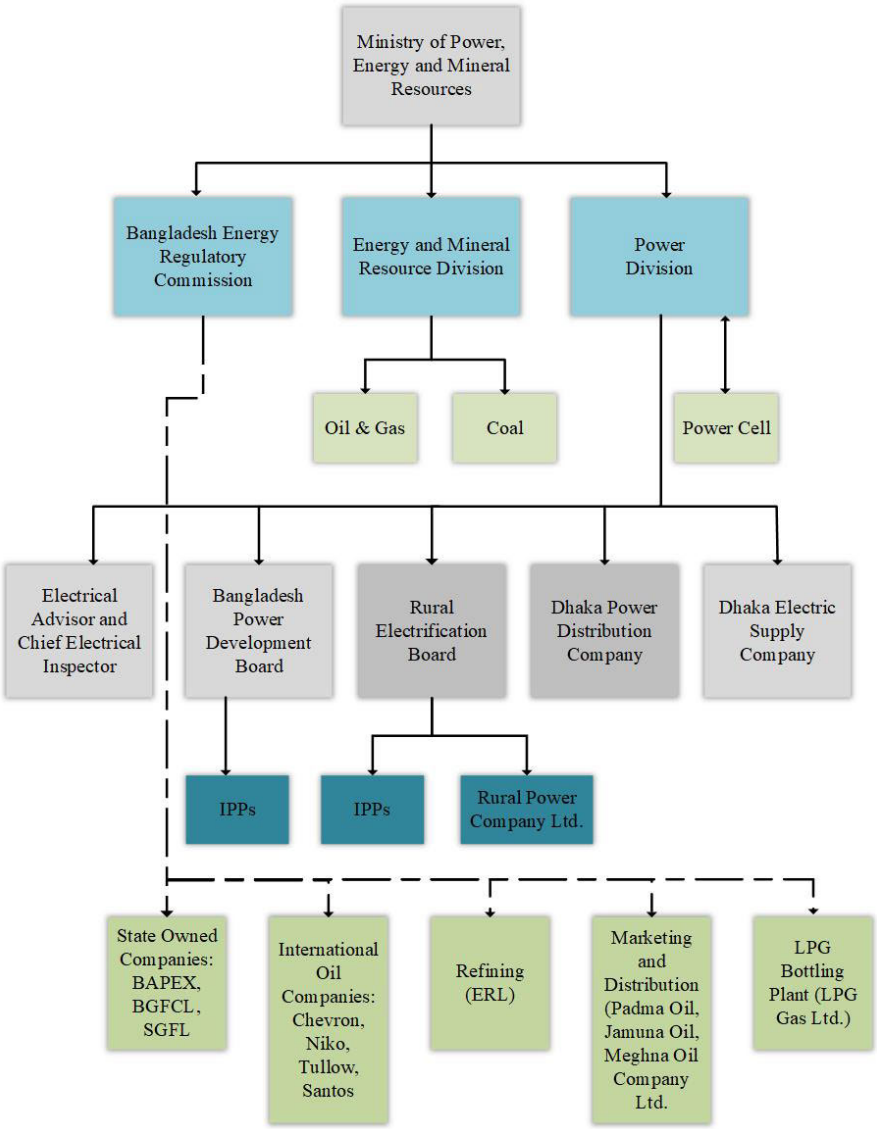

FIGURE 5. The institutional set-up of the energy sector in Bangladesh.

B. ENERGY SCENARIO IN INDIA

India, South Asia's largest economy has been growing substantially at Compound Annual Growth Rates (CAGR) 7.1 percent in the past five years [29]. Increase in foreign and domestic investments have contributed to the growth momentum of the country [51], [52]. The country's demand for energy is escalated by the steady growth in industrial activity and improvement in its per capita income. The power sector of India is transforming at fast pace. In the last five years, power generation of over 120 GW capacity is added while there is a major contribution of thermal power observed at 73.3 GW [53], [54]. India's overall coal production increased from 662.5 million tons in fiscal year 2017 to 817 million tons [29]. During this time, the remaining share in the total production was covered by captive production (47 million tons) [29], [55]. 45% of the nation's energy needs or demand is met by coal. Coal is mixed with raw material, which is then utilized to make finished products (foundries, steel). It also provides heat for the production of clinker and generation of power. Though fossil fuels like oil, gas and coal will still be the major contributors towards the primary demand for energy in the country. Nevertheless, excess capacity in the energy sector and low growth in power demand have resulted in idle capacity and declining load factors (LFs), mainly in thermal plants (CAGR demand growth of 5.2 percent from fiscal 2013 to 2018 compared with CAGR 9.6 percent growth in power generation [29], [55].

1) DEMAND FOR PETROLEUM IN INDIA

Overall demand for POL products is reported to have escalated from fiscal year 2013 to 2018 to 5.5 percent CAGR. During the same fiscal years, the consumption of petrol is

seen to have risen at CAGR of 11% owing to the increase in the usage of public transport. Sale of passenger vehicles did rise by 10%, [29], [49]. Although main POL products involve LPG, oil, petrol, diesel and aviation fuel, pet coke accounted for 13 percent of total POL demand in fiscal 2018.

Demand for pet coke is sharply increased by 21% as the cost of coal rises, thus making the use of pet coke in the cement industry more competitive during fiscal years. Over a year ago, in August 2019, the sale of fuel and its consumption had increased at the rate of 2.8% to 17.04% million ton (mt) [29], [55]. Sale of petrol is improved by 8.9% to 2.57 mt, sale of pet coke enhanced to 1.79 mt by 3.8 % and sale of LPG is upgraded by 13.0% to 2.40 mt while the sale of other products improved to 0.98 mt by 10.8%. Fig. 6 illustrates the demand for POL in India during the years 2018/2019.

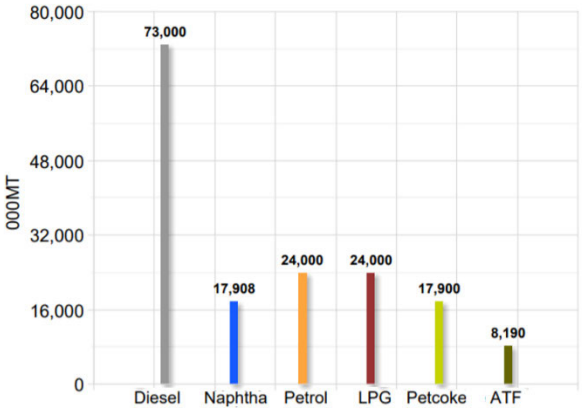

FIGURE 6. POL Demand in India in 2018/2019.

2) RENEWABLE ENERGY DEVELOPMENT IN INDIA

The government of India is tapping more focus on renewable energy sources with continuously dropping tariff [56], [57]. Under COP-21 commitments, the Indian government also intended to minimize emissions by 33-35% by 2030 from 2005 level [58], [59]. The government of India has also planned to bring 10% reduction in the energy imports by 2022. Some significant steps have been taken, such as increasing the thrust towards biofuels, clean coal technologies and the use of electric vehicles. By 2022, a renewable energy goal of 175 GW is set by the government [59], [60]. The country has installed solar capacity of 22.1 GW in the fiscal year 2019. Yearly installed capacity in the fiscal year 2018 increased to 9,363 MW compared to 5,526 MW in fiscal 2017 [61], [62]. The country has observed a significant development of solar power due to a sharp decline in the PV module prices, the economy of scale advantages with the dropping tariff of Rs2.7/unit. The country has rallied to bid solar power, propelled by a greater Renewable Purchasing Obligation (RPO) and small tariffs. Additions in installed power capacity were primarily driven by states such as Karnataka, Tamil Nadu, and Andhra Pradesh with an altogether installed 1452 MW of wind capacity [63], [64]. In addition to this, increased capacity of wind power will be determined by the advanced acquisition from non-windy states and the drop in tariffs. As of 2018, around 8 GW was the total installed capacity from biomass source [63]–[69].

Fig. 7 shows the installed and projected capacity of solar and wind energies in the year 2019 and 2030, respectively.

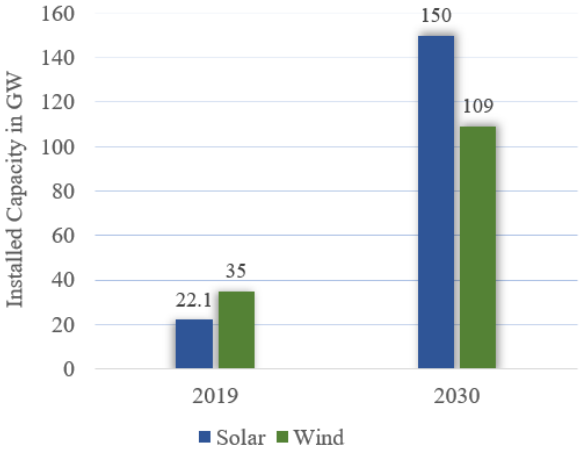

FIGURE 7. Capacity of solar and wind energies in India.

3) ENERGY POLICY OF INDIA

Development of energy policy in India is based on its rapid growth, which now mainly focuses the sources of energy like nuclear, wind and solar to meet the ever-increasing energy deficit. Stage-wise evolution of the country's energy policy is illustrated in Fig. 8. Energy planning of India during 1950–1970 was mainly focused on providing electricity and the development of gas and oil sectors [70], [71]. The main aim was to support the supply sufficiency, which was unable to meet the then electricity demand. In this regard, some institutions were established like the Central Electricity Authority, Energy Survey of India Committee and Planning Commission of India. The Electricity Supply Act 1948 highlights the

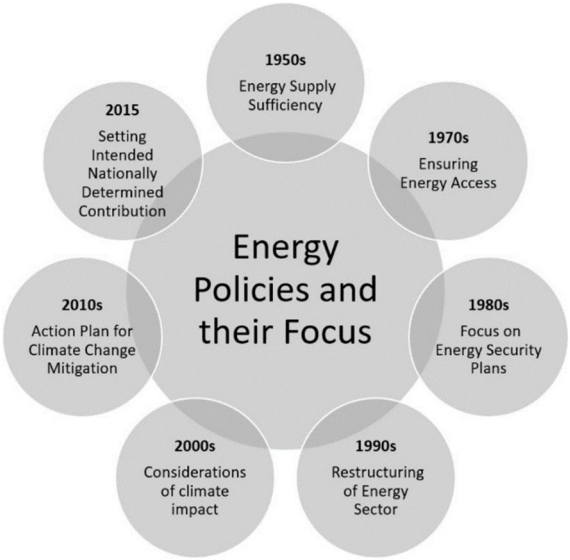

FIGURE 8. Stage-wise evolution of energy policy in India.

significance of a sustainable power system which defines the energy vision of India. Throughout this period, the main goal of energy policy was to regulate India's coal mining industry used for its energy security. Coal demand by the year 1950 did rise to 32 MTs (million tons), through the biggest consumer being the railways with about 31%, whereas 7% of it was consumed through the power industry [72]–[74].

In order to encounter the emerging energy crisis caused as a result of the global oil blow in 1970s, the focus of the policy shifted towards energy conservation. In the 1980s, expansion of the business sector caused a massive increase in energy needs. In India, new schemes in energy management and production started to describe the route of the energy sector [73], [74]. In the 1990s, there was a major development in India's energy sector due to the liberalization and freedom of India's regulated economy. Different policies were adopted by India's Planning Commission, including introduction of the foreign investment to the energy market, privatization, and strategy for the reformation of deregulation in the energy sector [70], [75]. Modernization and upgrading of energy area as well as demand-side changes and alternations due to the historical delays in the effectiveness of the electricity system of India, leakages and losses, were carried out at that stage. The government's consideration towards sustainable energy policy was portrayed by the establishment and foundation of the ''Bureau of Energy Efficiency'' (BEE) and the formulation of the ''Conservation Bill of Energy''. In the 2000s, weather modification was introduced, which is the current weather ongoing energy planning in India. New scientific instruments were promoted, power purchase, settling-sale and the ideal grid discipline through the availability-based tariff introduced by CERC in the year 2000 [100]–[103]. The ''Reforms-Program'' (APDRP) and the ''Accelerated Power Development Program'' were introduced in 2002 with the sole purpose of attracting private financiers; however, that was deteriorated because of the low investment in the distribution area. The National Action Plan for Climate Change (NAPCC) guidelines were used to design the present electricity policies, which have a significant role in the primary energy mix on renewables integration. The National Solar Mission Jawaharlal Nehru 2010 envisioned solar power of 22GW of grid linked by 2022, that is today 100 GW of solar power as per India's Nationwide known work to battle weather change [73], [76]. The coal supply for power generation has seen a considerable deficit due to the power plants controlled through the private region in the eleventh 5 Year Strategy, thereby increase in the imported introduced coal dependence (presently, 18% of the entire electricity production). Such changes affect the cross-support mechanism in the nation that, is a result, forms the basis of a major road chunk in gathering the 2022 renewable goals [77], [78].

4) INSTITUTIONAL FRAMEWORK OF ENERGY SECTOR IN INDIA

In India, there are separate regulatory bodies that formulate the policy for gas, coal, power, and other fuels including POL products. The main bodies are New and Renewable Energy Ministry, Coal Ministry, Power and Renewable Energy Ministry, and Petroleum and Natural Gas Ministry. India's hydrocarbon resources are cared for and managed by The DGH (Directorate General of Hydrocarbons) [79], [80]. Production of India's 80% crude oil is done through an upstream body, ONGC (Oil and Natural Gas Corporation Ltd), by being the main participant. Hindustan Oil Exploration Co Ltd, Cairn India Ltd and Oil India Ltd are some other groups that are involved in the production and exploration of this zone. Production and exploration have been taken care of by the licensing policy of the exploration and hydrocarbons. Ministry of Natural Gas and Petroleum also does the production and exploration of gas and oil. The marketing, refining of petroleum, transportation, conservation of petroleum products, distribution, import, and export are managed by the Natural gas and Petroleum Ministry [79]–[81]. India's systematized structure of the energy sector is shown in Fig. 9. Power grid corporation of India Ltd, state. transmission utilities (STU) and a central transmission utility (CTU) are the two figures responsible for preparing the development and progress of the intra-state transmission system and inter-state transmission systems (ISTS). Power System Operation Corporation Ltd (POSOCO) from National Load Dispatch Centre (NLDC) and five regional load dispatch Centres (RLDC) manage regional and national grid through unified load dispatch and communication facilities [81], [82]. Also, private body is permitted to function and play as transmission licensees. Nationwide states are responsible for the transmission and distribution of power to urban and rural consumers for power distribution. Both private and public companies manage the distribution of power within the country.

C. ENERGY SCENARIO IN PAKISTAN

Due to increasing industrialization and economic growth, the country's demand for energy has increased since the fiscal year 2014 at an average annual rate of 5 percent [83]. The energy requirement of the country has sharply increased to 75.95 MTOE from 58 MTOE at the rate of 5.2% CAGR in years 2013 to 2018 [28], [84]. The nation relies on the imports of fossil fuels (around 85 percent of the country's crude oil and petroleum products are imported internationally), entrusting itself with the global oil price and supply shocks. Rich renewable energy sources in the country have the potential of generating capacity of more than 120 GW but are not used significantly due to which it only has installed capacity of approximately 1400 MW [84]. Referring to the Economic Survey of Pakistan for the year 2019-20, the installed power generation capacity is 37,402 MW in the year 2020, which has seen an addition of at least 12000MW in the last five years. Importantly, rising electricity generation rates from thermal power units and incoherent fuel mixes still have to be resolved. Domestic gas, the other most important source of energy, is expanding the country's dependence on liquified natural gas (LNG) imports to reduce shortfalls [85], [86].

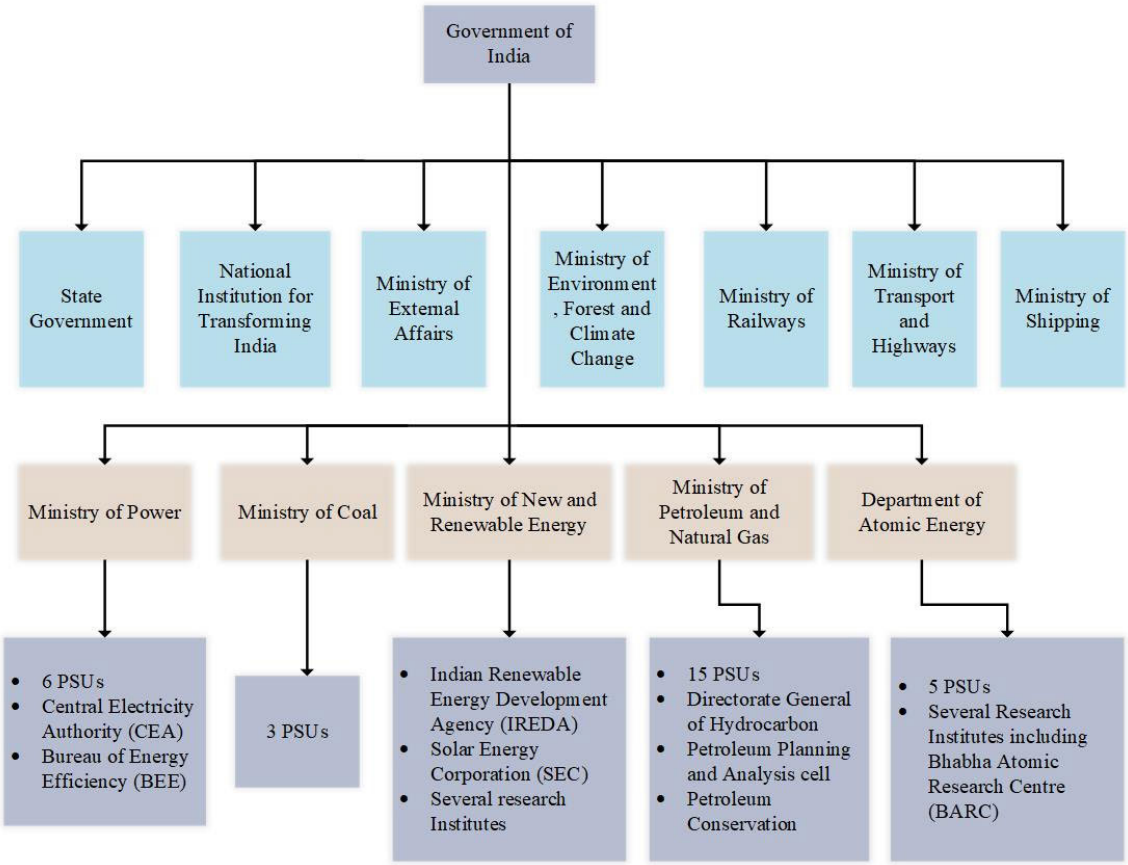

FIGURE 9. Institutional set-up of energy sector in India.

The capacity of gas-based inclusions stood at very low while, on the other hand, Pakistan has added power plants based on nuclear and fuel oil (FO) [28]. FO and natural gas make major contributions of around 29% each in the total mix. The generation of hydropower lags with a plant load factor (PLF) (49 percent in the fiscal year 2013 versus 37 percent in 2018) due to a lack of water supply and erratic climate conditions [86]–[88]. The total installed capacity of hydro projects in Pakistan is estimated to be 9,732 MW in fiscal 2018 [89]–[91].

1) PETROLEUM DEMAND IN PAKISTAN

In the years 2016-2017, 7.9% consumption of petroleum products did rise to 25.8 million tons from 23.9 million tons [28], [92]. Major driving factors were power and transport that recorded a high consumption growth of 10% and 12% in the respective years of 2016 and 2017. During the same years, in government and agriculture sectors, POL products consumption contracted by 8% and 13% [92]–[95]. Petrol use did rise in fiscal year 2017 by more than 16 percent. This rise might be driven by the growing demand from the transportation industry (the main user of motor spirits in terms of volume), especially owing to the increasing number of cars and motorcycles and partly due to the cheaper fuel costs over the years. Over the years, oil consumption has risen sharply wheelers, expanding at a rate of 7, 17, and 16 percent, respectively, between the years 2017 and 2018 [95], [96]. Moreover, low accessibility of gasoline and CNG (compressed natural gas) together with cheap prices of crude oil has enhanced the utilization of petroleum. to limit the usage of CNG, the government of Pakistan banned the import of CNG cylinders and kits in 2011. Fig. 10 shows the total demand for pol of Pakistan.

2) RENEWABLE ENERGY DEVELOPMENT IN PAKISTAN

Pakistan is blessed with a plenty of renewable energy sources like wind, solar etc. These resources can be used efficiently to generate electricity, and thus the energy demand for the country can be met. Over many years, the capacity of the generation of power from renewable energy sources has not been improved. It is quiet at an emerging stage. In the fiscal year 2018, solar power of 700 MU while wind power of capacity 740 MU was generated in Pakistan [28], [91]. Bioenergy potential existing in industrial sector has been studied in [97]. Biomass potential for biogas generation and biogas to electricity generation technologies have been studied in detail in [98]. In the year 2015-16, Quaid-e-Azam Solar Park (QASP) was functional with a capacity of 100 MW

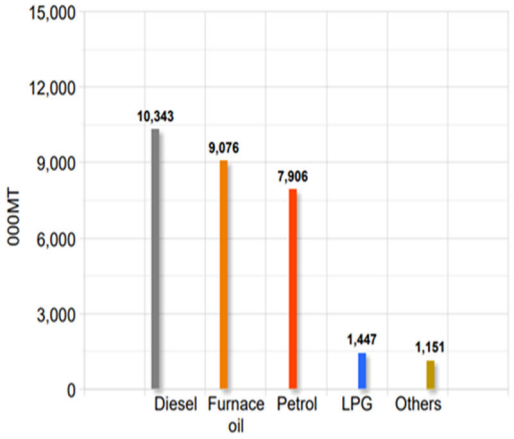

FIGURE 10. POL demand in 2018/2019 in Pakistan.

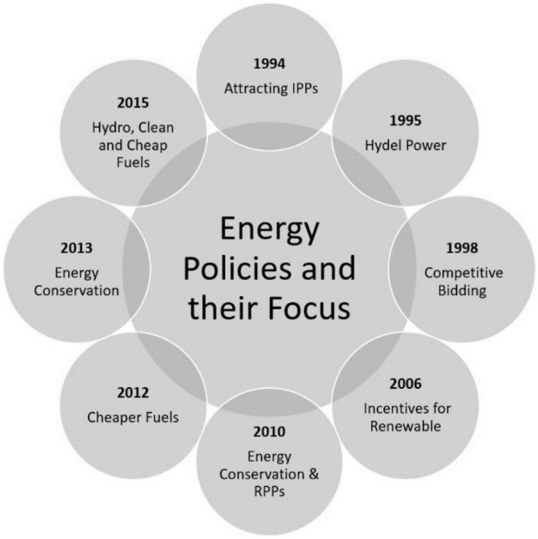

FIGURE 11. Evolution of energy policy in Pakistan.

which produced 25 GWh, whereas three 100 MW solar projects, each with its own cumulative installed capacity of 300 MW, are still under installation in QASP [99], [100]. Almost 43.871 GW of capacity is available in the coastal areas of Sindh out of which a capacity of 11 GW is very much pragmatic to be harnessed, as stated by Pakistan Meteorological Department (PMD) [101]. In 2013, Fauji Fertilizer Company Energy Limited (FFC) had installed the very first wind project of 50 MW. As of now, in wind corridors of Jhimpir and Gharo-Keti Bandar, Sindh Province, six wind projects of power generating capacity 308.2 MW are functional [102], [103]. Experience through Renewable Energy (RE) Policy 2006, together with international standards and best practices, will form the foundation for a more robust ARE Policy system, 2019 [25]. Most of the substantial and smart incentives of RE Policy 2006 are carried forward by this to uphold the investor's confidence [23], [105]. It continued to put more emphasis on the hostile growth of grid connected ARET (alternative renewable energy technologies) applications as well as a programmatic advancement of distributed power generation market on more viable terms.

3) ENERGY POLICY OF PAKISTAN

Until 1980s, the country's power and energy policy strategies have been faced with issues, i.e., either they lack in energy planning strategies employing energy modeling apparatuses or other problems like consistency, reliability, and implementation. In the year 1994, the government formally started to focus on the energy and power policy development and its formulation, though most of which focused on both readily accessible major energy sources or economical solutions, respectively [106], [107]. The policy documents include Renewable Energy Policy, Power Policy, Petroleum Policy, Energy Efficiency and Conservation Policy, and Policy of Environment [108]–[110]. Evolution of energy policy in Pakistan is illustrated in Fig. 11.

The first formal power policy of Pakistan was announced in 1994 which targeted to achieve electricity generation of 13000 MW by IPPs (Independent Power Producers). Generation of thermal power was primarily focused in 1994 policy by the IPPs, as such, to seek out suggestions for power generation. In 1995 government declared a new strategy of years the possession of the hydropower scheme would be moved free of cost to GoP [111]. Pakistan formally declared additional power strategy in 1998, i.e., a modified version of 1994 strategy with even extra explanation. In 1997 the creation of NEPRA was an outcome of reformation of the public WAPDA initiated in early 1990's. Nation-wide energy strategy 2010–2012; a brief energy strategy was announced with focus on the energy saving for shorter and longer period to plan for generation of electricity. To satisfy energy demand for the country, a ''controversial Rental Power Plants'' (RPPs), and investment by IPPs, and restoration of current public area power plants were part of this policy [112], [113]. National power policy 2013: the then Government announced which was focused on local source hydropower. The policy includes the following ambitions: the progress of electricity generation capability to satisfy the country's power demand, endorse power saving culture, and emphasis was made in order to generate electricity from different primary energy resources.

4) INSTITUTIONAL FRAMEWORK OF ENERGY SECTOR IN PAKISTAN

In Pakistan, central government agencies are primarily responsible for the smooth-running operation and management of the energy sector. In general, Ministry of Water and Power controls and manages the energy sector in Pakistan. In the country, oil and gas industries are comprised of public as well as private companies that are monitored by the Ministry of Petroleum and Natural Resources (MoPNR) and also controlled by the Oil and Gas Regulatory Authority (OGRA). The MoPNR makes new and effective policies

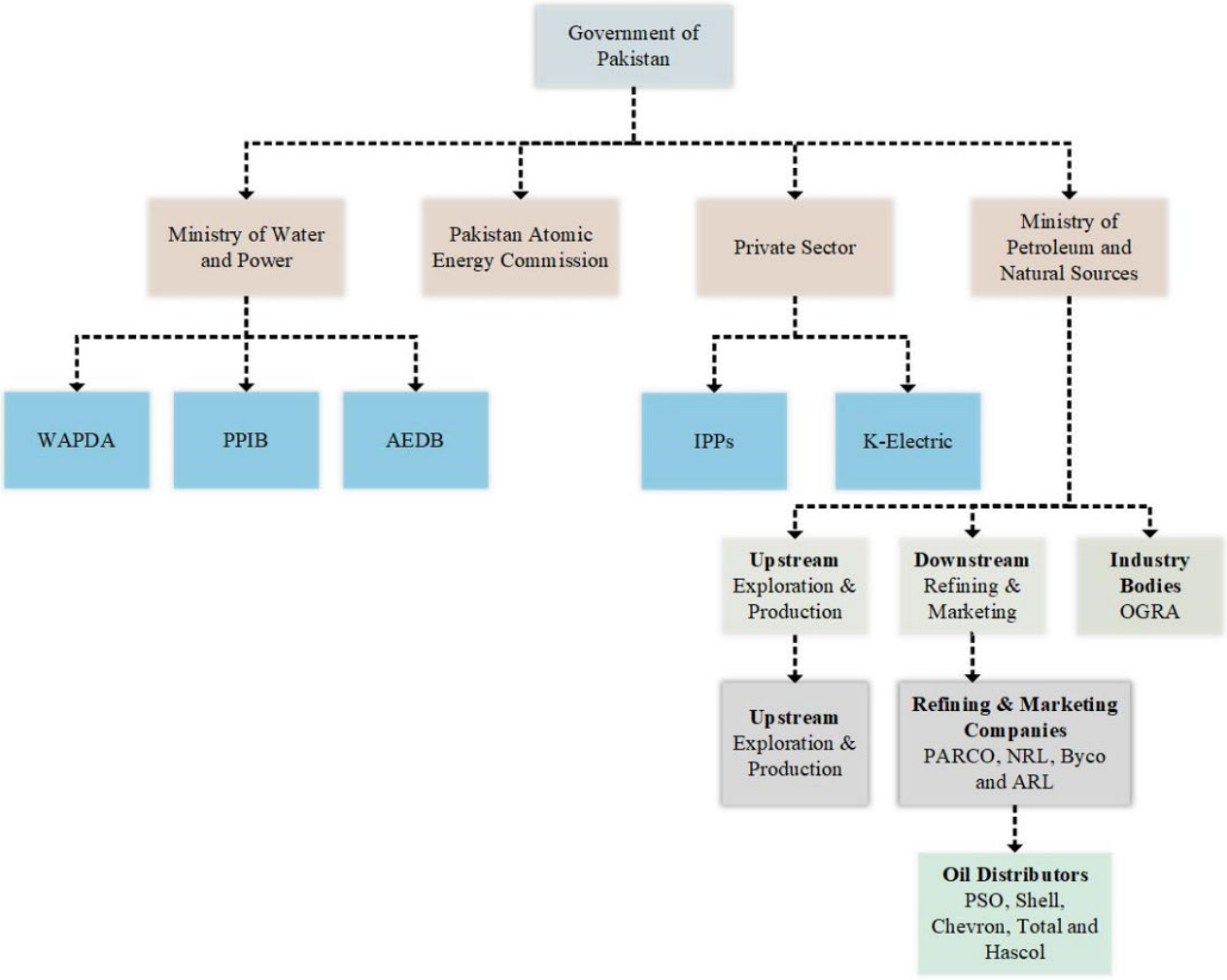

FIGURE 12. Institutional set-up of energy sector of Pakistan.

pertaining to oil and gas production. The OGRA works by increasing investment and competition for private sector regulate the midstream and downstream segments.

National Electric Power and Regulatory Authority (*NEPRA)* came to force under the Electric Power Act, 1997. Its major functions include providing with license for generation, transmission and distribution of electric power, and setting standards for performance of generation, transmission and distribution companies. Water and Power Development Authority (*WAPDA)* came to force with a soul purpose of providing water and the development of hydropower plants in the country. Private Power and Infrastructure Board (*PPIB)* works in order to promote and facilitate private sector participation in power sector. Alternative Energy Development Board (*AEDB)* represents Federal Government, whose major emphasis is on the development of alternative and renewable energies in the country [113], [114]. It also helps the development procedure for the RE by utilizing proper policy making and project execution. Institutional model of Pakistan's energy sector is shown in Fig. 12.

IV. DISCUSSION AND ANALYSIS

Over the past 15 years, the energy demand for South Asian countries has grown-up by 60% [26], [27]. Since 1990, the energy demand for South Asia is expanded by two and half times, according to the International Energy Agency (IEA). The South Asian nations have shared a common problem of unprecedented availability of energy resources, and environmental concerns [26]. Energy consumption of South Asian countries is anticipated to continue to grow in the next two decades due to substantial economic and population growth. India largely depends on coal, which was about 65% of its primary energy mix in the fiscal year 2018. Although there is a growing interest towards RE adoption and implementation, it still has quite a low percentage of the total energy mix. In Bangladesh, more than 70% of its energy total demand is met by the utilization of gas. Pakistan greatly depends

on gas and imported petroleum products with serious issues of supply and demand. The energy trade among the region needs to be improved from the federal government through the establishment of a huge energy market.

In the remote areas of Bangladesh, solar PV based projects of mini grid are set up in which the probability of grid expansion is distant in the upcoming years. The mini-grid project effectively developed access to cheap-emission electricity for nearly 5000 Bangladesh rural households. By 2018, Infrastructure Development Company Limited (IDCOL) has intended to achieve the bigger goal of installing a 50 solar mini grid. For improved reliability, sustainability, efficiency, low utilization of fossil fuels and emissions, new power plants based on coal are expected to have the latest technology. The development of an LNG terminal in the Moheshkhali-Materbari region is also expected to augment the supply of gas to dual-fuel power plants. Because LNG costs are large compared to coal, nuclear power plants will be cost-effective and sensible to utilize in peak power plants (simple cycle gas turbine or diesel engines) instead of combined cycle power plants, where total gasoline consumption is very high.

In India, during fiscal years 2013 and 2018, the primary consumption of energy and coal is boosted to 5.2% and 6% CAGR, respectively [49]. In the fiscal years 2013 and 2018, the primary energy of India has escalated from 652 MTOE to 817 MTOE (CAGR of 4.6%). Between the fiscal years 2018-2030, the consumption of petroleum products is estimated to reach 4.1% CAGR in India in contradiction to the growth of 5.5% observed during the last five years. The economic downturn is largely due to reduced demand for gasoline with increased replacement by CNG, mixed ethanol and augmented emphasis on electric vehicles. Over fiscal years 2019-2023 and 2024-2030, it is predicted that the solar capacity of India will experience a boost of 60 GW and 70 GW [54]–[57]. As per INDC commitments, non-fossil fuel (hydropower, wind, biomass, solar, waste to nuclear energy) are expected to add 40% in the country's total installed power capacity by 2030. It is also predicted that India will achieve its goal by 2030 by considering the trends of current growing capacity.

Pakistan has a decent level of electrification of almost 70% of its population [28], [63]. In the years 2013-2019, demand for power has increased at a rate of CAGR of 4.52% from 94,496 MU to 120,392 MU. One of the cleanest and cheapest form of available energy is hydropower as water is naturally available in the country. Pakistan has a collective hydropower potential of 60,000 MW, according to WAPDA. The obtainable technical potential for power generation through biomass, small hydro, wind and solar are measured in [96], [115], [116]. From the available sources of biomass, power of 35.625 million kWh can be generated on a daily basis, stated by [116].

Excessive use of fossil-fuels: Dominant fossil fuel resources remain one of the major issues with SAN-3 energy mix. In 2019, India in the region, was found to have a major recoverable coal. The country in South Asia focuses more on utilizing the availability of coal rather than developing other energy sources because of the pricing and availability of coal. There are some factors which weakened the SAN-3's vision such as the absence of will power to develop low carbon energy sources, incorporating all the energy market and insufficient capacity. Some of the significant challenges faced by electricity market and power system management are due to the development of renewable energy. Improvement in both the infrastructure and the management is the primary need to address those challenges which may hurdle and further discourage under-developed countries to go for green and clean energy mix.

Under-utilization of resources: The region has sound abundance of resources like (hydropower, gas, coal, and renewable energies), but it continues face more exploitation of fossil-fuel resources and the indigenous resources are less exploited. Pakistan, India, and Bangladesh are individually having substantial reserves of coal which have not been explored to their magnitude. Instead of having a smooth and secured chain of domestic supplies to accommodate to burgeoning demand due to collapse of gas supplies in Pakistan and Bangladesh, there is a growing pressure from the stakeholders to increase the import dependency.

Lack of diversification of fuel basket: There is a different energy consumption pattern (by fuel mix) in the three countries. The largest primary energy consumer is India which uses 65% coal as a portion of primary energy in fiscal year 2018. In Bangladesh, gas reserves serve the most of its primary energy demand, i.e. 70%. There are a number of reasons which makes it liable to use gas in different economic and social sectors like massive local gas reserves, lower cost and properly designed pipelines. Pakistan is also dependent heavily on its gas reserves, i.e. a total of 48% of primary energy in its fiscal year 2018, although because of some local supply issues as well as growing confidence on foreign LNG, i.e. imported, its usage has tempered. Thus, almost all the countries have less diversity in their energy mix.

Strong focus on imports: All the South Asian nations trusted in and continued their energy journey dependent on foreign reserves, i.e. the imports, instead of utilising their own domestic reserves of renewable energies. One of the main reasons of being dependant on heavy imports is the absence of refinery infrastructure in the region (except India). In countries like Pakistan and Bangladesh there is a growing concern about the energy security after rapid reduction in their domestic gas production.

Limited focus on renewable energies development: despite having an abundance of renewable energies in the region, use of resources like wind and solar is poor in all the countries. This also imposes a negative impact on their currency exchange due to heavy foreign debts and huge bill of energy imports.

Lack of intra-regional energy trade: There lies a gap in energy trading which is reduced to only POL and electricity. Insufficient regional harmony and strong economic

progression are the main factors responsible for bringing about a minor renewables portion in the region's energy mix, despite having ambitious energy targets. The current statistics about the trade between different regional countries in electricity is as; Bhutan (sells 1,450 MW) and India; India (600 MW) and Bangladesh; and India (300 MW) and Nepal. An absence of intra-regional gas pipelines is greatly felt in the region. India, also exports its oil and petroleum products to different countries including Bangladesh (only for diesel), Sri Lanka, and Nepal. However, among the nations, the extend of trade is insignificant concerning their volume of energy use and the traded POL. In order to connect two or more countries of the region, vast development of intra-regional trade for energy via India 's power transmission system, power interconnection between adjacent countries, and transmission of gas and oil using the structured pipelines is needed. A little investment in renewable energy remains a major challenge. This is due to the huge initial costs, and little monetary benefits from these projects that may further take time to emerge. All the countries have started to work for the proper execution of its crude oil and POL imports from nearby countries. It is essential to realize the scale of energy, which is to be traded to examine the impact of imports. Bangladesh has started to import LNG in year 2019 and, therefore, has also signed SPAs with countries including Oman, Indonesia, and Qatar. The imports in LNG for India, Pakistan and Bangladesh are expected to grow. These challenges can be summarized as under:

Summary of technical, economic, and policy challenges:

- No financial incentives for privatized segment, and varying rules and regulations.
- No feed-in tariff model.
- Fossil fuel aids or subsidies.
- Weak and little importance to renewable governance energies in overall planning and poor operational agenda.
- Lack of technical capacity for designing; installation; operation; management and maintenance in renewable energy services
- Technical deadlocks for reliable and a widespread mapping.
- Lack of domestically manufactured equipment.
- Absence of safety & standards, and SOPs in the technical domain.
- Drawback in the economy, such as small-scale economy, huge initial costs, and a long time for repayment.
- Absence of funds and credit from the government.
- Lack of knowledge on market potential.
- User end level involves high installation costs.
- High chances of risks and uncertainties.
- Fragmented information and data about funds, equipment, RE resources, technologies, and engineering aspects.
- Inadequate expertise in business management and marketing skills.

SWOT analysis of the region's energy sector is given in Table 2. The SWOT analysis demonstrate that to start a clean, and green energy mix, nations will have to prepare for several challenges and to gain various opportunities.

V. POLICY IMPLICATIONS

To achieve sustainable future energy mix, SAN-3 could help by taking measures to limit the use of fossil fuels and lowering the subsidies for fossil fuels. The countries need to implement renewable energy (RE) expansion plans and programs for energy efficiency, developing a regional incorporation at the greater scale and connectivity in the energy sector. For uplifting the economy, the governments must bring in new investors for developing renewable energies. An appropriate energy policy can help the South Asian countries to fix the issue of energy deficit. Economic conditions can be improved by giving localized and domestic renewables access by authorising different groups and people to regulate energy supply, reducing prices with enhanced occupation. Emissions from natural gas in terms of power generation to that of a coal plant is about 40–50%. Thus, coal plants are to be upgraded to natural gas plants, i.e. gas plant for short term and renewables plants for long term to cut short the growing emissions from power generation.

Energy efficiency in Bangladesh would lead to a decrease in fuel imports for generating electricity meaning a potential saving of BDT (Bangladeshi taka) 2.3 trillion by year 2030 [117]. Annual savings are estimated to be 15% of total GDP, i.e., almost BDT 135 billion [117]. Problems related to land shortage and grid stability should also be properly examined before the national grid integration. There is a small proportion of the total production of renewable energy sources i.e. less than 2 percent. Bangladesh's government is attempting to promote the utilization of renewable energy sources and is formulating a policy on renewable energy [118].

In India, power sector has been governed through the 2003 Electricity Act, which gives the laws related to natural gas and petroleum, trading, generation, transmission, distribution, to ensure electricity supply to all areas. The solar energy is anticipated to be the most practical choice in the future, as its unsubsidized cost will be inexpensive than the other fuels. However, to create a better cost-effective strategy, the present tariff strategy focused on the accelerated depreciation demands amendments. Therefore, it decreases tax liability for a shorter period, but on the other hand, it comes to be very concerning when the value of assets largely depreciates.

Pakistan has been faced with some challenges in its energy policy in terms of development and implementation plan. Pakistan possesses a subject-wise sub-policy for its energy sector. A new plan is set in which Pakistan aims to produce 20% capacity as RE technologies by 2025 and 30% capacity by 2030 (20×25 and 30×30 target) instead of installing projects related to Renewable Energy on a reactive basis [25]. Together with 30% of hydel generation, as compared to the heavily dominated mix of imported fossil fuels in the former

TABLE 2. Swot analysis.

Strengths	Weaknesses
Enriched with low carbon energy resources and renewable energies	Massive capital investment required
Well-developed maps of renewable energies are available	Ignored underprivileged areas within the countries
Gaining interest of private investors.	Dominant resources of fossil fuels
INDCs to mitigate GHG emissions.	Unavailability of efficient DC operated appliances.
Presence of a strong institutional framework.	Absence of highly skilled and trained workforce.
Low cost of O&M	Inefficient management of biomass
A massive agricultural potential	Variety of problems related to biomass
Approved local biogas technologies and successful testing	Developing solar powered home energy systems
Availability of agricultural and industrial biomass on a massive scale	Excessive time required for projects execution
	Deterioration of existing physical structures due to culture of low maintenance; Lack of political and government will

Opportunities	Threats
Enhancing technology with increased efficiency	Utilization of conventionally evolved technologies
Planning and development of small-scale micro-grids	Absence of incentives given to micro and mini installations
Enabling environment under multi-billion project China	Lack of sources by the selection of improper sites for renewable power plants
Pakistan Economic Corridor (CPEP), for Pakistan	Ill-conditioned power grid to accommodate renewable energies
Beneficial usage of waste biomass	Improper policy framework for forest lumber accumulation through harvesting.
Providing electricity to rural areas.	Uncertain fluctuations in the price of biomass
Availability of biogas in rural areas	Absence of locally manufactured equipment and the related technologies
Slurry fertilizer available.	Increasingly growing environmental deterioration
Small-scale, i.e., mini, and micro-hydro potential.	Lack of political stability
Management of flood risks.	Extensive subsidies on fossil fuels
Expansion of existing dams	
Increased supply-demand gap	
Significance to enhance regional energy trade	
Appropriate climate for the successful operation of bioclimatic criteria	

Recommendations
Effective implementation of regulating principles
Promoting the need of small-scale distributed energy resources
To bring reforms for the stressed energy markets and networks
National focus on the energy security criteria in view of the clean and affordable energy mix
To implement standards for energy efficiency in the industrial sector
A political and governmental will for creation and capacity building
To ensure effective security criteria for infrastructure and personnel
To develop trust and confidence building for foreign investors
To design and develop new products and technologies as per international standards.
To use scientific methods for appropriate site selection for RE plants without political influence
Providing good incentives and subsidies to each level of installation
Farmers must be given educated on possible use of crops residue for power generation instead of burning in the atmosphere
To offer awareness to the people by educating them
Briquetting and palletizing machines should be introduced by the government in order to make the process easy

years, this goal will give the most affordable, less polluted and environment-friendly mix of energy.

An absolute regional interconnection is required for the development of readily available but unevenly spread resources of low-carbon and a weak energy market incorporation because of fossil fuel subsidies and the national security. Comprehensively focused, and coherent guidelines which complement the global climate change regulations should be designed to move towards energy security. Reduction in limitations that are non-economic may include regulatory bodies, hurdles, problems with grid, fuel subsidies, and lack of capability. The countries must move towards development of South Asian Power Grid for the greater cooperation and incentives for RE promotion. The legislators must design policies to account for some other or new productive uses of electricity beyond its traditional consumption patterns.

There are some direct and institutional strategies that offer technical support such as the promotion of energy efficiency; renewable energy; practising a cleaner use of coal; reforms to subsidize fossil fuel and augmentation of energy market. The indirect strategies that can technically support include political will and capacity building; a change in the energy security paradigm; and a little trust and hope in political institutions.

Importantly, to successfully conduct cross-border trade, the development of appropriate infrastructure is very important. The countries of the region, which includes Nepal, India, and Bhutan, have already taken some initiatives in this regard. A back-to-back 400 kV HVDC link between India and West Bengal has started, namely, Cross-border Electricity Trade (CBET) with the new addition of 500 MW of capacity. In February 2016, a 100 MW of power transfer was commissioned to Comilla located in Bangladesh from Tripura, located in India. At present, Bangladesh receives an imported diesel from India using a rail route. Whenever there is an approaching parity between the demand and the capacities between the neighbouring countries, it becomes very easy to have a running inter-country trade. Such arrangements are further liable to accomplish even more as in case of India-Bangladesh, India-Pakistan. An energy cooperation and trade among the nations can bring significant changes to sustainable energy mix.

VI. CONCLUSION

Over the next decades, energy demand for South Asian countries would increase enormously due to rapid urbanization, surge in population, geographical advancement, and continuous economic growth. It is visible that coal dominates energy sector in India, Pakistan, and Bangladesh are dependent on fossil-fuels and natural gas. As drawn by SWOT analysis, the region has to encounter several challenges and use some effective prospects to develop energy via RE sources for a sustainable energy mix. The advancement of abundant but unequally distributed resources of low carbon requires regional interconnection, which is given less attention by the stakeholders of the countries. With the help of the identified challenges and the proposed strategies, all these South Asian countries can ensure reliable energy mix through encouraging effective utility of fossil fuels, embracing RE sources and effective energy policies, promoting regional energy cooperation, energy market integration. Although, the countries are attempting to implement their energy vision with a main emphasis on the environment, it is considered challenging for the developing nations to ensure security of their increasing energy demand with a paradigm shift to renewable energy development. In Bangladesh and Pakistan, prospects for growth and development are huge but their current economic situation is not that sound to support such ambitious energy projects without foreign direct investment and funding for international monetary bodies. Importantly, energy access to remote and rural areas of the countries can be safeguarded by fostering dispersed power generation and developing mini grids in the region.

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