

Energy

Energy is an integral part of the economic order of Pakistan because energy demand and economic growth share a tight bond. Pakistan is overcoming a severe energy crisis that has directly and indirectly affected all sectors of the economy especially in terms of the evolving energy-mix. The energy side bottlenecks have corroded the economy of the country in the past as well. To fix such congestions and bottlenecks for the smooth delivery of energy services, massive projects with great political optics were incorporated to the supply side in between years 2013-18, adding a cumulative capacity of 12,230 MW. Although the added capacity has helped ease the bottlenecks at generation side, yet the transmission and distribution side congestion and inefficiencies has hampered the sustained delivery of energy services. Additionally, the higher energy prices in the current times as well as in the near future, are a bi-product of such aggressive capacity additions during 2013-18.

Prime Minister (PM) formed task force on Energy to propose immediate, medium and long-term policy interventions with the aim to provide indigenous, affordable and sustainable energy for all. Further, National Transmission and Dispatch Company (NTDC) has prepared and submitted Indicative Generation Capacity Expansion Plan (IGCEP) 2018-40 to National Electric Power Regulatory Authority (NEPRA), the electricity regulator. This expansion plan is a part of the Integrated Energy Plan, which will include power, as well as petroleum demand and supply plans until 2047. Such evidence based policy instruments and documents are momentous achievements for the entire power sector of Pakistan. The plan envisaged transformation of power generation sector from thermal production to renewables and nuclear power. In this context, looking ahead until 2047 one can learn a lot from the previous few decades of primary energy supplies and how the energy mix of Pakistan has evolved over time.

In term of energy-mix, Pakistan reliance on oil reached 43.5 percent in FY1998 and FY2001. For the FY2018, oil reliance has reduced to 31.2 percent. Similarly, hydro had a 13.1 percent share in FY1998, which is standing at 7.7 percent in 2017-18. Though the declining share of oil is a welcoming sign due to less burden on the national exchequer, the diminishing share of hydro represents the shortsightedness of policy as well as the inability of successive governments to undertake such capital-intensive projects in a timely manner.

Pakistan dependence on natural gas reached an all-time high of 50.4 percent in FY2006 in the overall energy mix. For the FY2018, reliance on gas has reduced to 34.6 percent. This reduction of share in the energy mix is somewhat attributed to declining natural gas reserves as well as restricted consumption of gas in the transport industry and the induction of LNG since 2015. The share of imported LNG has increased from 0.7 percent in FY2015 to 8.7 percent in FY2018, which represent a magnanimous increase of the said fuel in an energy mix. The share of coal has remained in single digit percentages over the last two decades. However, this FY2018 has recorded a high of 12.7 percent coal consumption in the energy mix. Likewise, the share of renewables was recorded to be 0.3 percent in the year FY2015, which was steadily increased to 1.1 percent in FY2018. The share of nuclear on the other side has steadily increased to 2.7 percent in FY2018 compared to 0.2 percent in FY1997. Such historical variability for each energy source in the energy mix of the country has been used to formulate the Integrated Energy Plan. The Integrated Energy Plan will not only help in

envisioning the energy demands and respective supply paths of the future but also to formulate evidence based long term policy options.

Global and Regional Perspective

A look at International Energy Agency (IEA) Global Energy forecast (World Energy Outlook 2018) highlights that the fastest energy growth will occur in Africa followed by Middle East and then Asia Pacific. The next in line is the Central and South America, which will experience tremendous growth. In contrast, electricity demand in Europe and North America are each expected to increase much lesser but still be in positive account with regard to a double-digit growth.

Regionally, primary energy demand in the Asia Pacific region is expected to grow by over 40% to 2040, based on the IEA's central scenario, accounting for two-thirds of the global growth. China's blue sky policy, the enforcement of coal-to-gas switching, and the structural shifting in China's economy to a consumer base from an industrial base; all represent the shifting trends of the regional market leader.

In the western world, the increase in energy demand due to higher living standards is offset by energy efficiency gains borne by the use of energy efficient technology and energy conserving programs and policies. Thus, global energy supply is seeing a shift towards renewable energy growth and a transitioning and resilient grid. The developed countries are restructuring their energy systems to integrate distributed energy in general and renewable energy in particular, with visible changes being made on the technological front through switching to low carbon technology to mitigate and adapt to the climate change.

Vision of the government: A broader picture

Pakistan energy requirements are increasing rapidly. The government is focused to ensure availability and security of sustainable supply and delivery of energy service along with the development of natural resources and minerals. Ensuring energy security with affordability and universal access based on indigenous resources is the goal of the current government.

Pakistan is blessed with enormous hydro and coal potential, which, if carefully exploited, can ensure our future energy security on long-term basis. Utilizing distributed resources in indigenous capacity while meeting the demands of volatile economic sine curves of growth and development, require a perspective of sustainable energy utility with resilience and adaptive capacity at core and at large. The Ministry of Energy is tasked with expansion in the capacity of delivering energy, requiring supporting expansion in the transmission infrastructure for evacuation of the power. The government has encouraged local and foreign investment in the generation, transmission and distribution supply chains of the delivery of service to fuel the economy.

Anti-theft campaign

The immediate focus of the government has remained on reducing the losses and increasing effectiveness of the whole value chain. Launch of Anti-theft campaign with the formation of special task forces in Punjab and Khyber Pakhtunkhwa has been launched since 13th October, 2018. Within a short span of 3 months (September to November 2018). A total of 6880 cases were detected resulting in registration of 1441 FIRs with the amount of detection bill charged reaching PKR 267.571 Million.

Power Division, Ministry of Energy has given a target to DISCOs to recover PKR 80 billion from old receivables while freezing the receivable figures as they stood on 31st October 2018. Further, DISCOs have been given a target to recover another PKR 60 billion by controlling theft and improving governance and efficiency.

Activities boosting the efficiency of governance of the power sector has already started across Pakistan and showing positive results. Reducing losses, increasing efficiency and recovering the receivables provides much needed financial cushion to the already burdened power sector with subsidies. Along with other subsidies; Industrial support package (ISP) subsidy has been continued at PKR 3 per unit for industries while for five main exports oriented industries (zero rated industry), the tariff has been capped at the rate of US cents 7.5 per unit for electricity and USD 6.5 per MMBTU for RLNG. The government's support to Industrial sector aims to boost the manufacturing activity and help to enhance exports of value added products. It also aims to stimulate economic activity leading to greater job opportunities in the country. Additionally for our vulnerable farmers, agricultural tube well subsidy in Baluchistan has been extended until the end of calendar year 2019 while for the rest of the country the subsidy has been extended at a lesser rate of 5.35 PKR per unit.

The activities aimed at improving efficiency and reducing losses of the power sector, in the long run, will help in setting off of the impact of Industrial support package (ISP) subsidy, thus providing more flexibility to the national exchequer. The government has a policy understanding of pro-consumer tariff determination and on war footing has also released PKR 130 billion as subsidy for the agriculture and industrial sectors along with tariff differential subsidy.

As far as reducing losses and increasing effectiveness are concerned, advance technology is to be deployed as a policy measure. As such, advanced metering infrastructure is being launched with the help of \$ 400 Million committed for the first phase by Asian Development Bank (ADB). Customer Complaint Management System has resolved 81,174 out of the 82,189 received complaints. Removing the constraints for efficient transmission, the ministry has identified 40 major areas and has divided the respective work into different phases. In addition to reducing losses, a massive sum of taxpayer money is being spent on the subsidy of 30,000 tube wells in the province of Baluchistan. A feasibility is being undertaken on the prospects of solarization of agri-tube wells thus providing off grid solutions and reducing the burden on taxpayers.

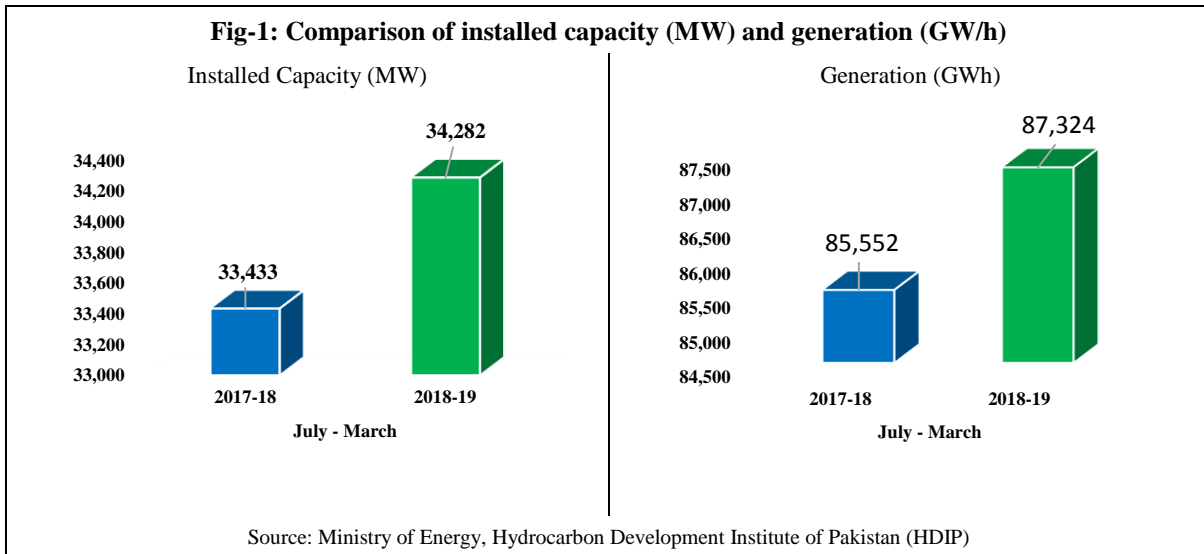
Long-term Policy frameworks for renewable energy, national electricity planning and forecasting the demands of energy until 2047 is being done for 100 Pakistan.

Generation Capacity and Energy Mix

Oil-based power generation plants which remained the face of the power sector of Pakistan for over three decades, have been planned to be phased out over the next few years and it is expected that the share of furnace oil-based energy will decline to single digit percentage in the overall energy mix in the coming years. On the other hand, Pakistan has large indigenous coal reserves estimated at over 186 billion tons which are sufficient to meet the energy requirements of the country on long-term basis. Apart from indigenous coal resources, there has been significant increase in import of coal as well due to commissioning of new power plants based on imported coal at Sahiwal and Port Qasim. However, domestic production of coal is expected to increase in the coming years with projects on Thar coal.

Hydropower plants are considered one of the most capital intensive projects and for a country like Pakistan, it is not possible to undertake such big projects without the financial support of international development agencies — a fact which brings in its own share of peculiarities and challenges.

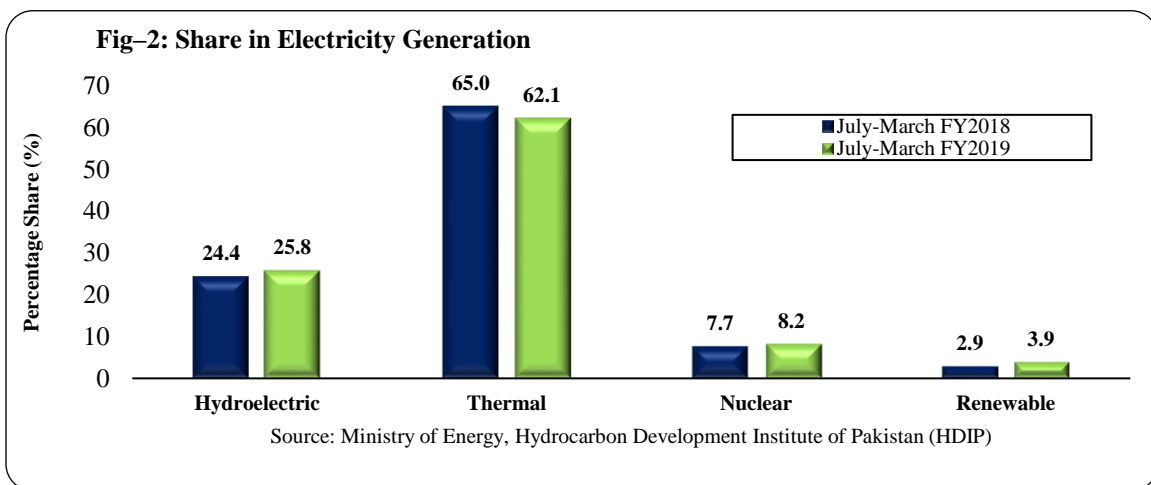
During July - March FY2019, installed capacity of electricity reached 34,282 MW, which was 33,433 MW in corresponding period last year, thus, posting a growth of 2.5 percent. Although electricity generation varies due to availability of inputs and other constraints, the generation increased from 82,011 GWh to 84,680 GWh, posting a growth of 2.1 percent during the period under discussion. Figure-1 gives the comparison of installed capacity (MW) and generation (GWh).



Share in Electricity Generation

As far as the share of different sources of electricity generation is concerned, it can be observed that the share of hydro in electricity generation has decreased over the last few decades. Availability of water is also one of the main reason for reduced generation from hydel power plants. Currently, thermal has the largest share in electricity generation. Gas and RLNG are other cheaper sources. RLNG tremendous growth in energy mix has helped supply the demand to various power plants (Bhikki, Haveli Bahadur Shah, Balloki, Halmore, Orient, Rousch, KAPCO, Saif and Sapphire) while, the remaining was supplied to fertilizer plants, industrial and transport sector.

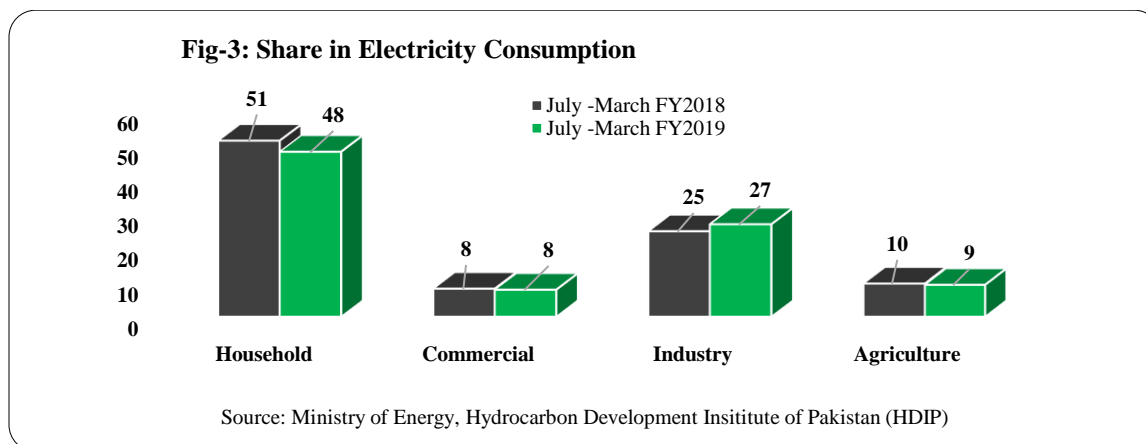
As an alternate, the government showed commitment for electricity generation capacity through renewable energy sources. During July - March FY2019, there was an increase of 1 percent in share of renewables in electricity generation, and it is expected that the share will increase in coming years as well. The comparison of share of different sources of electricity generation is given in Figure-2:



Electricity Consumption

Regarding consumption pattern, there is no significant change in the consumption pattern of electricity. However, during July-March FY 19, the share of household and agriculture in electricity consumption has been decreasing which is indicating that people are trying to rationalize the usage

due to increase in its tariff. The increase in the share of industry in electricity consumption is a positive sign showing revival of industry which was suffering earlier due to load shedding. The comparison between consumption patterns of electricity during July - March FY2019 with corresponding period last year is shown below in Fig-3:



Oil (Petroleum Product)

Pakistan mainly depends upon oil and gas resources to fulfill energy requirements. The domestic production of crude oil remained 24.6 million barrels during July - March FY2019 compared to 21.8 million barrels during the corresponding period last year. Indigenous resources of oil are not enough to quench energy thirst of a growing economy. As a result Pakistan has to import large quantity of oil as well as oil based products from Middle Eastern countries especially from Saudi Arabia. During July - March FY2019, the quantity of crude oil imported remained 6.6 million tons with value of US \$ 3.4 billion compared to the quantity 7.8 million tons with value US \$ 2.9 billion during the same period last year. The decline was mainly due to increase in international prices. The deferred payment on imported oil from Saudi Arabia will give an ease to the government on balance of payments.

Transport and power are the two major users of oil. During July - March FY2019, share of oil consumption in transport increased to 77 from 56 percent during the same period last year, while share of oil consumption in power decreased to 14 percent during July - March FY2019 which was 25 percent during the same period last year. Mainly, gas being the cheaper source, there is continuous shift of power sector from oil to gas.

The indigenous and imported crude is refined by six major and two small refineries.

Efforts to bring improvement in existing refineries as well as attracting foreign investment in this sector include but are not limited to:

- ▶ Byco Oil Pakistan Limited (Byco) has established an Oil Refinery at Hub, Balochistan with refinery capacity of 120,000 Barrel Per Day (5 million tons/annum) at cost of US\$ 400 million. Byco has also installed Single Buoy Mooring (SBM) facilities for transportation of imported Crude Oil and petroleum products from ships to the storages tanks. The capacity of said facility is 12 M. tons per annum.
- ▶ Attock Refinery Limited (ARL) has started producing Euro-II (0.05 % Sulphur HSD) Further, the refinery has also installed isomerization plant and enhanced the production of Motor Gasoline.

- ▶ Pakistan Refinery Limited (PRL) has also installed isomerization plant in 2016 and since then has doubled its production of Motor Gasoline.
- ▶ Pak Arab Refinery Limited (PARCO) is implementing PARCO Coastal Refinery project at Khalifa Point, near Hub, Balochistan, which is a state of the art refinery having capacity of 250,000 barrels per day (over 11 Million tons per annum). Estimated cost of the project is over US\$ 5 billion.

Natural Gas

Natural Gas is a clean, safe, efficient and environment friendly fuel. Its indigenous supplies contribute about 38% in total primary energy supply mix of the country. Pakistan has an extensive gas network of over 12,971 Km Transmission 139,827 KM Distribution and 37,058 Services gas pipelines to cater the requirement of more than 9.6 Million consumers across the country. Government of Pakistan is pursuing its policies for enhancing indigenous gas production as well as imported gas to meet the increasing demand of energy in the country. At present, the capacity of two Floating Storage and Regasification Unit (FRSU) to Re-gasified Liquefied Natural Gas (RLNG) is 1200 MMCFD and accordingly RLNG is being imported to mitigate gas demand-supply shortfall. The average natural gas consumption was about 3,865 Million Cubic Feet per day (MMCFD) including 785 MMCFD volume of RLNG during July 2018 to February 2019. During July 2018 to February 2019, the two Gas utility companies (SNGPL & SSGCL) have laid 69 Km Gas Transmission network, 3,232 Km Distribution and 1,366 Km Services lines and connected 165 villages/towns to gas network. During this period, 428,305 additional gas connections including 425,404 Domestic, 2,770 Commercial and 131 Industrial were provided across the country.

It is expected that Gas will be supplied to approximately 430,695 new consumers during the fiscal year 2019-20. Gas utility companies have planned to invest Rs. 7,161 Million on Transmission Projects, Rs. 48,288 Million on Distribution Projects and Rs. 18,556 Million on other projects bringing the total investment around Rs. 74 billion during the fiscal year 2019-20.

For viable growth of this sector, Government has approved provision of RLNG to this sector with fiscal incentives of gas infrastructure development cess (GIDC) at the rate of zero and Sales Tax at the rate of five percent.

Table – 1: Average Sector Wise Natural Gas Consumption in Million Cubic Feet per Day (Mmcf) (July 2018 – Feb2019)

Sector	Gas Consumption in MMCFD	RLNG	Total
Power	865	546	1,411
Domestic	889	-	889
Commercial	84	5	89
Transport (CNG)	136	47	183
Fertilizer	621	24	645
General Industry	485	163	648
Total	3,080	785	3,865

Source: Ministry of Energy, Directorate General Gas

Nuclear Energy

Pakistan Atomic Energy Commission (PAEC) is the sole department in Pakistan engaged in electricity generation using nuclear technology. There are five nuclear power plants operating on two sites in the country, one unit namely, Karachi Nuclear power plant (KANUPP) at Karachi and four units of Chashma Nuclear power plants (C-1, C-2, C-3, C-4) at Chashma (Mainwali District of Punjab Province). The gross capacity of these five nuclear power plants is 1,430 MW that supplied about 7,267 million units of electricity to the national grid during 1st July, 2018 to 31st March, 2019.

KANUPP, the oldest of the nuclear power plants, has now completed 47 years of safe and successful operation. The four units of Chashma are amongst the best performing electricity generating plants in the country, in terms of endurance and availability. Some performance parameters of these operating plants are presented in the following table:

Table 3: PAEC's Performance Parameters

Plant	Capacity (MW)		Electricity sent to Grid (Million KWH)	
	Gross	Net	1 st July 2018 to 31 st March, 2019	Lifetime upto 31 st March, 2019
KANUPP	100	90	88	14,472
C-1	325	300	1,501	37,129
C-2	325	300	1,926	17,888
C-3	340	315	1,822	5,646
C-4	340	315	1,930	3,695
Total	1,430	1,320	7,267	78,830

Source: PAEC

There are two more units being constructed near the KANUP site Karachi, the Karachi Nuclear Power Plants-2 & 3 (K-2 & 3). First concrete of K-2 was poured on the 20th August, 2015 and that of K-3 on the 31st May, 2016. Work on the construction of these nuclear power plants is progressing according to schedule and the K-2/K-3 plants are likely to complete on time. In FY2021, PAEC is planning to intensify its activities to meet the nuclear electricity generation target of 8,800 MW by the year 2030 set through government's Energy Security Plan formulated in 2005. Completion of K-2/K-3 project will be a big step that will bring PAEC 2,200 closer to achieving this target. PAEC is planning to develop additional sites to house more nuclear power plants in future with the sites identified throughout the country being investigated and acquired for development.

Technical and engineering infrastructure is in place to support the existing, under construction and future nuclear power plants. This infrastructure is based on indigenous institutes imparting state of art training and education in all relevant disciplines and at all levels, from technical training to academic programs.

Coal

Massive energy resource in shape of coal exists in the country and further exploration in different areas is continued but only a fraction of it is being utilized. Shifting power generation to country's indigenous coal will help Pakistan gain momentum on the road to sustainable development. All four provinces have coal reserves but the significant deposits are located in Thar, Sindh. Coal mining currently being done in Balochistan, Sindh, Punjab and Khyber-Pakhtunkhwa mostly comprises small-scale operations. The country's first large-scale coal mine (3.8 million tons per annum) along-with integrated power generation plant (2x330 MW) has been recently made operational at Thar coalfield. The production and import data for the period from July 2018 to June, 2019 has been estimated for the first half of this financial year. Details are tabulated as under:

Financial Year	Domestic Coal Production		Coal Import		Total Supply	
	Million Tons	Million TOE	Million Tons	Million TOE	Million Tons	Million TOE
2017-18	4.30	1.92	13.70	9.00	18	10.92
2018-19 (Estimated)	5.50	2.46	15.50	10.19	21.00	12.65

Source: Ministry of Energy, Mineral Wing

In coming years, local coal use should be promoted to achieve larger contribution. Thar coal utilization is accorded strategic importance. Many coal mining and power generation projects are in

process of development in Thar coalfield. Imported coal-fired power plants may also be required to consider mixing with Thar Coal. Spontaneous combustion is a potential problem for long distance transportation and long-term storage, and thus restricts Thar coal use as a downside.

Clean Energy

The Government of Pakistan is emphasizing on utilization of indigenous and environmentally clean energy generation resources. In this regard, the promotion of alternative and renewable technologies is amongst the top priorities of the Government. Several initiatives have been taken to create a conducive environment for the sustainable growth of the clean energy sector in Pakistan in order to harness the potential of indigenous renewable energy resources.

The development of large scale grid connected renewable energy based power generation projects are being pursued through private investors. The following progress has been achieved on development of renewable energy based projects during the fiscal year 2018-19 so far:

- ▶ Five (05) wind power projects of 246.6 MW capacity were completed and started supplying electricity to the national grid.
- ▶ Two (02) bagasse cogeneration projects of 58 MW capacity were completed.

In order to ensure sustainable supplies and energy security, the Government of Pakistan (GoP) is focusing on exploiting the abundant potential of wind and solar resources for power generation whilst keeping in view the best possible mode for benefiting with declining prices of renewable energy. Formulation of a new clean/renewable energy policy has been initiated with the aim of establishing a robust framework for creating a conducive environment for the sustainable growth of renewable and distributed energy resources in Pakistan. The GoP's strategic objectives of Energy Security, Economic Benefits, Environmental Protection, Sustainable Growth and Social Equity with indigenous resources will further be harnessed under the Renewable Energy Policy 2019.

Apart from on-grid, large scale renewable based power projects, smaller renewable energy applications are also being promoted for lighting purposes, water pumping, heating and power generation etc. As such, distributed energy generation and its synchronization with the grid includes our way forward.

Way forward

Pakistan has successfully removed bottlenecks on the generation side of electricity during previous government. However, congestion, inefficiency and lack of infrastructure on the transmission and distribution side of the supply chain has hampered sustained delivery of electricity and energy services. Furthermore, such aggressive capacity additions are now a fundamental part of our energy pricing mechanisms of near and medium term future. Contextualizing the aggressive capacity additions of previous governments will help us guide our way forward in addressing the capacity payment issues of near to medium term future.

Integrated Energy Plan, which details the demand projections from power as well as petroleum divisions, will help in foreseeing the evolving energy mix as well as keeping the focus on indigenous resources. Such detailed planning will help us avoid issues of circular debt and capacity payments for future with evidence based policy interventions. Foreseeing our energy mix and dependence of our energy security on indigenous resources will need to be synchronized with our international obligations under Nationally Determined Contributions (NDCs) and Sustainable Development Goals (SDGs).

It is the focus of the GoP to provide sustainable energy for all. Furthermore, improvement of access to energy and off grid solutions will be provided to masses under the new renewable energy policy.

For the sustainable provision of such services, market forces as well as policy levers need to be harmonized accordingly. As far as market forces are concerned, business models of energy services companies (ESCO) and sustainable energy utility (SEU) should be developed and incentivized. Such market forces should be encouraged since it will provide jobs to the masses. On the policy levers front, up-gradation and modernization of the grid is necessary. A transitioning grid is a reality among developing and developed economies, where distributed energy resources and advanced technology need to be incorporated and harmonized with the existing grid. Additionally, policy handles need to be designed and processed while transitioning from a single buyer model to competitive markets. Further segregation of distribution companies on the basis of rural and urban divide as well as for the ease of administration will help ease the burden on distribution chain of the electricity sector. Similarly, on regulatory fronts, further closer cooperation between regulatory authorities of petroleum and power is integral towards our path to advanced energy economics and further democratization of energy sector.
