MEANINGFUL ENERGY TRANSITION IN PAKISTAN: MICROSCALE TO MACROSCALE

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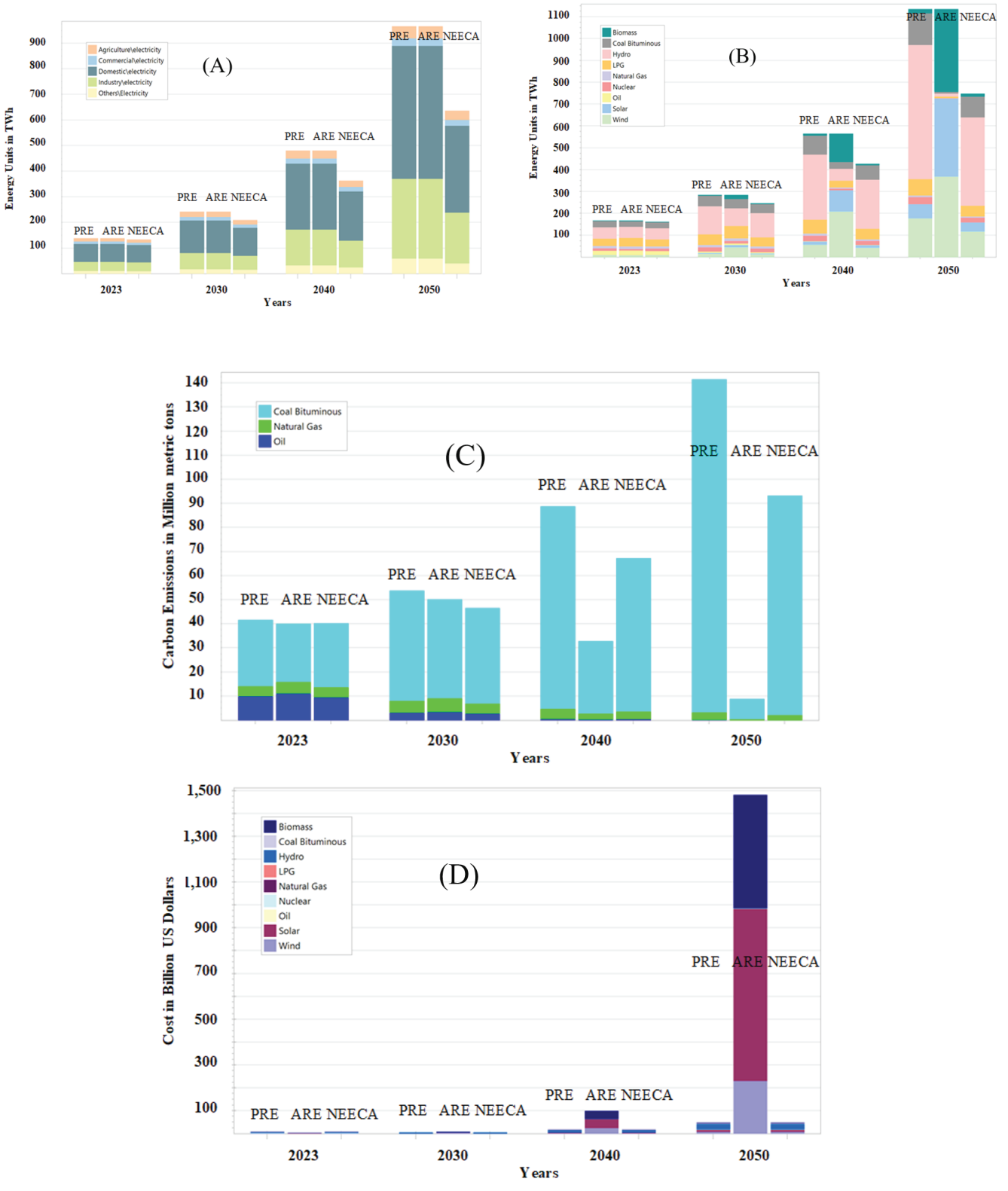
Sea level is rising and glaciers are melting as a result of increasing global temperature 1.5 0C above pre-industrial level. Other effects of climate change include drought and flooding, which uproot millions of people, plunge them into hunger, poverty, and prevent them from fundamental services like education and health, stifle economic growth, and even spark conflict. In order to save lives and livelihoods, it is imperative to take rapid action to stop climate change and its terrible impacts. It is also essential to implement the Paris agreement targets of climate change at national level and 2030 agenda for sustainable development and to meet the objectives of SDG-13. Under the Paris Agreement's targets of climate change, nations are developing climate action plans to reduce emissions. To fulfill the 1.5°C objective, a paradigm shift is under way in developed nations for achieving climate change targets by exploiting green energy potential but Pakistan's present national pledges are insufficient. This article presents the solution for Pakistan to overcome the negative effects of climate change for sustainable environment.

Pakistan is a developing country with tough political and economic conditions, posing a serious challenge to develop a policy that supports the energy transition from fossil fuels to renewables. Pakistan is blessed with a huge 3425.796 GW renewable energy potential including wind (346 GW), solar (2,900 GW), hydro (59,000 GW), geothermal (100 GW) and biomass (20 GW) despite the fact that Pakistan is producing electricity mostly from imported fossil fuels (coal, furnace and natural gas) with 58.8% share followed by 25.8% hydro, 8.6% nuclear and only 6.8% from solar and wind sources. Renewables contribute only 32.6% in the total energy mix of Pakistan. This article discusses the possibility of an energy transition from fossil fuels to renewables, in terms of the initiatives that will need to take place to make it possible in Pakistan with good benefits offered to all stakeholders in a manner that avoids environmental pollution. An important condition here is that that fossil fuel based power plants are shut before their economic lifetime ends.

Ministry of Energy (Power Division), Government of Pakistan developed a policy entitled, "Alternative and Renewable Energy (ARE) Policy 2019" with the aim of increasing the renewable capacity by 30% by 2030 with the majority of electricity produced from indigenous energy sources including biomass, wind and solar. However, this target cannot be achieved with the present transmission and distribution network. The Asain Development Bank (ADB) claims that with the exception of China, the countries under its Central Asia Regional Economic Cooperation (CAREC) project would have to invest from USD 25 billion to USD 49 billion to upgrade their power transmission and distribution infrastructure. If China is included, the cost goes up to USD 901 billion, as per predictions in a note from the CAREC Energy Outlook 2030. The ADB noted that the region, with the exception of China, needed around USD 340 billion in energy investments by 2030. If China is included, then investment needs were valued at USD 3.8 trillion. Pakistan also aims to have 20% electricity saving in all electricity consumer groups like domestic, commercial, industrial, agriculture and others under the National Energy Efficiency and Conservation Authority (NEECA) policy of 2023. This NEECA policy coupled with ARE policy will put Pakistan on a map of world with cleanest mix of energy.

This article suggests how clean energy targets should be achieved over the years until 2050 by using Low Emissions Analysis Platform (LEAP) software. Figure I shows results of overall energy demand, production, carbon emissions and systems cost for the period 2023 to 2050 under the three policies: present (PRE) policy, ARE policy of 2019 and NEECA policy of 2023. Present policy provides results on the basis of technical report pertaining to Pakistan's energy planning and policies including 2021 Indicative Generation Capacity Expansion Plan (IGCEP), Pakistan's Vision (2025), and China Pakistan Economic Corridor (CPEC). ARE policy of 2019 incorporated greater share of renewables and lower share of fossil fuels in total energy mix while NEECA policy of 2023 is geared to facilitating the use of efficient technologies for both renewable and non-renewable systems with 20% saving in all consumer groups. These three policies consider the Gross Domestic Product (GDP), population, number of households, past consumption of electricity and their growth rates.

Figure 1: Energy demand, production, carbon emissions and systems cost



The energy demand under the PRE and ARE policy is the same for the year 2050, i.e. 966.05 TWh. Energy demand of the domestic sector is 518.94 TWh in the year 2050, followed by industrial at 311.70 TWh, agriculture at 46.95 TWh, commercial at 29.62 TWh, and others at 58.85 TWh. The energy demand under the NEECA policy is found to be much less, at 635.85 TWh. The domestic sector consumed 339.09 TWh of energy, followed by industrial at 197.95 TWh, agriculture at 34.85 TWh, commercial at 23.07 TWh, and others at 40.87 TWh until 2050. Energy production is also estimated under the PRE, ARE, and NEECA policies for the study period from 2023 to 2050, as shown in Figure 1(b). The total production of energy in 2050 is 1135.20 TWh under the PRE and ARE policy while under NEECA policy, it is found to be 747.15 TWh. The share of hydro is greater under the PRE policy because the government wants to install more hydro plants in the future, whereas under the ARE policy, the share of biomass, wind, and solar is greater. NEECA policy incorporated the energy saving potentials, which ultimately reduces the power generation capacity. In the PRE policy, the hydro source has the greater contribution of 614.14 TWh in the total energy mix, followed by wind at 177.07 TWh, coal at 144.48 TWh, LPG at 75.57 TWh, solar at 64.61 TWh, nuclear at 32.74 TWh, biomass at 19.15 TWh, natural gas at 7.25 TWh, and oil at 0.19 TWh until 2050. Under the NEECA policy, the hydro source has a greater contribution of 404.21 TWh in the total energy mix, followed by wind at 116.54 TWh, coal at 95.09 TWh, LPG at 49.74 TWh, solar at 42.53 TWh, nuclear at 21.55 TWh, biomass at 12.60 TWh, natural gas at 4.77 TWh, and oil at 0.12 TWh until 2050. Finally, under the ARE policy, 30% contribution of biomass, wind, and solar will be incorporated into the total energy mix by 2030. If this trend proceeds until the year 2050, biomass contribution in the total energy mix will be 378.80 TWh, followed by wind at 368.56 TWh, solar at 356.70 TWh, hydro at 13.82 TWh, coal at 8.83 TWh, LPG at 6.45 TWh, nuclear at 1.94 TWh, natural gas at 0.88 TWh, and oil at 0.02 TWh.

Carbon emissions of fossil fuels are also forecasted for the study period 2023 to 2050, as shown in Figure 1(c). Under the PRE policy, coal produced 138.27 million metric tons of carbon emissions, followed by natural gas producing 3.17 million metric tons and 0.10 million metric tons by 2050. Under the NEECA policy, energy demand and production are reduced by incorporating energy efficiency measures, so carbon emissions are also reduced to some extent, but coal still contributed more, around 91.01 million metric tons, which was followed by natural gas, 2.09 million metric tons, and oil, 0.06 million metric tons by 2050. Under the ARE policy, coal will produce 8.45 million metric tons of carbon emissions, followed by natural gas, 0.38 million metric tons, and oil, 0.01 million metric tons, by 2050. The investment cost required to implement the energy systems is also forecasted, as shown in Figure 1(d).

In the PRE and NEECA policies, investment costs required lesser because the existing capacity will deliver power until 2050, and some new plants will also be installed to meet the energy demand of the nation. The greater investment cost required for the development of a hydro plant is USD 23.96 billion; solar, USD 9.47 billion; wind, USD 7.85 billion; coal, USD 3.14 billion; biomass, USD 1.27 billion; and nuclear, USD 1.10 billion until 2050. Under the ARE policy, the development of solar power plants requires a greater investment cost of USD 417.07 billion; biomass, USD 286.31 billion; wind, USD 147.11 billion; hydro, USD 1.41 billion; coal, USD 0.94 billion; and nuclear, USD 0.40 billion until 2050, respectively.

The switch from imported fossil fuels to indigenous renewable sources for energy transition is crucial for climate change. Indigenous renewable sources offer enormous potential for clean energy production, but it is yet not fully utilised for sustainable environment. However, this ambitious target of energy transition is discussed in this article and it is possible to achieve through a lot of planning and dedication by all stakeholders to achieve the clean and green environment in Pakistan.

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