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Deployment of renewable energy in the province of Punjab – Drivers and barriers

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Abstract: In this paper, drivers and barriers associated with deployment of solar, wind and hydro green energy generation in Pakistan's second largest province Punjab have been explored. Through extensive analysis, it is established that foreign investments in local projects, advancement in renewable energy (RE) technologies such as energy storage systems, reduction in carbon emissions, provision of net-metering, and significant cost and energy savings are key factors in driving the use of renewable energy systems in the region. On the other hand, barriers towards the deployment of renewable energy generation are equipment theft, lack of trained personnel, site conservation issues, lack of long term policy, high transaction costs, financial and institutional barriers and power sector transmission losses. In order to overcome these barriers, substantial action is being taken by the Government of Punjab in the form of training programs, revised legislation, monitoring of installed renewable energy projects and proposing more efficient models of renewable energy generation.
Keywords: Renewable energy, drivers, barriers, policy

1. Introduction

As a developing country, Pakistan is heavily dependent on power generated from fossil fuels. However, with growing energy demand, the government is keen to incorporate renewable energy resources to meet the needs of the growing population in a sustainable way. As part of the Glasgow climate pact (COP26), Pakistan has pledged to reduce the use of coal-fired power and eliminate subsidies on other fossil fuels. However, keeping in mind the practicality of this decision, it has been stated that the country will continue using domestic coal but will phase down and no longer have imported coal projects. Being a developing as well as a climate-vulnerable country, Pakistan has set an ambitious target of 50% reduction in emissions by 2030, based on the condition that the country receives $100 billion financing to help transition to clean energy (Qasim, 2021).

1.1 Punjab – the highest energy consumer

Punjab is one of the four provinces of Pakistan, also recognized as the world's fifth-most populous subnational entity. It houses major cities of the country and is an economic hub, recognized for its service and agriculture sectors. This provinces contributes most to the national GDP, and is a major consumer of electricity, with 70,504 GWh of energy reportedly consumed in 2020 (Ceicdata.com, 2021).

For this research project, the province Punjab has been selected as it presents an ideal combination of factors that should be considered while studying implementation of renewable energy technologies. The province experiences three major seasons (Hot summer, monsoon, cold harsh winters), is the center of a growing and populous country and it is also

accelerating towards urbanization and technological advancement. This scenario presents quite realistic parameters in determining the drives and barriers faced by the deployment renewable energy systems at both on individual and commercial scale. In addition, the province also houses large scale renewable energy projects and government initiatives which provide valuable data as to what measures worked in the past and what are the shortcomings of these projects.

1.2 Literature review

According to the Asian Development Bank, energy consumption in Pakistan has increased 7.7% annually from 2013 to 2018, and its expected compound annual growth rate (CAGR) is 5.8% by 2030 (Sadiqa et al., 2021). Despite having numerous renewable energy projects, the total installed capacity of solar and wind energy in Pakistan is ~1,500 MW, which comes to around 4% of the total capacity and only 2% of total energy generation (Worldbank.org,2020). Pakistan's energy mix is shown in figure 1. Figure 2 shows the electricity demand and supply of the country, as presented by the National Transmission and Dispatch Company (NTDC). Due to the COVID-19 pandemic, a decrease in energy consumption has been observed. However, this correlates with the negative economic growth in the country (ITA, 2022).

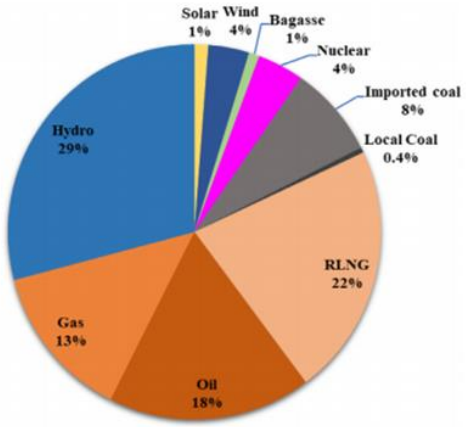


Fig 1. Power generation technologies mix in Pakistan in 2018 (Irena.org, 2018).

Fig 2. Electricity demand and supply for 2016 –2020 (Sadiqa et al., 2021).

Currently, renewable energy projects under different development stages in Pakistan include 856 MW solar, 2638 MW micro hydro, 297 MW bagasse and 1140 MW wind projects (cumulative capacity). On the other hand, operational projects are 98 MW mico hydro, 308 MW wind, 145 MW biogas and 100 MW solar (cumulative capacity). These projects give an optimistic outlook for achievieng the country's renewable energy targets (Kamran, 2018).

Over a period of 1.5 years, a study was carried out by Tractebel Engineering GmbH, analyzing the reneweable energy targets set by Pakistan's Governement i.e to increase Variable Renewable Energy (VRE) provision to 20% of the overall electricity mix by 2025 and 30% by 2030. As per the report, this can be achieved with a massive and immediate expansion in solar and wind power - at least 6,700 MW of wind power plants and 17,500 MW of solar photovoltaics need to be installed by 2030. For these projects, significant financing is also required. It is also suggested that power generation from uneconomic power plants should be reduced and investment should continue in hydropower (Schmitt, 2020).

The Tractebel Engineering report concludes that substantial investments in the grid are required to support energy transition away from domestic coal. 'Climate finance' could in

theory facilitate the rapid expansion of VRE, and can also assist in the introduction of concentrating solar power (CSP) and battery storage. With strong financing and investment support, the functional flexibility of large dams can also be increased, where previously hydropower was a by-product. Strong coordination and continuous effort is required at both federal and government level, in order to achieve the proposed introduction of VRE in the energy mix, which is ~24,000 MW of additional capacity by 2030. Investment is also needed in the transmission system, including new automation and control systems. With a clear capacity expansion plan, long term benefits of cost reduction, mitigation in external risks and lower GHG emissions can be achieved (Schmitt, 2020).

2. Methodology

The research study has been split into three parts, as detailed below:

- Part 1 – Exploring renewable energy systems present in case study province, establishing energy consumption pattern, power generation capacity, current RE projects (Government and individual) and related policies.
- Part 2 – Data collection through online surveys and interviews to determine end user perception of renewable energy resources, and goals and motivations of RE project producers and regulators (private and Government agencies).
- Part 3 – Critical analysis of data collected in order to determine drivers and barriers of RE deployment in the region. Analyzing both long term and short term factors affecting RE operation and future expansion.

3. Data collection

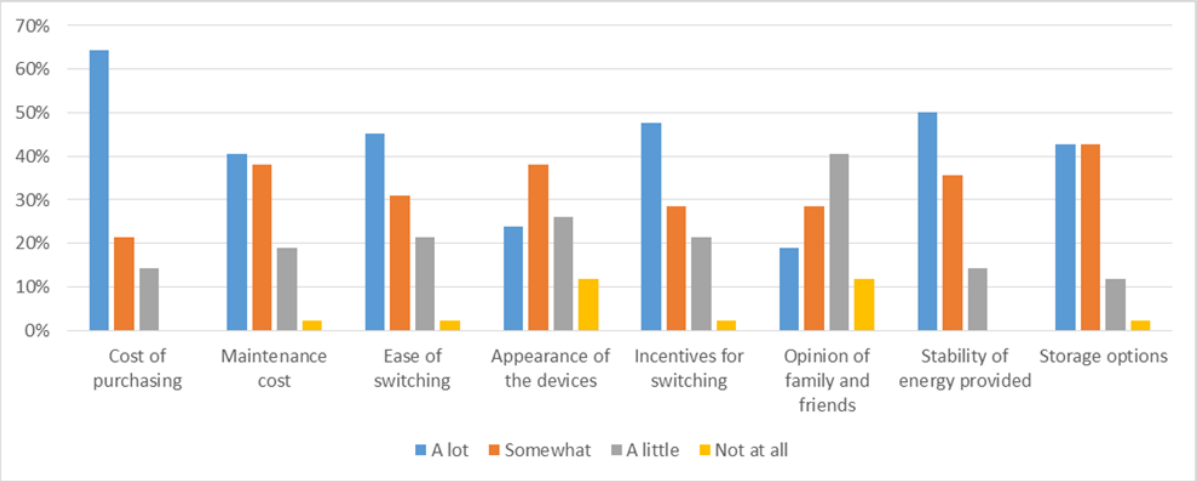
3.1 Survey data and analysis

A total of 142 research study participants completed the online survey. It is understood that the sample size is small. However, considering the time constraint and distance from the case study location, it is still an adequate response and can be utilized to understand the public perception of renewable energy in Punjab.

Around 90% of the sample population has basic knowledge regarding renewable energy systems. However, this could be because 78.6% of the respondents are students and full time employed professionals. As per the survey, 21.4% of the respondents have a monthly household income of PKR 200,000 (£834), while 19% households earn less than PKR 50,000 (£208). This reflects the financial situation of individuals living in a developing country such as Pakistan, where the average income is comparatively less.

Candidates were asked to give their opinion regarding factors that have the most influence when deciding the switch to green energy. The results are shown in graph 1. The cost of purchasing was rated the highest, with stability of energy provided, incentives for switching and ease for switching following suit. Participants showed interest in renewable energy if there are adequate financial incentives from the government, the energy generated is cheap and the installation process does not require a high investment. As per graph 1, the maintenance cost and storage options associated with the RE were given importance as well, as this defines the performance of the installed RE system. The influence of society, family and friends was rated minimal, with the appearance of RE devices receiving an average rating. Through this part of the survey, it was determined that the general population would be more receptive to renewable energy schemes if the installation/switching process was made easier, the technology and function of the installed RE system explained in simple terms and an

attractive cost benefit is present (as compared to when the consumer uses electricity from the grid).



Graph 1. Factors influencing the switch to green energy

3.2 Municipality interview

As part of this research study, an experinced project manager from the Energy Department (Government of Punjab) was interviewed. To provide insightful data for the study, the interviewee provided access to State of industry report 2021 and Climate interactive (An online simulation tool used to help policymakers, educators and the public in testing and exploring cross sector climate solution). Main takeaways from the interaction are: (1) The solarization projects running in Punjab are financially feasible and have performed well. (2) Net metering policy by NEPRA (National Electric Power Regulatory Authority) should be improved, so that surplus energy generated can be supplied to the National grid. (3) There are some misconceptions such as high cost per unit of green energy generated and inefficiency of installed solar power plants. (4) There are limited incentives provided by Government of Punjab for installing renewable energy systems.

4. Drivers of renewable energy development in Punjab

Many renewable energy projects relating to solar, wind and hydro are operational, at commissioning stage or being planned in the province of Punjab. Analyzing the data collected via literature and institutional reports review, end consumer feedback surveys and interviews, following are the drivers of RE projects identified in the region:

1. Foreign investments model: For commercial scale RE projects, foreign funding is received from entities such as the Asian Development Bank, USAID or other investors. A renewable energy program is then established, with well-defined project milestones and targets. Through this model, the deployment of commercial clean power generation plants has been completed successfully. However, each RE project is unique in nature (type of RE, location, site requirements). Therefore, it has specific energy agreements and net-metering policy from NEPRA.
2. Domestic on-site RE projects: Domestic consumers have taken upon themselves to install and use on-site power generation sources. This is an emerging trend in Punjab, as the residents are looking for alternate sources of energy as solutions to power cuts and rising electricity prices.

3. Net metering license: The government has enabled the regulatory process of net-metering licensing from NEPRA, which allowed solar panel owner to sell surplus energy to the grid. This further encouraged the shift to solar power generation.
4. Cost and electricity savings: With reference to table 1, RE projects have achieved significant annual electricity and cost savings, reduced greenhouse gas emissions and have provided clean and reliable energy.
5. Reduced carbon emissions: RE projects such as the installation of 100 MW solar power plant in Quaid e Azam solar park has reduced greenhouse gas emissions by 0.19 million tons. This in turn contributes to counter the adverse effects of climate change, and is considered a strong driver of RE projects in the region.
6. Economic development: Through foreign investments in renewable energy projects and energy infrastructure of a country, its energy security increases. This has a positive effect on the country's economy, due to provision of clean, reliable and sustainable energy as well as job creation at the regional level.
7. Advancement in battery storage technology: Large scale and on-site RE projects both use advanced storage technologies which assist in providing a reliable source of energy and store surplus energy for later use. Through effective storage options, higher shares of solar and wind renewables can be introduced to the energy mix.

5. Barriers towards the deployment of RE projects

Through data collected, following barriers and obstacles have noted in current operational RE projects in Punjab. Solutions to these issues, where applicable, have also been discussed alongside.

1. RE equipment theft: For the solarization projects located in Punjab, especially in rural areas, the security of the installed system needs to be robust, as there is risk of solar PV panels, copper wires and storage equipment being stolen. As a security measure, motion detectors, alarms and perimeter fence can be installed. Cable locks are also an effective way of securing commercial solar PV panels.
2. Lack of awareness: Information regarding renewable energy projects is not as well-known as one may perceive. This leads to lower community participation and private investments in local RE projects. There is also lack of trained professionals who can effectively carry out the operational and maintenance duties of the installed RE plants. This usually occurs in rural areas, with limited access to trained personnel. To address this, the government is carrying out technical trainings for operation and maintenance of installed RE plants. On the other hand, private corporations are investing in local RE projects as part of their CSR (Corporate Social Responsibility) activities.
3. Installation location issues: The installation of a large scale renewable energy generation project depends on the availability of a large piece of land, type of soil, connecting roads and electrical infrastructure. The effects of construction on the environment and ecosystem may also need to be considered.
4. Lack of long-term policy and regulations: There are regulatory barriers, in terms of getting approvals, clearances and allotment for RE projects.
5. High transaction cost: In terms of renewable energy, transaction cost represents the time and money invested in bringing the RE project to operational stage. This includes project financing, approvals and agreements, site analysis, feasibility studies, procurement and construction.

6. Financial barriers & lack of incentives: For small scale projects, there is a lack of capital and RE equipment lending facilities. From the government, there aren't any significant incentives for using on-site renewable energy system. In addition, recent taxation on RE products by federal government has made RE equipment expensive.
7. Energy surplus cannot be exported: As per NEPRA net metering regulations, net metering is allowed only for power plants up to 1 MW rated capacity. This restrains smaller RE plants from availing benefits of net metering.
8. Institutional barriers: Currently, a lack of coordination between individual provincial agencies, ministries and other stakeholders is observed, leading to a fragmented nature of RE project application. Energy policies and regulations also require to be standardized on a national level, so that there's adequate guidance and direction for the development of RE projects.
9. Transmission and distribution loss: The power sector has experiences >20% loss in the transmission and distribution of electricity. This is due to poor energy infrastructure, low billed amount recovery, transmission network flawsand outdated methods of monitoring.

6. Conclusion

To ensure successful operation and expansion of reweable energy generation systems in Punjab, it is necessary to address all drivers and barriers relevant to the region and form a strategic approach enabling both large scale and domestic RE projects to operate with optimum efficieny and monetery benefits.

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