



STUDY OF EFFECTIVE **ALTERNATIVE ENERGY SYSTEMS IN RURAL SINDH**

**Reviewing Best Practices, Policy Gaps, and Sustainable
Energy Solutions for Rural Development in Pakistan**



Research and Development Foundation (RDF)

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Executive Summary

The Clean Energy and Resilient Infrastructure project, implemented by the Research and Development Foundation (RDF) with support from Kindernothilfe (KNH) and funding from BMZ, addresses critical energy access challenges in the rural districts of Tando Allahyar and Sanghar, Sindh. The initiative aligns with RDF's broader mission of promoting sustainable livelihoods, climate resilience, and community empowerment.

This report encompasses an extensive study that reviews and analyzes the existing conditions and future scope of alternative energy systems in rural Sindh. It highlights the effectiveness, constraints and opportunities of clean energy alternatives for the under developed and marginalized communities. Through field surveys, stakeholder consultations, and policy analysis, the study investigates the dynamics among manufacturers, traders, and end-users while assessing affordability, technical performance, market access, and post-installation support.

Key findings reveal that majority of study area face critical energy shortages due to unreliable or absent grid electricity, impacting daily life and essential services. Solar energy is emerging as a practical alternative, supported by pilot projects, though adoption is limited by cost, maintenance issues, and lack of technical skills. Community awareness is growing but remains fragmented. To improve uptake, the creation of local energy committees, hands-on training, and micro-financing options is essential. Beyond solar, biogas and wind energy offer untapped potential. Hybrid systems and local cooperatives could accelerate access, with public-private partnerships key to scaling efforts. Decentralized renewable energy is vital for improving livelihoods and driving sustainable development in rural Sindh.

The study includes a hypothetical proposal for solarization of a domestic unit and small-scale commercial facility. Furthermore, it identifies several best practices, including community-led microgrid models, inclusive financing options, and integrated maintenance frameworks that ensure long-term viability. Policy gaps were mapped, along with a set of actionable recommendations aimed at improving service ecosystems, incentivizing clean energy businesses, and fostering a more enabling environment for renewable energy deployment in rural Sindh.

By amplifying local insights and aligning with global sustainability goals, this report serves as a practical roadmap for policymakers, development actors, and energy stakeholders working to scale equitable, resilient, and clean energy access across rural Pakistan.

Introduction

The unprecedented global challenge of climate crisis, mainly caused by the high levels of greenhouse gases in the atmosphere has a devastating impact on the world. The burning of fossil fuels for energy is a primary contributor to the problem, being responsible for approximately 75% of global carbon emissions. In this backdrop there is an increasing agreement amongst scientists, policymakers and the general population to rely more on clean energy sources and mitigate the climate change.

Countries like Pakistan severely faces the challenges of climate change despite of being a minor contributor of carbon emissions. A more vulnerable condition is observed in the second largest province of the country. The rural areas of Sindh are grappling with significant energy challenges, primarily due to limited access to reliable electricity from conventional sources. This lack of dependable energy infrastructure has far-reaching implications, affecting socio-economic development and the overall quality of life for residents. In response to these pressing issues, this project aims to conduct a comprehensive assessment of the current alternative energy supply, market dynamics, and consumption patterns in rural Sindh focusing on the District of Tando Allahyar and the District of Sangher.

The study of region investigates the current situation of energy practices and consumption of the rural population. Furthermore, it expands to document and identify the challenges faced for promoting and initiating the clean energy projects from the perspective of local manufacturers, traders and end users. Additionally, the report examines the role of clean energy in enhancing energy security and promoting sustainable development. The findings presented in this report highlights the importance of accelerating the transition to clean energy and provide actionable recommendations for governments, businesses, and individuals to support this critical shift. Moreover, the study will explore viable alternative energy solutions that can be implemented to meet the specific needs of these communities.

The Research and Development Foundation (RDF), in collaboration with Kindernothilfe (KNH), is implementing the 'Clean Energy and Resilient Infrastructure' project, funded by the German Federal Ministry for Economic Cooperation and Development (BMZ). RDF is a non-political, non-profit, and non-governmental organization recognized both nationally and internationally. At the national level, RDF works with grassroots NGOs and community-based organizations (CBOs) at the village level. Globally, it is connected through various NGO networks across Asia, Europe, Africa, South America, and North America. RDF's activities are carried out with the active participation of community institutions and focus on five major themes 1. Agriculture and Livelihood, **2. Water and Energy Resource Development**, 3. Health, Nutrition, and Sanitation, 4. Education and Learning and 5. Community Resilience Building.

Through these initiatives, RDF aims to foster sustainable development and improve the quality of life for communities in Sindh and beyond.

Background

Pakistan is in abundance with natural energy resources, these include both renewable and nonrenewable resources. All of these resources are therefore also present in the Province of Sindh. Wind Energy, Solar Energy, Municipal Solid Waste, Agriculture Waste, Livestock Waste, Bio Fuels, Geo-thermal Energy, Tidal Energy and Micro Hydel (run of the river) are readily found in the study areas. These energy resources can be utilized as fuel or indirectly for electric power generation at macro and micro level.

The Government of Sindh is facilitating local and foreign investments for implementation of mega projects based on Renewable Energy Technologies. A number of these projects; Wind Power Plant and Solar Energy Parks can be seen and marked throughout the province. These large-scale projects are feeding the on-grid system of electricity. The real problem lies within the remote areas of the province which due to unavailability of on-grid system face problems in their livelihood and have a compromised routine life.

Pakistan is amongst countries where the community is facing energy crises, especially electricity outages across the country. Rural people, especially the underprivileged communities, are facing acute energy crises and in many remote regions of the country, people do not even have access to electricity. Among alternative energy sources, solar systems are quite common in many areas, as their capital cost is not very high. Yet, the communities in several remote villages cannot afford to install the solar system. Due to the unavailability of electricity, the dwellers of those areas are facing numerous economic, social and health-related issues such as the limited economic activities during the night, loss of education of children, limited access to water as they do not have the power supply to pump water and thus poor water and hygiene condition.

Therefore, Solar power has become progressively popular in rural Sindh due to its cost-effectiveness and sustainability. Many households and farmers have adopted solar panels for electricity and irrigation. Other renewable resources like wind energy, biomass, and micro-hydel are also being explored. The residential, commercial and agricultural market in Sindh is characterized by smallholders who often rely on intermediaries to sell their products. There is a growing trend towards renewable energy solutions, driven by the high cost and unreliability of conventional electricity

Energy Consumption Patterns: Energy consumption in rural areas is primarily for agricultural activities and basic household needs. Solar power is increasingly used for irrigation and household electricity. The lack of reliable energy infrastructure significantly impacts the quality of life and economic activities

Challenges of Existing Energy Solutions: The main challenges include the high initial cost of solar installations, maintenance issues, and the outdated energy grid

Despite these challenges, solar power remains a viable solution due to its long-term cost savings and sustainability

Alternative Energy Solutions: Expanding the use of solar and wind energy, along with exploring biomass and waste-to-energy projects, can provide sustainable energy solutions for rural Sindh. Government policies and incentives play a crucial role in promoting these alternative energy sources

The use of solar energy systems and other small scale alternate energy solution would reduce the consumption of fossil fuels for cooking, lighting lamps, and operating the water and sewerage system especially in schools and health centers.

Access to energy is essential for poverty alleviation and sustainable rural development of the region. The Sustainable Development Goal 7 (SDG7) of the United Nations (UN) aims to achieve the goal - everyone has access to affordable, reliable, and sustainable energy. Solar system is an important and affordable solution to the energy crises, it is even cheaper than grid electricity and it also offers better reliability.

This comprehensive approach can help address the energy challenges in rural Sindh, promoting sustainable development and improving the quality of life for its residents.

The study will delve into the effectiveness and challenges associated with existing energy solutions from the perspectives of manufacturers, traders, and end-users. By evaluating these aspects, the project seeks to identify gaps and opportunities within the current energy landscape. Furthermore, the study will explore viable alternative energy solutions that can be implemented to meet the specific needs of these communities.

Objective

The primary aim of the research is to bridge the research gap of a comprehensive on ground study on alternate energy supply and initiative. This study gauges the effectiveness, opportunities and challenges of the existing energy practice and need based energy supply in remote areas of Sindh.

The three major stakeholders, the manufacturers, traders and users are the main targeted beneficiary of the project and the study. Moreover, their valuable feedback is critically analyzed and findings facilitate the recommendations that will raise awareness amongst policymakers and aid towards a sustainable rural development.

- Assess the current state of alternative energy options in rural Sindh, focusing on market availability and consumption patterns.
- Identify opportunities and barriers for accessing and adopting alternative energy options.
- Map out policy recommendations to improve the deployment and scaling of alternative energy systems in rural areas.

SDGs Mapping

All the tasks, activities and deliverables of the study project is precisely aligned with the United Nations Sustainable Development Goals (SDGs). This strategic alignment ensures that the project not only meets the immediate energy needs of rural Sindh but also contributes to broader global objectives, fostering sustainable development on multiple fronts.

The well-aligned Sustainable Development Goals (SDGs) includes SDG-13 Climate Action: the study directly links with making efforts towards a sustainable development by decreasing the reliance of fossil fuel and reducing carbon emissions, SDG-7 Affordable and Clean Energy will allow the underprivileged communities to improve on their livelihoods and development within their means and for SDG -11 Sustainable Cities and Communities: the community will

be self-reliant and independent on the production and utilization of energy as per their own requirement and will.

SDGs Mapping



SDG 7: Affordable and Clean Energy: Ensure universal access to affordable, reliable, and modern energy services by 2030. Enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency, and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology.

SDG 11: Sustainable Cities and Communities: The community-based approach promotes sustainable urban and rural development by equipping communities with the tools and knowledge to adapt to climate change.

SDG 13: Climate Action: This task fosters community resilience to climate change, enhancing local adaptation strategies and contributing to global climate action efforts.

Introduction to Study Areas

District Tando Allahyar at a Glance

Tando Allahyar was awarded the status of district in year 2005, before that it was taluka of district Hyderabad. It lies in between 68 degrees 34' 23" to 68 degrees 57 min 35 sec east longitude and 25 degrees 12 mins 24 sec to 25 degrees 45 mins 17 secs north latitude. It shares the boundaries with district Mirpur Khas at east, District Sanghar on Northern side, district Hyderabad and Matiari on the west and District Tando Muhammad Khan and Badin on Southern side.

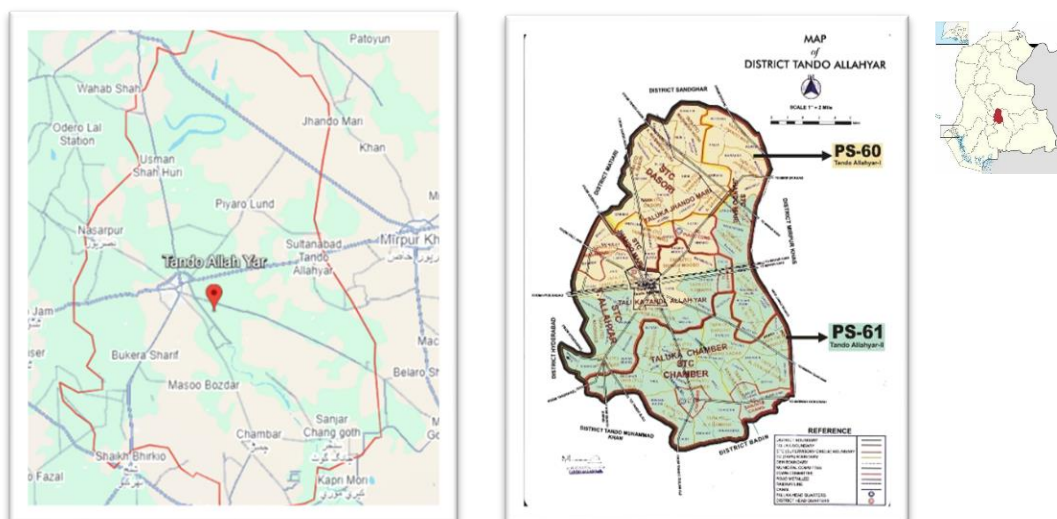


Figure 1: Map of District Tando Allahyar with boundaries

Administrative Division: The district has 3 Talukas i-e Tando Allahyar, Jhando Mari and Chamber comprising of 19 Union Councils and 201 villages. While the targeted study is focused on 50 villages from 2 UCs Tando Allahyar and Jhando Mari and 1 Village from Chamber.

Climatic Conditions: Tando Allahyar has temperate climate neither very hot nor very cold, the hottest month in summer are June and July while the coolest months are December and January. Wind direction is South to North in summers and north to south in winters.

Crops: The crops cultivated in this district are cotton wheat, sugar cane. Mangoes cultivated here are famous all over the country for its sweetness.

Culture: Tando Allahyar has a rich traditional Sindhi culture. Sindhi and Urdu are the major languages of the district, Marwari and Seraiki are also used here as minor languages. Islam is the main religion here but Hindu communities are also present here in minorities. Women usually wear shalwar qameez but also wear their traditional dress ghaghro or parro while men usually wear shalwar qameez with notably broader bottoms and traditional sindhi style cap.

Agriculture: There are 87 mouzas (revenue villages) in district out of which 85 are rural, one is urban and one is partly urban. Majority of male population in the district is associated with agriculture while other sources of income are business, casual labor, trade and government jobs. Total reported area of the district is 173,000 hectares while 118,000 hectares are cultivated that comprises the 70 % of land.

Industry: Industries here complement the agricultural production of the district; Mehran Sugar mill is the largest sugar mill of the district while cotton ginning factories are also present abundantly in this district along with flour and oil mills that have also been established.

Livestock:

Good breed of cows and buffaloes are present in the district while sheep, goats and mules are also kept but people prefer cattle over sheep and goats for domestication.

District Sanghar at a Glance:

Sanghar district is located in the southeastern region of the Sindh. Sanghar shares its boundaries with Shaheed Benazir Abad on the northwest, Umer Kot and Mirpur Khas on the southern side, Tando Allahyar to the southwest and Rajasthan state of India to the east. Sanghar was declared as district in 1954 with its headquarters in the Sanghar city. Sanghar landscape is a mix of arable land and desert region. The district has 6 talukas and 73 Union Councils.

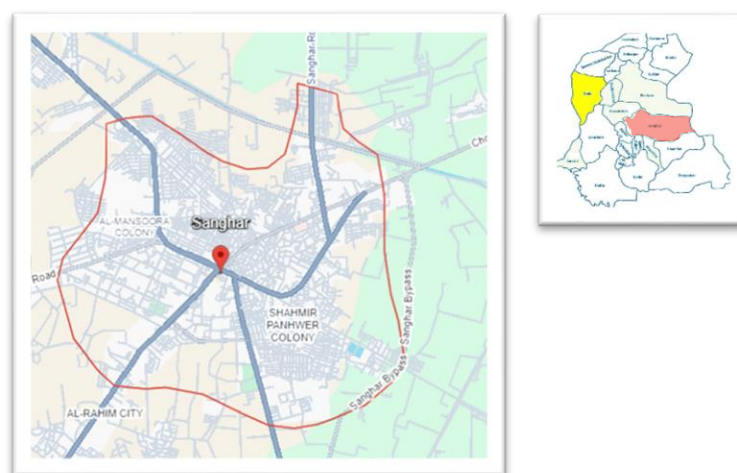


Figure 2: Map of District Sanghar with boundaries

Climate: The climate of district Sanghar is hot and dry. Summers are intensely hot with temperature rising above 40 degrees Celsius while winters are milder with average temperature in between 5 to 20 degree Celsius making the evenings and nights relatively cool. The region receives rainfall during monsoon typically from July to September.

Demographics: The total population of Sanghar district is 2,3,07,831 from which 73% of the population is rural and 27 % is urban. 1.17 million is male and 1.13 million is female.

Livelihood: Livelihood of people of district Sanghar is mainly dependent on agricultural activities around 63.2% of people in rural Sanghar and 19.9% of urban Sanghar is dependent on agricultural activities while 12% are associated with industrial activities and 24% with services sector, reflecting agricultural activities as main source of livelihood.

Crops: The district terrains support extensive farming activities. Wheat, Onion, chillies, sugar cane, bananas, mangoes, citrus fruits, cotton crop are cultivated here.

Culture: This district has a rich cultural heritage. A lot of heritage sites are present in this region like the shrine of Pir Hadi Hassan Bux and Brahmanabad. The region is home to many indigenous communities the mehers, Sammas, Bhattis, Thakurs, juts, Lorras. The primary language of Sanghar is Sindhi while Seraiki, Balochi and Urdu are also used here. The region is known for its handicrafts like hand woven carpets, embroidery, woven nets. Etc. The major religion of this district is Islam while 21% people follow Hinduism and Christianity.



Figure 3: View of District Tando Allahyar



Figure 4: View of District Sanghar

Research Methodology

The focus of this study is to explore the effectiveness of alternative energy options in selected rural areas of Sindh. The Tando Allahyar and Sanghar districts are selected for the identification of the current clean energy options and practices that are used in the areas of mentioned districts, moreover, the study employs subjective and objective research approaches for collecting the data. The field exploration is based on the existing documentation and mapping of the situation of the electricity supply of 24 targeted villages of two districts of Sindh Province of Pakistan.

Furthermore, the quantitative and qualitative method is used, to collect the perception of the locals of communities through structured and focus group questionnaires and interviews. The baseline survey has been carried out by primary data collection through the household, commercial and institutional survey. This includes assessing how well the product range in

the clean energy sector meets the needs of the local communities, financial constraints for end-users, and conducting a gap analysis to determine barriers and opportunities for improvement in the alternate energy sector.

Summarize findings in a comprehensive report with clear evidence-based recommendations. Outline strategies for scaling successful energy models and improving access to alternative energy in rural Sindh. Provide insights for policymakers, manufacturers, and traders to inform their decision-making and planning.

Study Areas

Tando Allahyar is the district in the Hyderabad division, provenience of Sindh Pakistan. The satellite map of selected district is shown as in figure 5. The study area is divided into fifty villages.

The baseline survey was conducted in seven villages of three union councils of mentioned district due to their limited access to conventional energy sources and the growing interest in adopting alternative energy solutions. Table-1 represents the list of targeted villages for survey.

S. No.	Villages	UC	Taluka	District
1	Liaquat Thebo	Dasoori	Jhando Mari	Tando Allahyar
2	Saleh thebo	MailMori	Jhando Mari	Tando Allahyar
3	Khuda Dino Mirjat	Dasoori	Jhando Mari	Tando Allahyar
4	Mai Khan Thebo	Dasoori	Jhando Mari	Tando Allahyar
5	Shadiyon Walhari	Missan	Jhando Mari	Tando Allahyar
6	Heera Singh je Mari	Missan	Jhando Mari	Tando Allahyar
7	Momji Kolhi	Missan	Jhando Mari	Tando Allahyar

Table-1 List of selected villages of Tando Allahyar

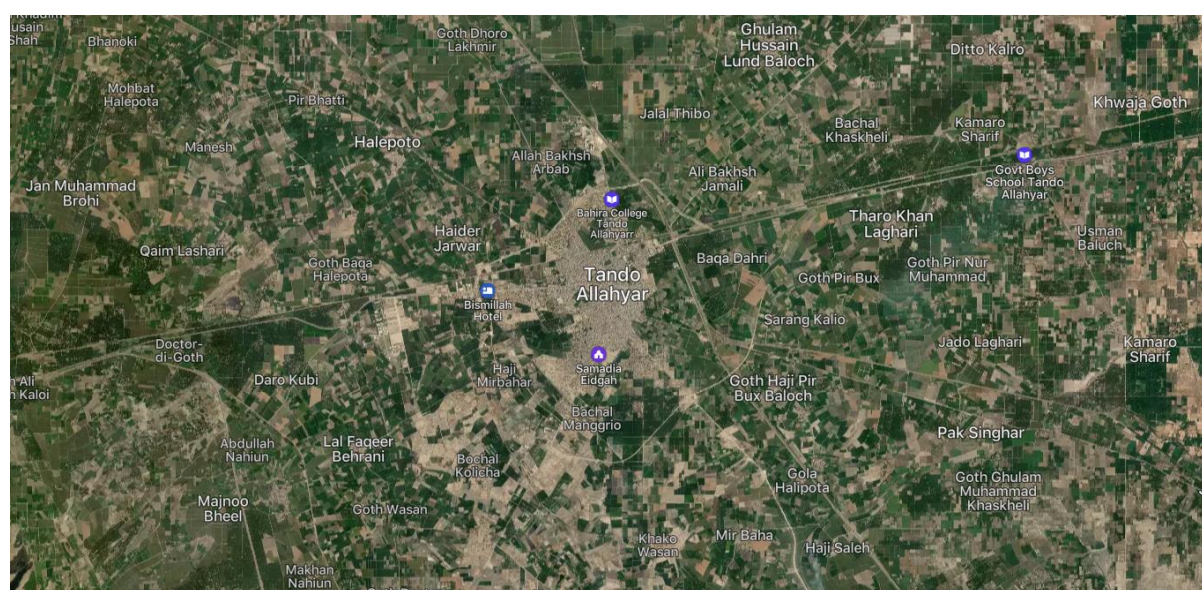


Figure 5: Satellite map of Tando Allahyar

Sanghar District

Khipro is the tenhsil of Sanghar district. The selected study area is one the largest district of Sindh. This area lies among 25°58'13" N latitudes and 69°024'4" E longitudes. The satellite map of selected district is shown as in figure 6.

The Sanghar district is divided into fifty sub-villages. Survey is conducted in seventeen villages of two union council in stated area. The list of selected villages for survey is presented in Table-2.

S.No	Villages	UC	Taluka	District
1	Mitho Hangorja	Ranaho	Khipro	Sanghar
2	Kalo Daras	Ranaho	Khipro	Sanghar
3	Faqeer Daras	Ranaho	Khipro	Sanghar
4	Asodar	Ranaho	Khipro	Sanghar
5	Ali jin Tar	Ranaho	Khipro	Sanghar
6	Bhorio Tar	Ranaho	Khipro	Sanghar
7	Dhagraho	Ranaho	Khipro	Sanghar
8	Saedo	Ranaho	Khipro	Sanghar
9	Khogapni	Ranaho	Khipro	Sanghar
10	Loung Hingorjo	Ranaho	Khipro	Sanghar
11	Dodo Faqeer Chaniho	Ranaho	Khipro	Sanghar
12	Rabeel Daras	Ranaho	Khipro	Sanghar
13	Tar Babar	Ranaho	Khipro	Sanghar
14	Jedam Daras	Ranaho	Khipro	Sanghar
15	Laal Muhammad Khaskheli	Khori	Khipro	Sanghar
16	Allahdino Daras	Khori	Khipro	Sanghar
17	Jetho Maghwar	Khori	Khipro	Sanghar

Table-2 list of selected villages of Sanghar District

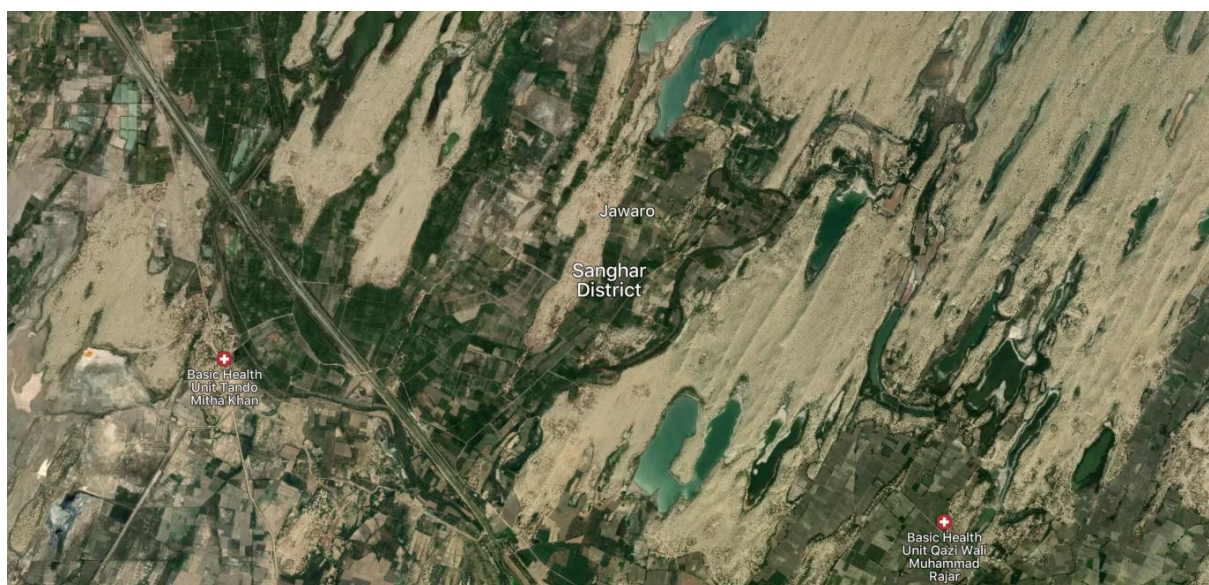


Figure 6: Satellite map of Sanghar District

Literature Review

The environment and the economy are negatively impacted by conventional energy sources, such as coal, gasoline, and other fossil fuels. Pakistan's reliance on these resources has resulted in a catastrophic energy crisis. (Asghar et. al, 2022) Pakistan is facing multiple challenges for harnessing the indigenous energy resources and devise rational energy policies. Pakistan is facing severe electricity crisis and outages ranging from 8 to 12 h a day in urban areas and up to 18 h in rural areas. (Mirjat et. al, 2017). The energy supply in Pakistan is highly dependent on thermal power generation which accounts for 60 percent of total energy. Any price surge in the foreign petroleum and natural gas market substantially affects power generation in Pakistan. (Tani et al, 2020). The GHG (greenhouse gas) emission from energy sector is 48.62 million ton consuming almost 14.19Mtoe and according to Intergovernmental Panel on climate change human activities in south Asia is 90% responsible for GHG emissions. (Renewable energy market update, Oct, 2022) update). Temperatures in South Asia are anticipated to rise by an average of 3.3 C by the end of the century, with Pakistan and India experiencing more significant rises than the average.

In Pakistan, the annual mean temperature has increased by about 0.5°C during the last half a century, the number of heat wave days per year has increased fivefold, and it has intensified the water and energy demand. Sindh is particularly affected with various manifestations of Climate Change such as increased variability of river flows and floods, heat waves and drought, these risks are affecting the health and economic well-being of the population and are resulting in social conflicts as well. In the face of natural hazards, it is essential to have development that is able to bear the impacts of these hazards and that is climate resilient development. Climate resilience is being woven into development approaches worldwide, which provide different development outcomes from business-as-usual scenarios.

Several countries have initiated the creation of a more environmentally sustainable and less harmful energy infrastructure that could meet the rapidly growing energy demands (Ullah et. al. 2020). Integrating renewable energy sources into the energy mix would reduce the adverse effects on the environment and the healthcare expenses associated with economic growth while reducing debt and stabilizing energy prices in the long run (Dinc et. al, 2019). Hence, there has been a lot of emphasis on developing renewable energy globally. Wind and solar energy may be the most sustainable options when considering ecosystem health, human well-being, and resource availability (Ahmed et. al).

The population of Sindh has reached 47.89 million¹³ with about 50% of the population concentrated in the cities. The demand for energy has also increased with rapid urbanization and industrialization in the province. In the past decade alone, Sindh has faced energy shortages, more specifically the electrical power gap: 5000MW and Gas: 1000-2000 MMCFD shortage in winters. 30% of the rural population in Sindh (approximately 8.4million people) have no access to grid electricity and 75% of the total population have no access to Gas. Sindh contributes to 70% of the country's gas reserves and 42% of the oil reserves (Government of Sindh 2016)

Sindh has large economically viable renewable energy resources:

Source	Quantity
Wind	55,000 MW
Solar	10,000 MW
Hydro (Small)	130 MW (Run of River)
Bagasse Cogeneration	1,000 MW (32 sugar mills & agro
Waste to Energy	500 MW (Karachi 11,000 MTPD)

Source: (Sindh Climate change Policy)

Proposed Measures by Climate change policy 2016

- I. Create a provincial energy policy with the goal of promoting domestic renewable energy sources like nuclear, waste-to-energy, solar, wind, geothermal, micro-hydropower, and bioenergy while reducing dependency on imported energy.
- II. Encourage domestic and international investment in the market for renewable energy by means of financial support systems and offer additional incentives such carbon fees, subsidies, and tax reforms.
- III. Determine any regulatory gaps or bottlenecks in the current framework for renewable energy and alter it to address them, paying special attention to off-grid rural people.
- IV. Create a GHG inventory of Sindh's energy production and consumption to give the energy and environment department important data to use in their yearly planning.
- V. carry out applied research to broaden understanding and knowledge regarding potential carbon reduction through the use of renewable energy and low-carbon energy, as well as the viability and affordability of these strategies from the standpoint of carbon mitigation;
- VI. Encourage decentralized renewable energy production in commercial, residential, and industrial settings. Examples include smart grids, smart metering, and community-based off-the-grid renewable energy production.

A financing agreement worth \$100.0 million was struck by the World Bank and the Pakistani government for the "Sindh Solar Energy Project," which aims to expand solar power generation and electricity access in Sindh Province. Three market sectors in Sindh will be served by the project: distributed generation, utility scale, and household level solar power installations. Utility-Scale Solar comprises the construction of solar parks to encourage private sector participation and the first competitive bidding for the generation of solar power in Pakistan, beginning with a pilot solar auction of 50 MW. At least 20 MW of distributed solar photovoltaics are installed on the roofs and other accessible areas of public buildings in Karachi, Hyderabad, and other Sindh Province districts.

Initiation of Sindh Solar energy Project aims to increase solar power generation and access to electricity in Sindh Province. This project has four components.

1. The first component, Utility-Scale Solar, aims for identification and development of a series of publicly owned solar parks, and support for the competitive selection of private sector developers through solar auction for the construction of solar power plants in the solar parks.

2. The second component, Distributed Solar, aims for procurement and installation of solar PV systems and associated energy management systems on rooftops and other available space on and around public sector buildings.
3. The third component, Solar Home Systems, aims for deployment of affordable SHSs in prioritized areas with low or no access to electricity, analysis and identification of priority areas, activities to enhance consumer awareness and financial literacy, product certification and quality control, and Monitoring and evaluation (M and E) activities.
4. The fourth component, Capacity Building and Technical Assistance, aims to support the design and implementation of the project and compliance with fiduciary, gender, M and E, procurement, and safeguards requirements.

The Project will introduce and showcase international best practice with renewable energy auctions, reduce the headline cost of solar deployment, create sustainable business models for potential replication, build institutional and private sector capacity, and identify opportunities for future renewable energy deployment that address issues of grid integration. The Project is designed to help steer Pakistan toward a lower-carbon path to development.

Research Method

The Architecture and Environmental Design department has started a research initiative on "housing and community development" since 2019. As part of the initiative, the AED department is developing learning materials and partnerships on Sustainable development goals. As part of this initiative, one team of three faculty members, Ar. Samar Shamim Hussain, from the AED department, Ar. Fabiha Khalid and Ar. Madiha Midhat, visited Tando Allahyar district on February 4, 2025. The team provided demonstration on the structured questionnaire survey related to clean energy solutions. The team also conducted an on-site briefing and demonstration to Survey Staff from local community of both districts representing RDF on how to conduct a questionnaire survey and engaged community to participate in the research. The purpose of this survey was to document the community's perspective on the situation of electricity supply and adaptation of clean energy sources. This survey was mainly about the demographic information of the household, their livelihood, access to electricity, water, healthcare, education, moreover, understanding and information of locals about renewable energy sources.

This research study will implement both **qualitative and quantitative research design** that focuses on understanding the perspectives of the end-users, industry stakeholders, and experts. It will utilize **exploratory** and **descriptive** research methods to explore the current trends and practices of locals in the adoption of alternative energy solutions.

Research tools

Structured Interviews

The study was used **structured interviews** to collect detailed, in-depth information from various stakeholders. These will include:

- End-Users: Community members in Tando Allahyar and Sanghar have accepted clean energy solutions (e.g., solar panels, biogas systems).

- **Manufacturers:** Local and regional manufacturers of clean energy products and solutions.
- **Traders:** People involved in the supply of clean energy technologies within the region.
- **Sector Experts:** Energy advisors, officials, and NGOs working in the renewable energy sector.

Questionnaire

- A structured questionnaire is developed for three major sectors of end-users for instance domestic, commercial and institutional. These questions are designed to ensure reliable data gathering across survey, while also permitting for give in apprehending detailed answers. The questionnaires survey was focused on the effectiveness of the clean energy products in assembly their requirements, product flexibility, ease of use, satisfaction, financial limitations, and challenges confronted.

Focus Group Discussions (FGDs)

- Focus group discussion were conducted with groups of community members in each selected area to better understand collective perceptions, attitudes, and challenges related to the adoption of alternative energy technologies. The discussions were also highlight local knowledge about energy needs and gaps.

Mapping and Site documentation

- The observation is another important survey tool to collect the data for the site documentation. The environmental factors, architectural parameter, energy demand and adaptation of alternative energy practices were documented through multiple site visits, photographs and mapping of the selected villages.

Sampling

- **Purposive Sampling:** This technique was used to select targeted villages of Tando Allahayar and Sanghar districts for identification of communities, manufacturers, traders, and experts who are actively involved or have extensive information of clean energy implementation in rural Sindh.
- **Sample Size:** A total of 1200 random sample population is selected for structured questionnaires and focused group interviews in different villages of stated districts. This is conducted with community members, including a mix of households, shopkeepers, training centers, vocational centers, school teachers etc that have accepted clean energy solutions and those who have not. Additionally, 10-15 interviews with manufacturers, traders, and sector specialists were conducted.

Data Analysis

Data will be analyzed using qualitative and quantitative techniques, including:

Thematic Analysis: To recognize patterns and themes from the surveyed questionnaires and structured interviews. This will support to understand the individual's needs, financial constraints and challenges of conventional and alternation energy solutions.

The gather data will consist of documentation and mapping of the villages, photographs of different kinds of activities of households, commercial and institutional activities related to problems that are facing without supply of electricity and other related information. A brief

database of the findings (strengths and weaknesses) of adaptation and effectiveness of clean energy solutions will be included in this report.

Gap Analysis: Comparing the community's needs and expectations with the offerings available in the clean energy sector to identify gaps in product availability, service delivery, and financial support.

Recommendations for the improvements in the energy sector: Review the clean energy programs and policies of the Government of Sindh and assess the provisions for clean energy business development and find out what incentives, subsidies and support is there for improving access of communities to clean energy.

Map out policy recommendations to support the distribution and scaling of alternative energy solutions in Tando Allahyar and Sanghar districts.

Data Collection

Tando Allahyar is the district in the Hyderabad division, provenience of Sindh Pakistan. The baseline survey was conducted in seven villages of four union councils as shown in figure 7. Table-1 represents the list of targeted villages for survey. The satellite maps of union councils of TandoAllahyar i.e Dasoori, Missan, Shaikh Moosa and Mailmori are shown as in figure number 8,9,10,11



Figure 7: Selected union councils marked on the map of Tandoallahyar

S. No.	Villages	UC	Taluka	District
1	Liaquat Thebo	Dasoori	Jhando Mari	Tando Allahyar
2	Khuda Dino Mirjat	Dasoori	Jhando Mari	Tando Allahyar
3	Mai Khan Thebo	Dasoori	Jhando Mari	Tando Allahyar
4	Saleh Thebo	MailMori	Jhando Mari	Tando Allahyar
5	Shadiyon Walhari	Missan	Jhando Mari	Tando Allahyar
6	Heera Singh je Mari	Missan	Jhando Mari	Tando Allahyar
7	Momji Kolhi	Missan	Jhando Mari	Tando Allahyar

Table-3 list of selected villages

1. Dasoori

Dasoori is a village located in the **Jhando Mari Taluka** of **Tando Allahyar district** in Sindh, Pakistan. It is located in the north of Tando Allahyar. Dasoori is one of the union councils of the mentioned district. The economic activities are majorly based on the agricultural crops. The village also has a growing awareness of accepting alternative energy solutions due to restricted access to conventional energy sources. The village has infrastructure and basic facilities of health, schools, and road networks to connect other towns and villages.

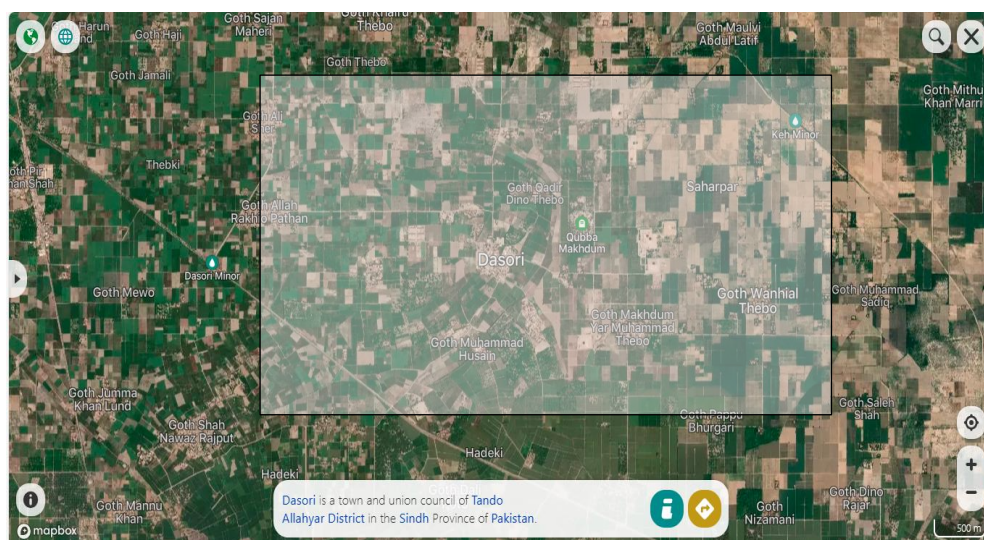


Figure 8: Map of Dasoori

1. **Liaquat Thebo:**
 - a. **Union Council:** Dasoori
 - b. **Taluka:** Jhando Mari
 - c. **District:** Tando Allahyar
 - d. **Details:** Dasoori is a town and union council with a population of 49,427. Liaquat Thebo is approximately **25 miles (40 km)** northeast of Tando Allahyar city.

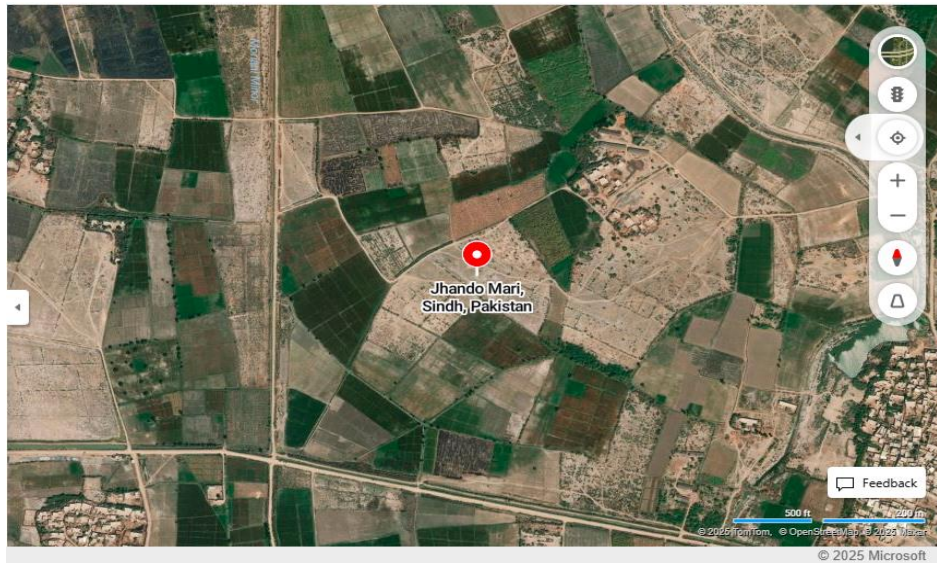


Figure :9 Map of Liaquat Thebo village

2. **Khuda Dino Mirjat:** Khuda Dino Mirjat is a village in the Dasoori Union Council of Jhando Mari Taluka, Tando Allahyar district.
 - a) **Union Council:** Dasoori
 - b) **Taluka:** Jhando Mari
 - c) **District:** Tando Allahyar
 - d) **Details:** Dasoori is a town and union council with a population of 49,427.

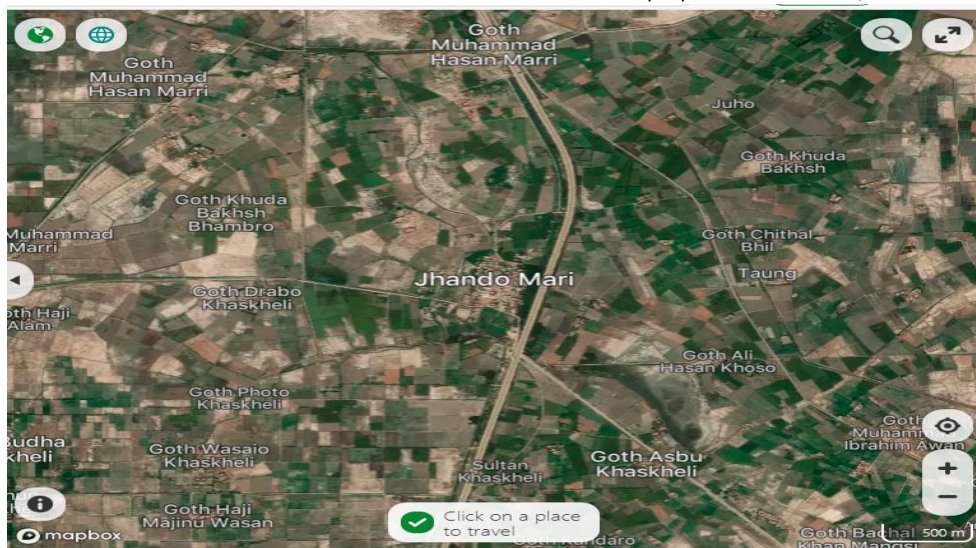


Figure 10: Map of Khuda Dino Mirjat

3. **Mai Khan Thebo:** It is situated in Dasoori Union Council, Jhando Mari Taluka, Tando Allahyar district, Sindh, Pakistan.
 - a. **Union Council:** Dasoori
 - b. **Taluka:** Jhando Mari
 - c. **District:** Tando Allahyar
 - d. **Details:** Dasoori is a town and union council with a population of 49,427. This village is located in the northern part of the district.

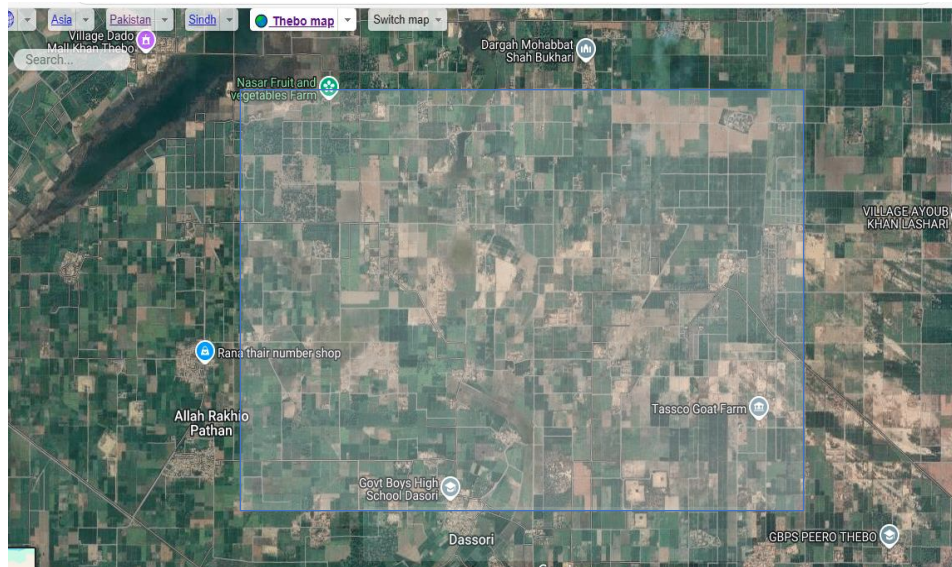


Figure 11: Map of Mai khan Thebo

2. MailMori

Mailmori Union Council is located in Jhando Mari Taluka, Tando Allahyar district, Sindh, Pakistan. It has a variety of villages, and the approximate population is 13,114 people who are engaged in different occupations, like primary agricultural activities; livestock farming is very common. It has basic facilities of infrastructure, including grid electricity, road connectivity, and piped water. However, some areas still face problems in terms of road connectivity, healthcare, and education.

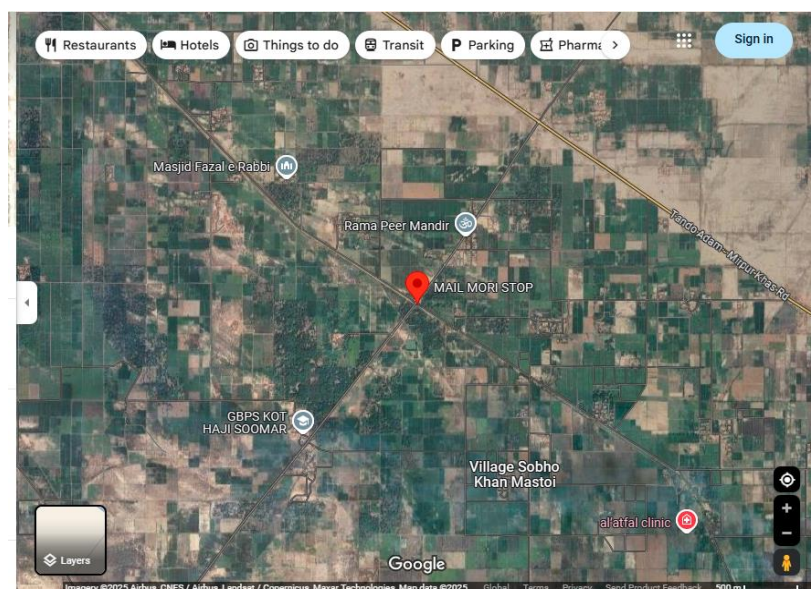


Figure 12: Map of MailMori

1. Saleh Thebo

Saleh Thebo is situated in Mailmori Union Council, Jhando Mari Taluka, Tando Allahyar district, Sindh, Pakistan.

- Union Council:** MailMori
- Taluka:** Jhando Mari
- District:** Tando Allahyar

- d. **Details:** Jhando Mari is a town and union council with a population of 30,384. It is located in the 30 kilometers northwest of the district.

3. Missan

Missan is a union council in Jhando Mari Taluka, Tando Allahyar district, Sindh, Pakistan. The major area of this village is based on the agricultural crops such as cotton, sugarcane, and wheat. It has a population of approximately 13,114 people. The basic facilities of infrastructure, water supply, and access to electricity are available in some areas of the village.

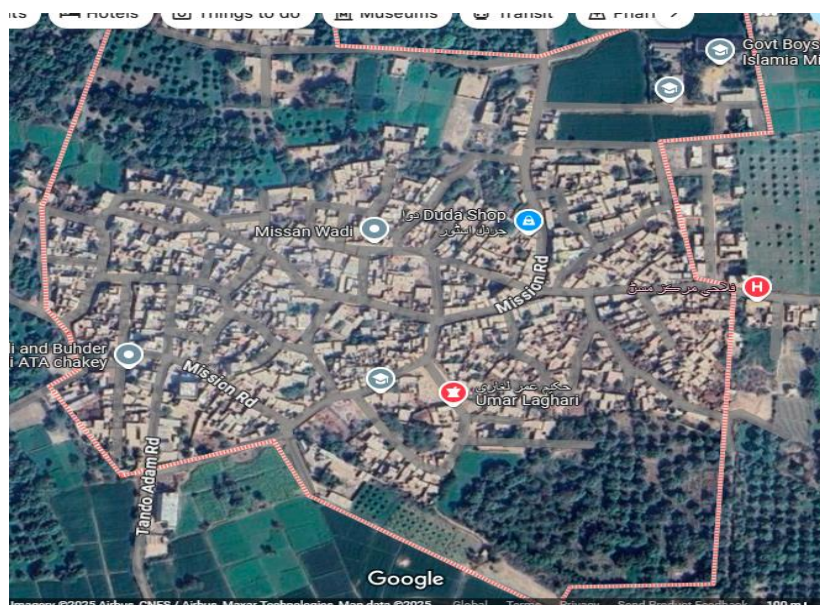


Figure 13: Map of Missan

1. Shadiyon Walhari

Shadiyon Walhari village is situated in Missan Union Council in the Jhando Mari Taluka of Tando Allahyar District, Sindh, Pakistan. The village has a moderate population, majority of the population works in the agriculture sector for their livelihoods, which then directly contributes to the local economy. Cotton, sugarcane, and wheat are amongst the main crops of Shadiyon Walhari. The village is facilitated with the mere basic infrastructure like , water and electricity but lacks road connectivity to access the healthcare facility, also long hours of loadshedding makes them rely on other sources like solar to meet their needs. The local population like others enjoys close-knit community with deep social ties and rich cultural traditions. Local events and festivals renders the social fabric of the village.

2. Heera Singh je Mari

Heera Singh je Mari, same as Shadiyon Walhari, is located in the Missan Union Council in Jhando Mari Taluka, Tando Allahyar District. Also the village's occupations is mainly agriculture, and farming. Crops such as cotton, sugarcane, and wheat are commonly cultivated in the area. Basic infrastructure exists, but the village faces issues such as limited road connectivity and healthcare access. Due to low population, the community is well-connected and thrives on strong social bonds. Traditional events and cultural celebrations remain central to life in Heera Singh je Mari, helping to maintain a sense of unity and shared identity among residents.

3. Momji Kolhi

Momji Kolhi is another village in the Missan Union Council, located in Jhando Mari Taluka of Tando Allahyar District. Kolhi community is the community that comprises the whole population of village which is less than 500. Like the two previous villages of the same UC for which agriculture remains the source of income for majority cultivating cotton, sugarcane, and wheat. The Kolhi community is deeply rooted in its cultural heritage, and traditional festivals and events are important in maintaining the social fabric of the village.

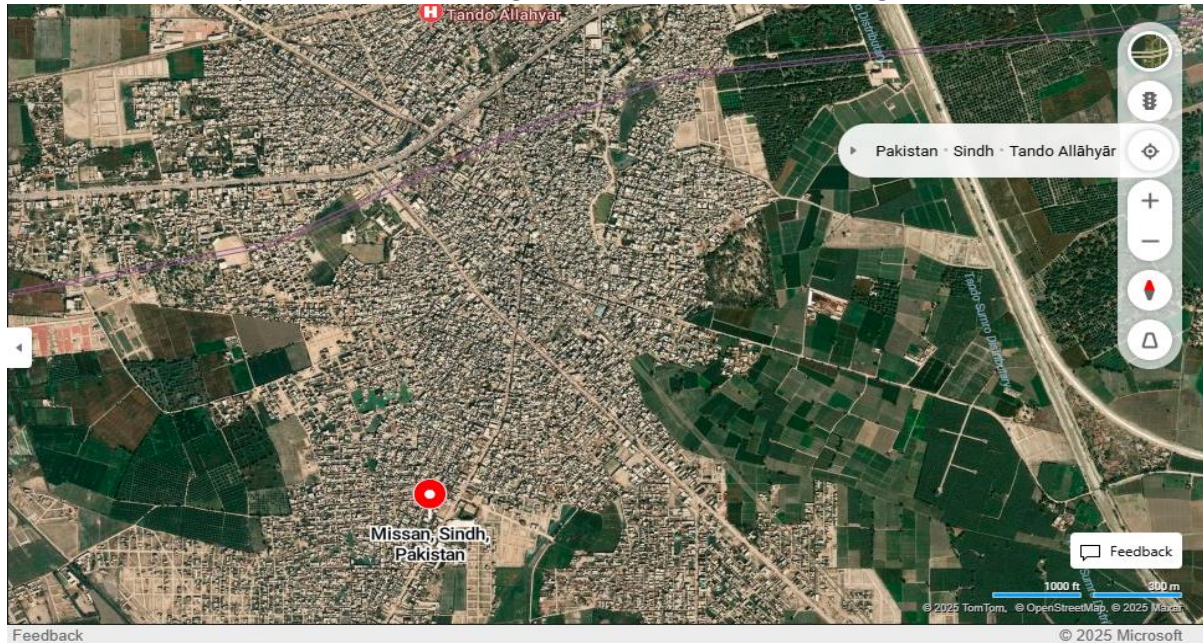


Figure 14: Map of

4. Shaikh Moosa

Shaikh Moosa is a town and union council situated in the Tando Allahyar District of Sindh Province, Pakistan. It is located in the center of the district, and the population of the Shaikh Moosa Union Council is approximately 65,776.

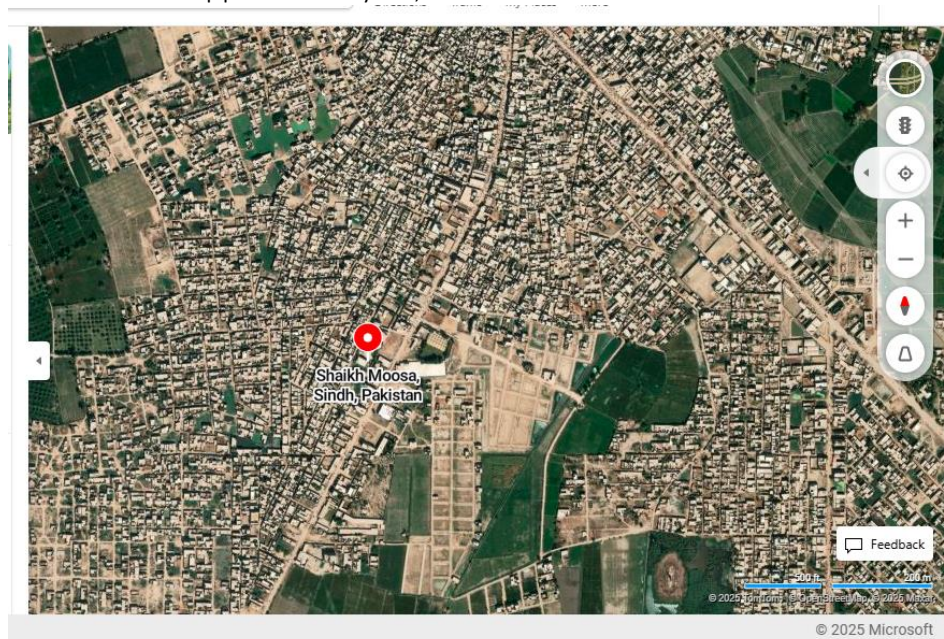


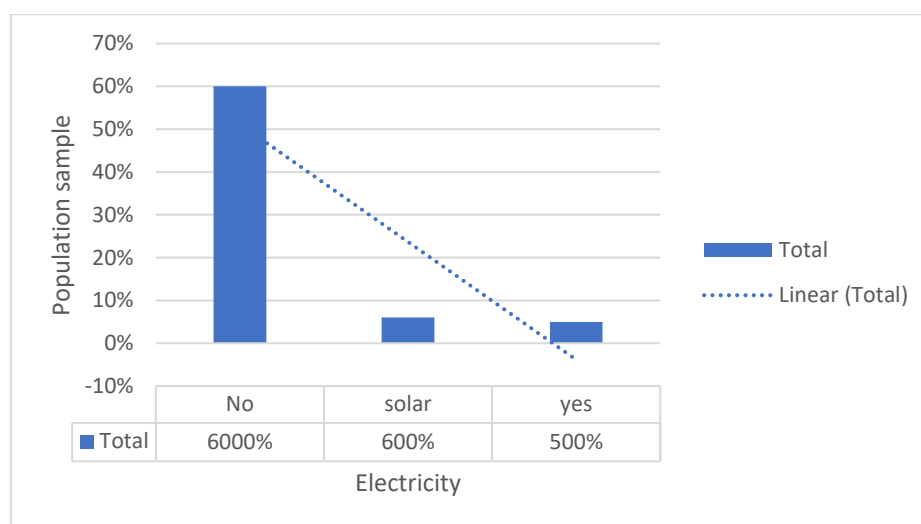
Figure 15: Map of Shaikh Moosa

Data Analysis and Findings

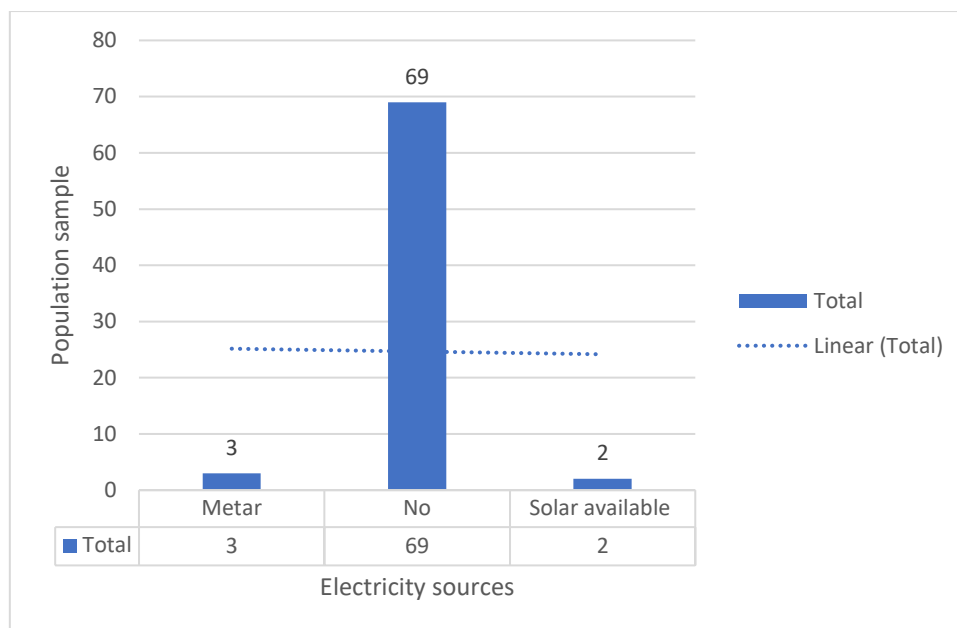
Questionnaire survey on the electricity and energy demands of Thando Allayar

1.Dasoori

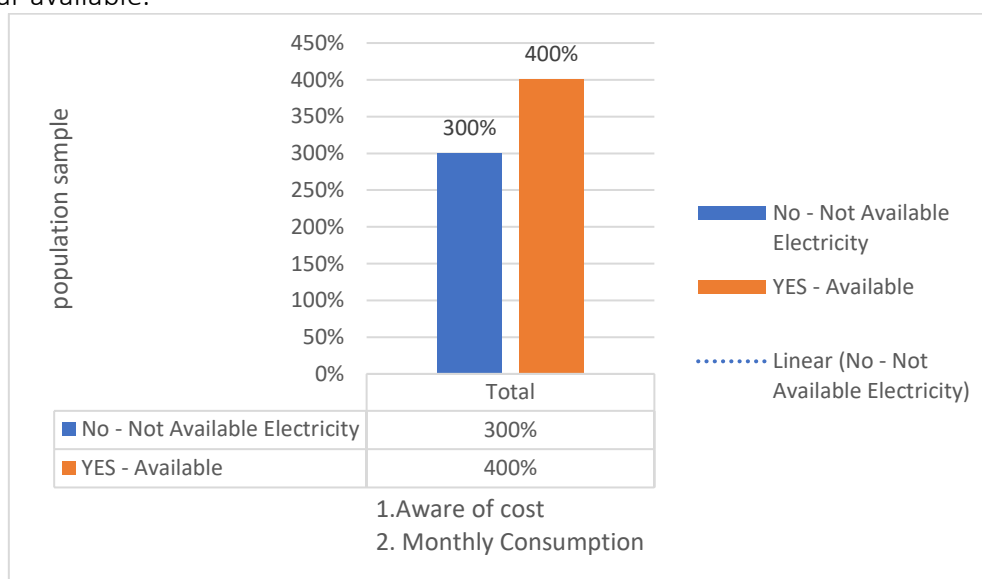
Dasoori: Area Sultanabad Station



- The inclination line advocates that selected areas without electricity have a higher population sample size. This could specify an essential requirement for infrastructure development to provide electricity and improve living conditions. There is a need to improve the living conditions of the community by working on electrification projects; the data can help arrange areas with no access to electricity (No) since they have the maximum population.
- Share this information with the NGOs, local government, and community to raise awareness of the current situation of electricity in Sultanabad. This data helps the local government to address the issue and take initiative for clean energy projects and improve the electrification system.



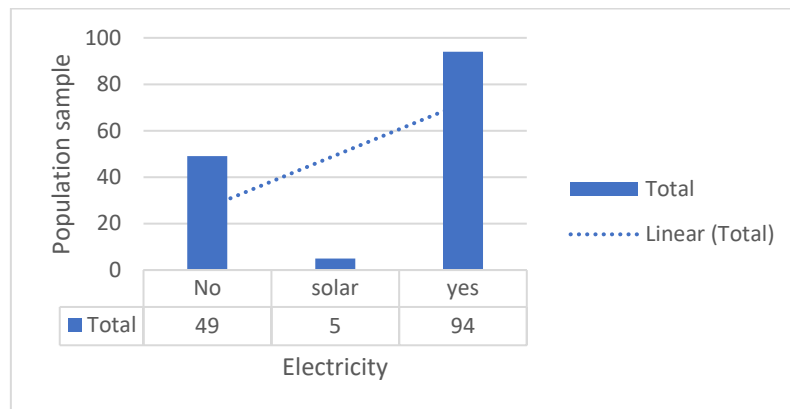
This bar chart represents the majority of the population under the no category, which is indicating there is no access to electricity. Promoting solar energy could be a sustainable solution, but present admittance is very inadequate, as indicated by the low population sample for "Solar available."



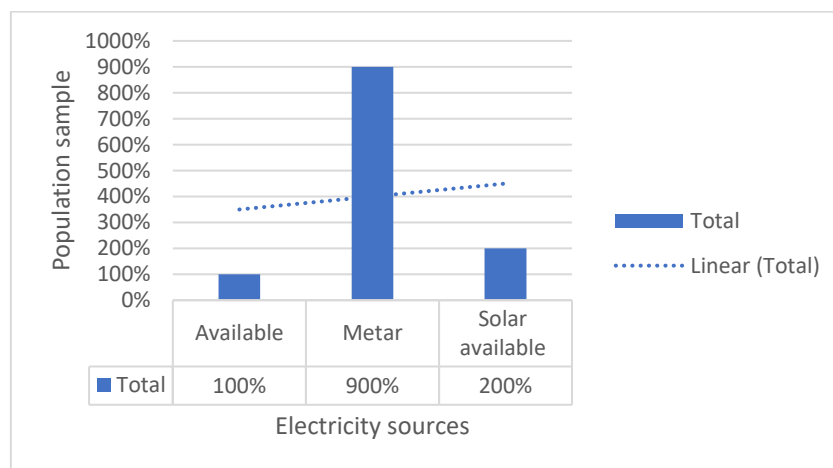
- The bar chart compares the population sample's awareness of cost and monthly consumption founded on the accessibility of electricity. The population sample (300) said that there is no access to electricity, and the other majority said that they have to access electricity.
- Similarly, the population sample with available electricity (orange bar) has higher monthly consumption (400%) compared to those without electricity (blue bar, 300%).
- This indicates that having electricity leads to higher monthly consumption. There is a need to reduce energy consumption and promote solar energy.

2. Missan

Name of villages Shadiyon Walhari; Heera Singh je Mari; Momji Kolhi



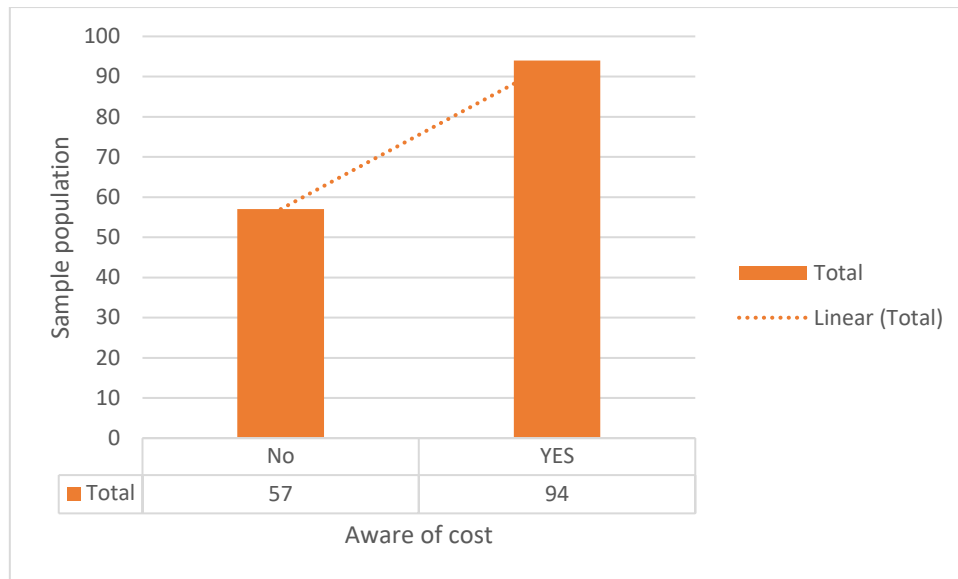
The mainstream of the population sample (94) shows under the "Yes" group, representative that the majority have access to electricity, and another part of the population group (49) does not have availability to electricity (No). A very minor part of the population sample (5) has access to solar electricity.



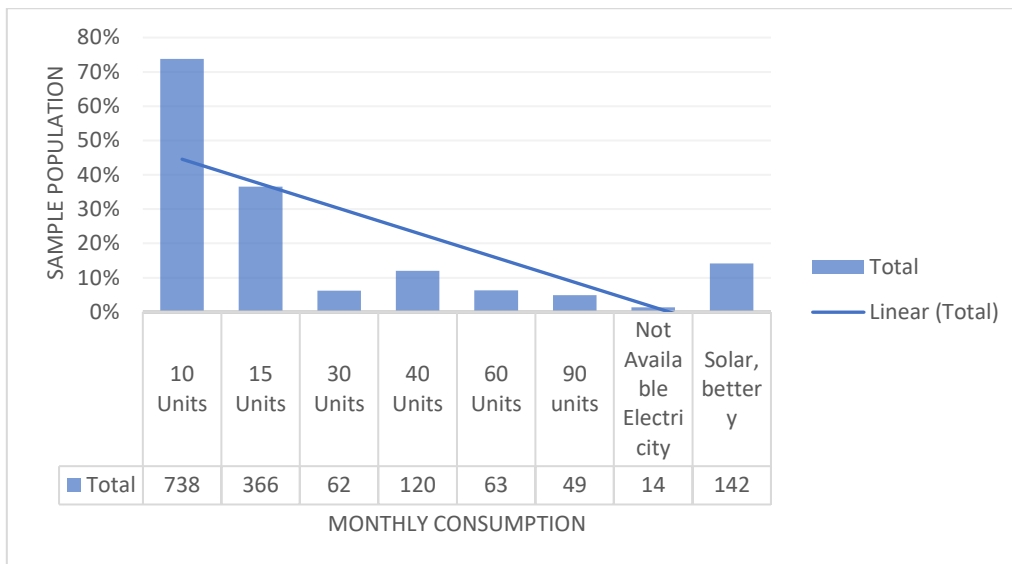
The peak population percentage (900%) is for the "Metar" category, representing a remarkable percentage of the population sample that uses electricity as a source.

The "Available" group has a population sample percentage of 100%, signifying restricted admittance to this electricity source.

- The "Solar available" category has a population sample percentage of 200%, indicating some acceptance of solar energy but not as extensive as "Metar."

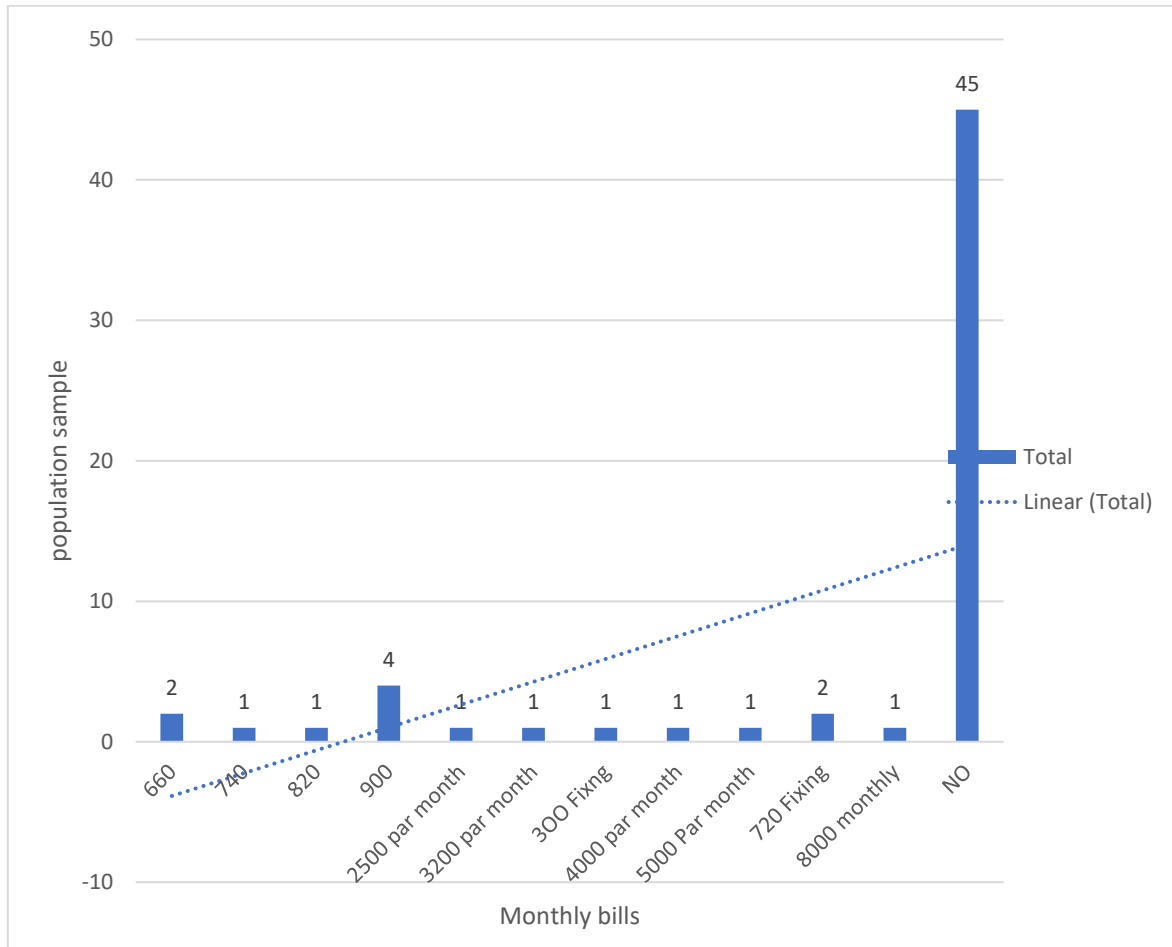


- The spotted line inclination represents a rising tendency from "No" to "YES," indicating an upsurge in the model population's awareness of cost.
- This trend suggests that awareness of cost is more prevalent among the sample population. Efforts to raise awareness about the cost should focus on the sample population that is presently unaware (57). This can be accomplished through better education and outreach programs related to solar energy projects and promoting clean energy education.

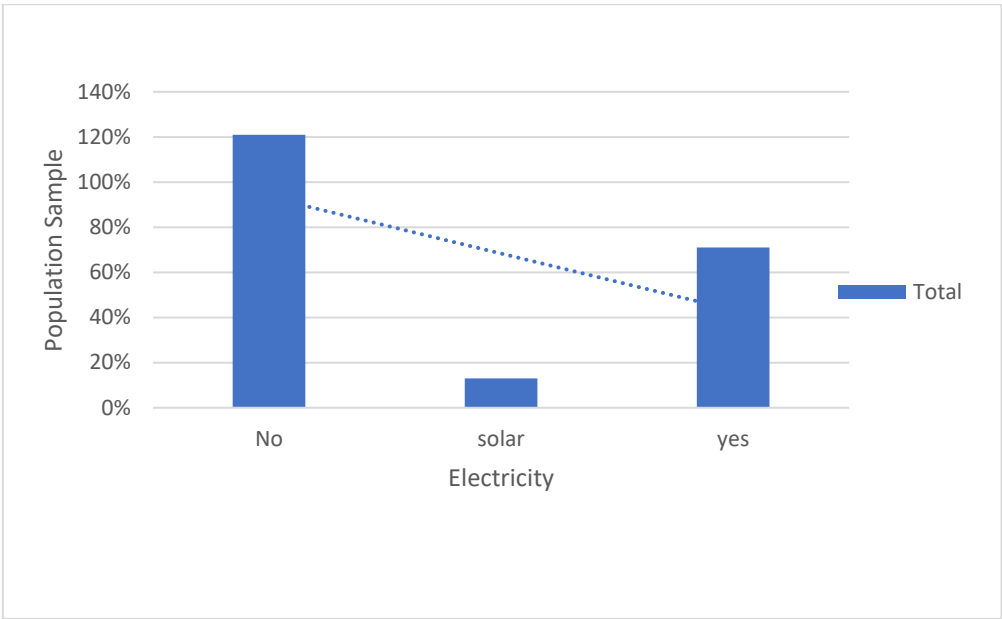


- The majority of the population is for the 10 units category (738), indicating that most of the population consumes 10 units of electricity monthly.
- The 15 Units category also has a significant sample population (366), but it is much lower than the 10 Units category.
- The sample population decreases sharply for higher consumption categories (30 units and above), with the lowest being 90 units (6).

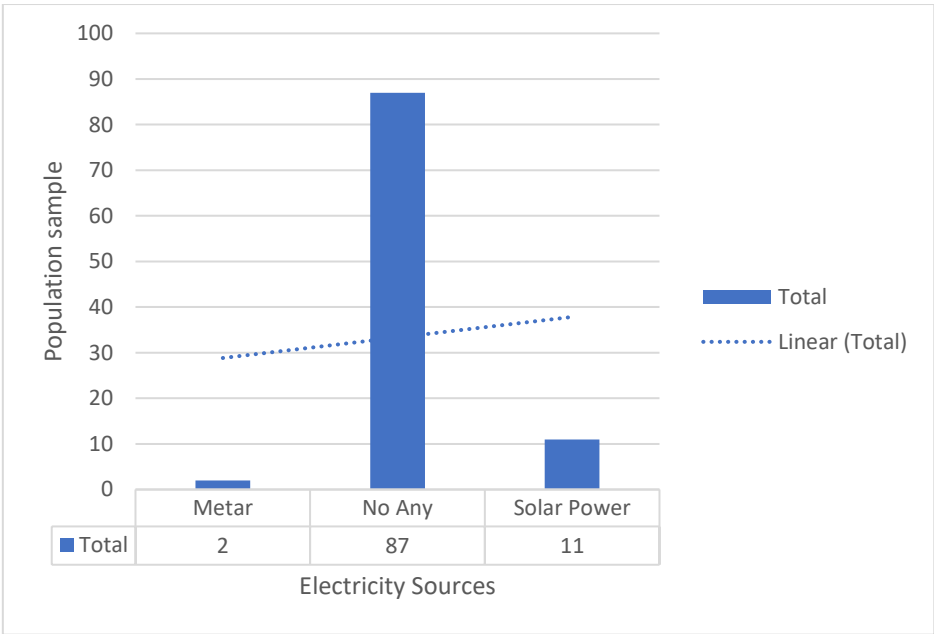
- The "Not Available Electricity" category has a small sample population (14), indicating limited access to electricity for some.
- The "Solar Battery" category has a notable sample population (142), suggesting some adoption of solar energy.
- The linear trend line shows a general decline in the sample population as monthly consumption increases.



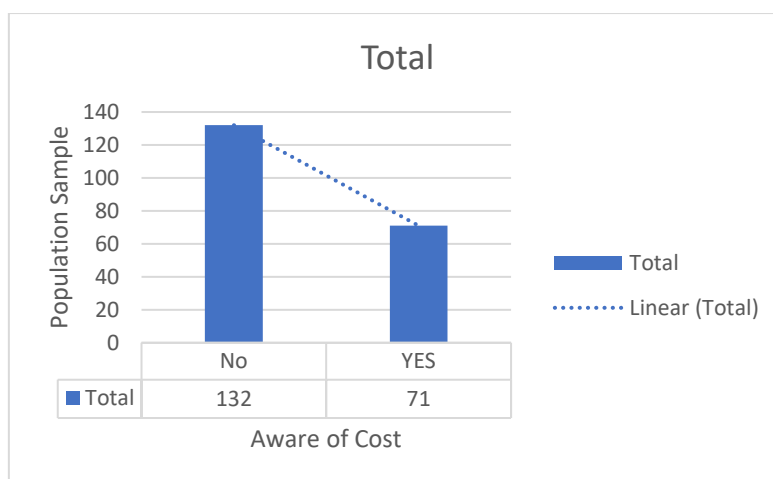
- The highest population sample (45) has a "No" category that indicates there is a major portion of the group that does not have monthly bills. And another portion of the sample size (4) is relatively high, indicating 900 monthly bills.
- The population sample for higher monthly bills (2500 per month and above) is very low, indicating limited affordability or access to higher monthly bills. The trend line shows inclinations towards the majority percentage of the population using electricity without monthly bills.



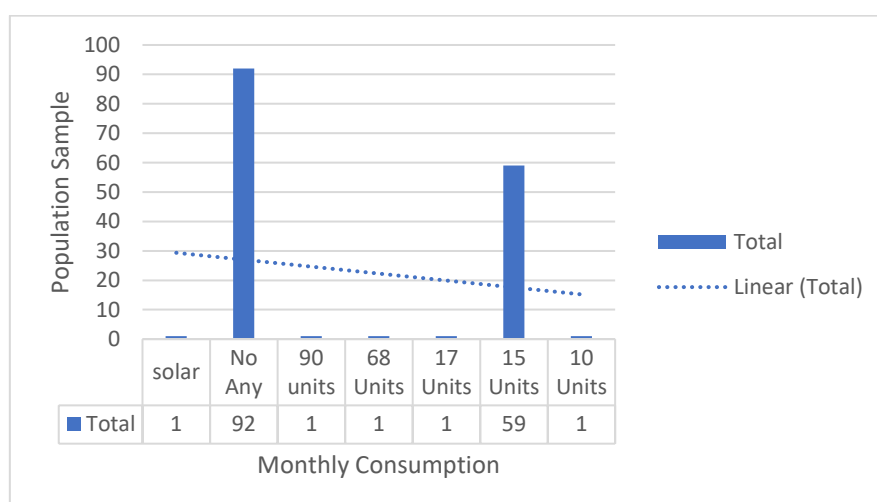
Majority of the population have “NO” access to electricity, and the other 80% of the population have availability to electricity. The solar category has the minor sample size that is indicating limited usage of solar energy. Promoting solar energy practices in the villages can be a sustainable solution to increase electricity access.



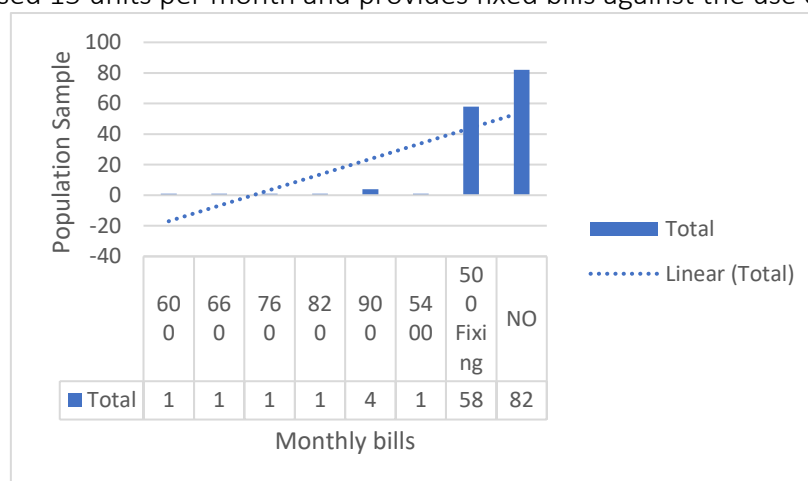
The majority population sample size (87) has “No Any” access to electricity, and the other sample size (11) has used solar power to generate electricity. However, the minor portion of the population has used grid electricity. There is an urgent need to address this issue and provide sustainable solutions for improving the infrastructure and electricity conditions.



Most of the population (132) has no awareness of the cost of electricity in the villages, and the other sample size (71) is aware of the cost and monthly bills against the electricity consumption.



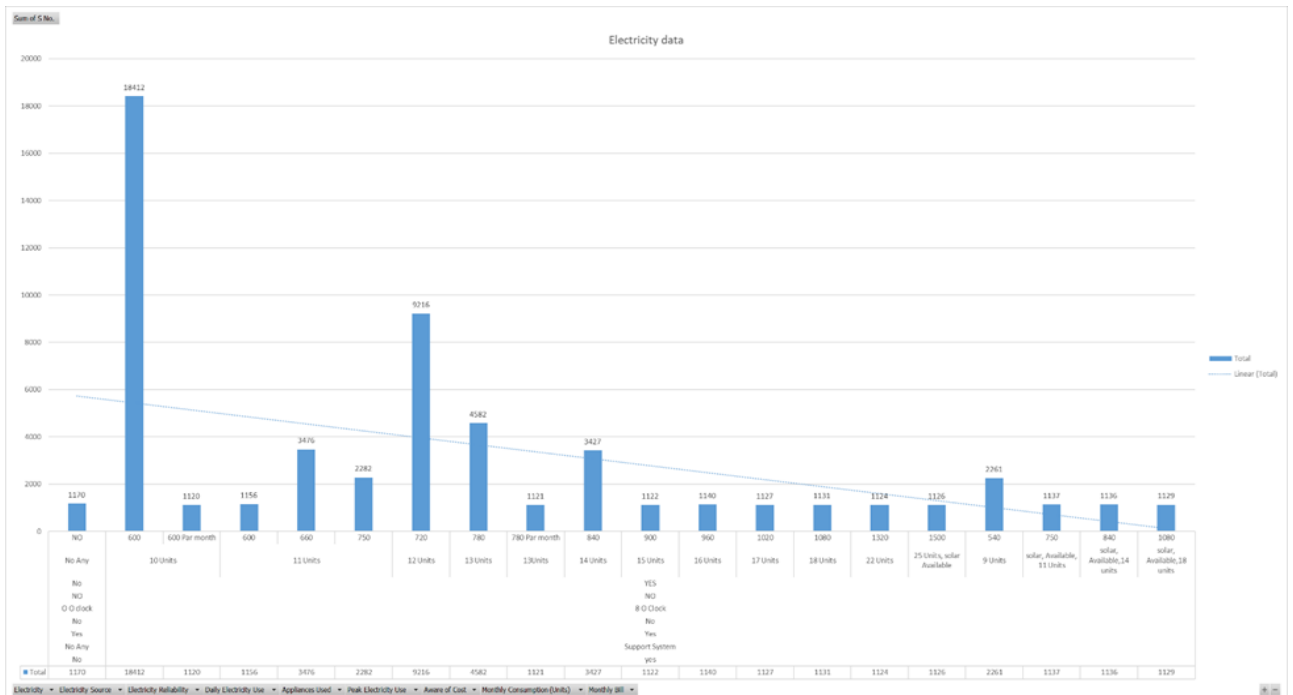
Most of the population (92) has no monthly consumption of electricity, and the other sample size (59) has used 15 units per month and provides fixed bills against the use of electricity.



The "NO" category has a significantly higher population sample (82), indicating a large portion of the population does not have monthly bills, and the other population sample is (58), representing the second largest portion of the population providing 500 fixed monthly bills.

However, the NO category represents the trend showing a large population sample without monthly bills.

3. Shaikh Moosa



The electricity and energy data of Shaikh Moosa represent the same situation that is already discussed in the above-separated graphs of electricity and energy utilization conditions. Ninety percent of the population is indicating “No” access to electricity and providing “No” monthly bills.

The minor population of sample size 10% is indicating that they are providing fixed bills against the use of grid electricity. The community of Shaikh Moosa has used solar power for electricity generation but has limited adaptation of solar energy.

Sanghar District

Khipro is a sub-division (tehsil) of the Sanghar District, which ranks among the largest districts in Sindh. The designated study area is located at coordinates 25°58'13" North and 69°24'4" East. A satellite image of the selected district is illustrated in Figure 16.

The Sanghar District comprises fifty villages, out of which surveys were carried out in seventeen villages from two union councils within the specified region. The names of these surveyed villages are listed in Table 2.



Figure-16 Map of Kipro District

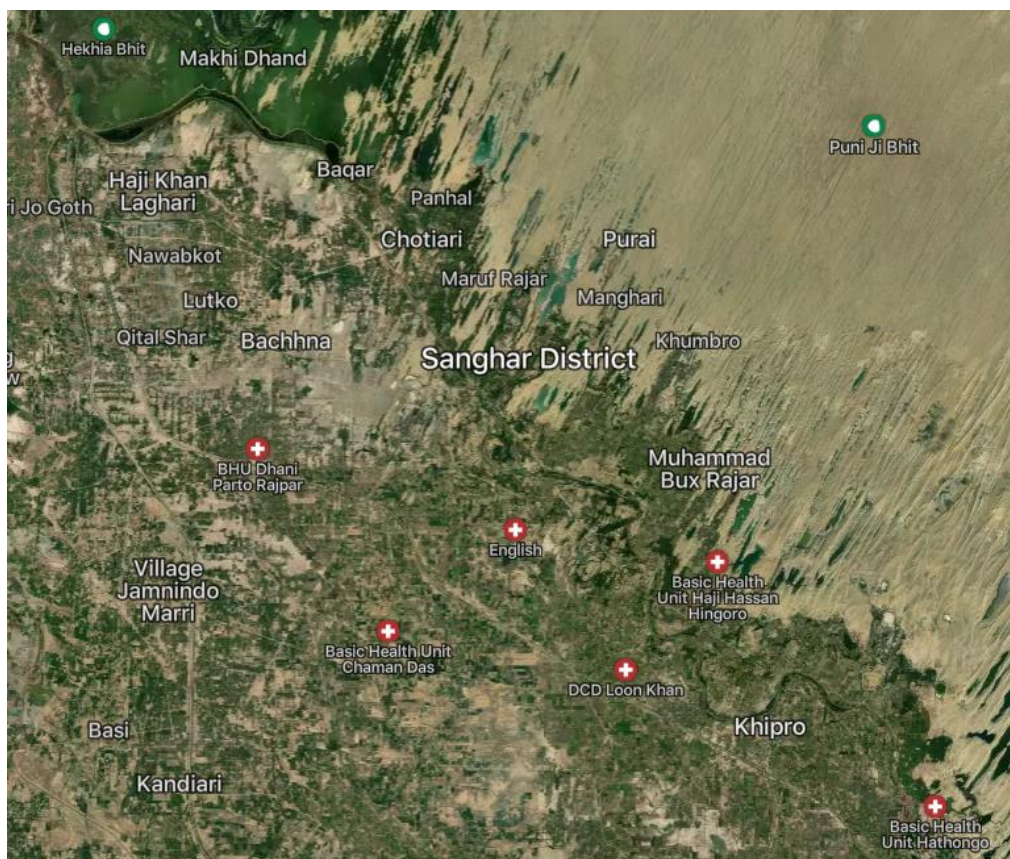
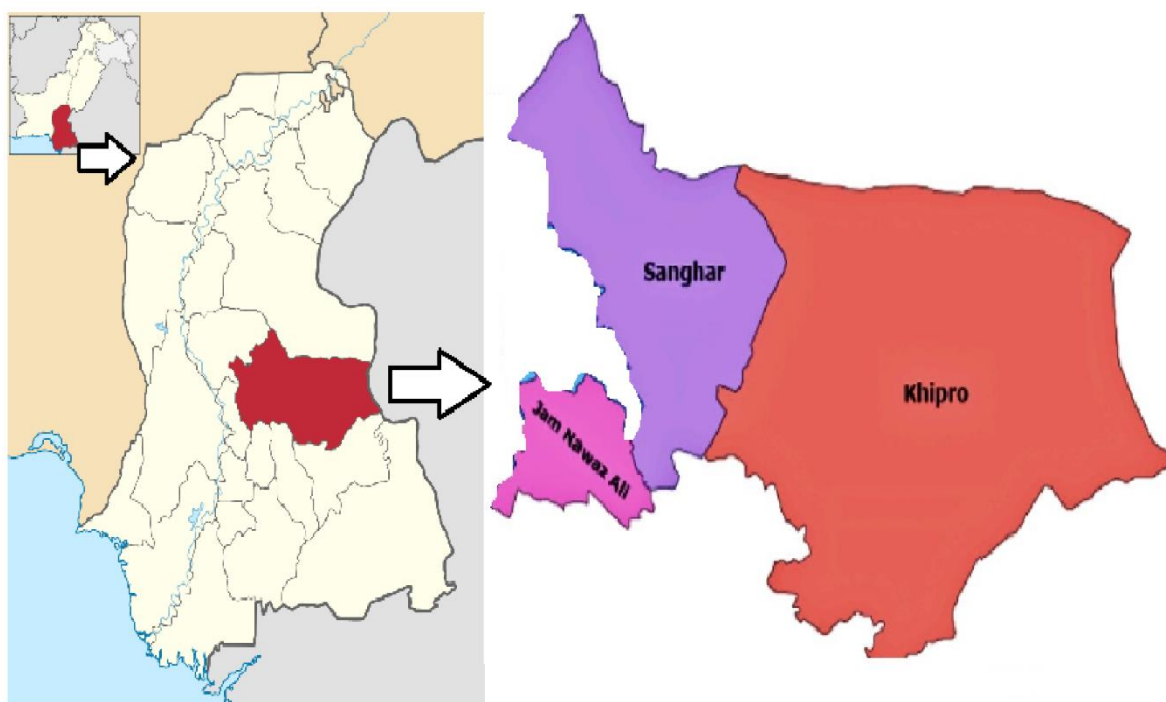


Figure-16 Map of Sanghar District



Map of Khipro tehsil and Sanghar District

S.No	Villages	UC	Taluka	District
1	Mitho Hangorja	Ranaho	Khipro	Sanghar
2	Kalo Daras	Ranaho	Khipro	Sanghar
3	Faqeer Daras	Ranaho	Khipro	Sanghar
4	Asodar	Ranaho	Khipro	Sanghar
5	Ali jin Tar	Ranaho	Khipro	Sanghar
6	Bhorio Tar	Ranaho	Khipro	Sanghar
7	Dhagraho	Ranaho	Khipro	Sanghar
8	Saedo	Ranaho	Khipro	Sanghar
9	Khogapni	Ranaho	Khipro	Sanghar
10	Loung Hingorjo	Ranaho	Khipro	Sanghar
11	Dodo Faqeer Chaniho	Ranaho	Khipro	Sanghar
12	Rabeel Daras	Ranaho	Khipro	Sanghar
13	Tar Babar	Ranaho	Khipro	Sanghar
14	Jedam Daras	Ranaho	Khipro	Sanghar
15	Laal Muhammad Khaskheli	Khori	Khipro	Sanghar
16	Allahdino Daras	Khori	Khipro	Sanghar
17	Jetho Maghwar	Khori	Khipro	Sanghar

Table-2 list of selected villages of Sanghar District

Ranaho is a locality situated in the Sanghar District of Sindh, Pakistan. It is located at approximately 25°55'59" N latitude and 69°47'19" E longitude, with an elevation of 25 meters (82 feet) above sea level. Nearby localities include Rablahu to the northeast and Assodar to the northwest, as shown in figure- 17. The area is characterized by its proximity to various hills, such as Thori Daro, Garkan Tor, Hirki Daro, Daduwaro Daro, and Bhirin Daro, which are situated within a 9 km radius.

Ranaho falls under the administrative jurisdiction of the Sanghar District, which is one of the largest districts in Sindh. The district is divided into six tehsils, with Khipro being one of them.

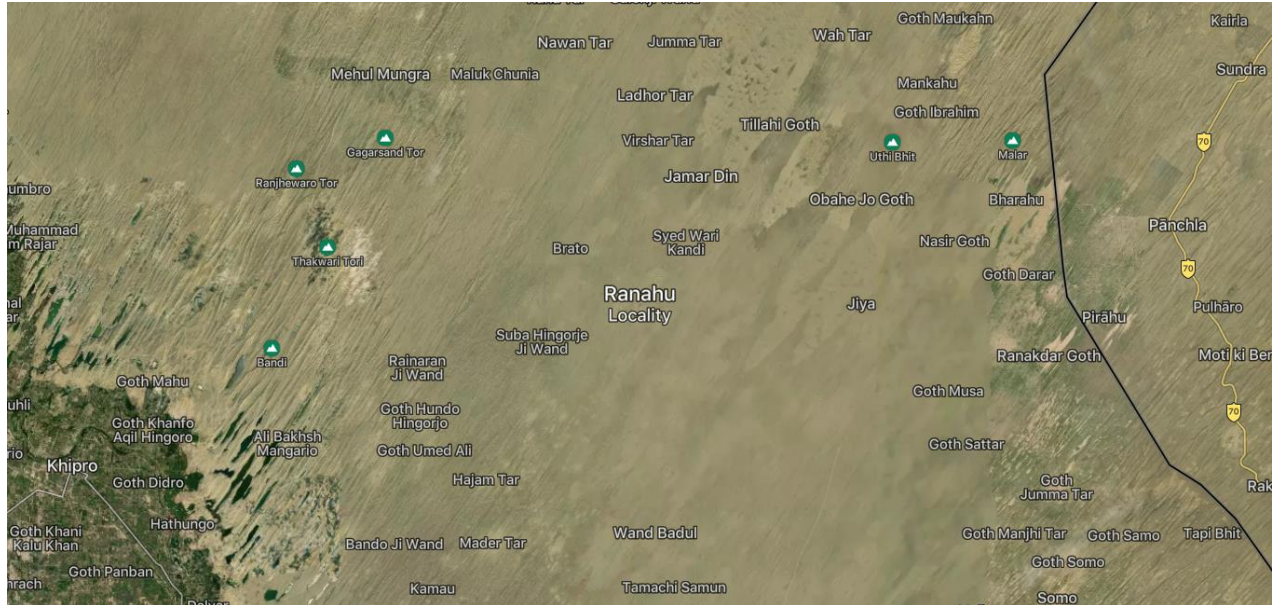


Figure-17 Map of Ranaho

Khori, Sanghar District

Khori is a locality situated in the Sanghar District of Sindh, Pakistan. It lies approximately 3.5 kilometers north of the Khipro Reserve Forest Reef and is surrounded by other localities such as Goth Badal Rajar, Goth Ghulam Haidar Ghazi Faqir, and Goth Kundhani. The area is characterized by its proximity to several reserved forests, including Khirro Reserved Forest and Gujro Reserved Forest, which are located within a 6 to 7 km radius. As shown in fig-18

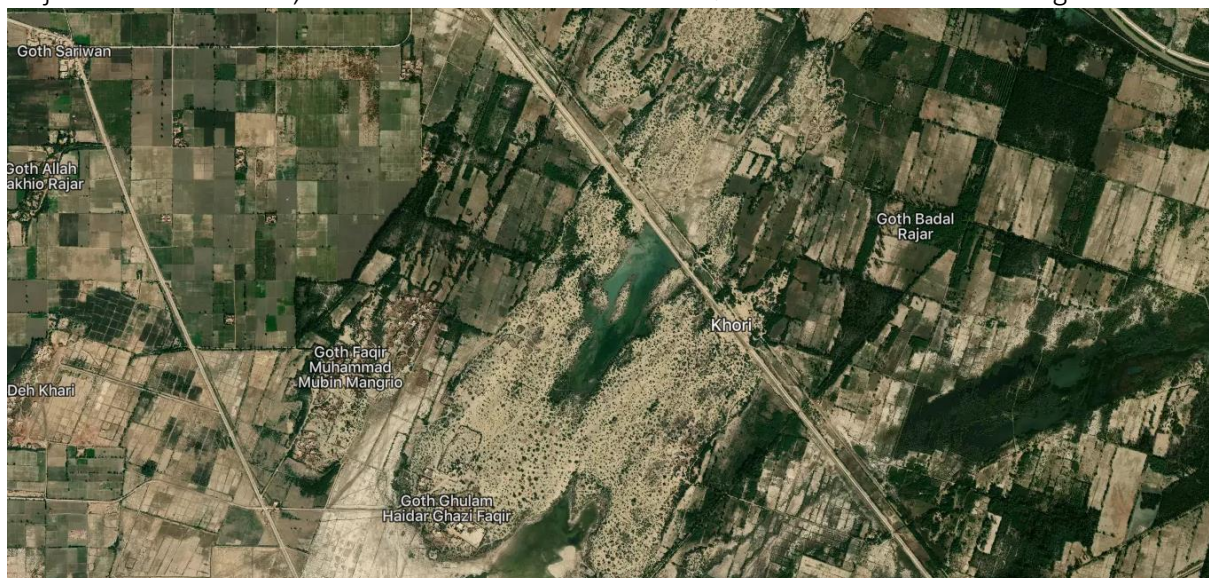


Figure-18 Map of Khori

Questionnaire survey on the electricity and energy demands of Sanghar district as shown in Table-3

S#	Electricity Available	Source of Electricity	Reliability of Electricity	Daily Electricity Use	Peak Electricity Use	Aware of Cost	Monthly Consumption (Units)	Monthly Bill
1	Yes	Grid	8hrs	Yes	Morning/Afternoon	Yes	Unknown	2000
2	Yes	Solar/Grid	12hrs	Yes	Morning/Afternoon	Yes	Unknown	5000
3	No	No	No	No	No	No	No	No
4	No	No	No	No	No	No	No	No
5	No	No	No	No	No	No	No	No
6	Yes	Solar Power	4hrs	Yes	Night	No	No	No
7	Yes	Solar Power	8hrs	Yes	Afternoon	No	No	No
8	Yes	Solar Power	8hrs	Yes	Afternoon	No	No	No
9	Yes	Solar Power	4hrs	Yes	Afternoon/Night	No	No	No
10	Yes	Solar Power	8hrs	Yes	Afternoon	No	No	No
11	Yes	Solar Power	8hrs	Yes	Afternoon/Night	No	No	No
12	Yes	Solar Power	4hrs	Yes	Afternoon	No	No	No
13	Yes	Solar Power	8hrs	Yes	Afternoon	No	No	No
14	No	No	No	No	No	No	No	No
15	No	No	No	No	No	No	No	No
16	Yes	Grid	8hrs	Yes	Afternoon/Night	Yes	53	2000
17	No	No	No	No	No	No	No	No
18	Yes	Solar Power	8hrs	Yes	Afternoon/Night	No	No	No
19	Yes	Grid	4hrs	Yes	Afternoon	Yes	Unknown	300
20	Yes	Grid	4hrs	Yes	Afternoon/Night	Yes	Unknown	2500
21	Yes	Solar/Grid	8hrs	Yes	Afternoon/Night	Yes	Unknown	1500
22	Yes	Grid	8hrs	Yes	Afternoon	Yes	Unknown	2000
23	Yes	Grid	8hrs	Yes	Afternoon	Yes	Unknown	4000
24	No	No	No	No	No	No	No	No
25	Yes	Grid	4hrs	Yes	Evening	Yes	Unknown	4000
26	Yes	Grid	8hrs	Yes	Afternoon	Yes	Unknown	3000
27	Yes	Grid	8hrs	Yes	Afternoon	Yes	Unknown	3500

This dataset presents information on electricity access and usage patterns in 27 surveyed households or units, from rural areas such as Ranahu and Khori in Sanghar District, Sindh. Here's a breakdown and interpretation of the key findings from the table:

1. Electricity Availability

- Total households surveyed: 27
 - Households with electricity access: 20
 - Households without electricity access: 7 (Households 3, 4, 5, 14, 15, 17, 24)
- This means about 74% of the surveyed units have some form of electricity.

2. Sources of Electricity

Among the 20 households with electricity:

- Grid only: 9 (Households 1, 16, 19, 20, 22, 23, 25, 26, 27)
- Solar only: 8 (Households 6–13, 18)
- Hybrid (Solar + Grid): 2 (Households 2, 21)
- No electricity source listed: 1 (Household 3 claims no electricity)

This shows that solar energy is being widely adopted, especially where grid supply is insufficient or unavailable.

3. Reliability and Duration

- Most common electricity duration: 8 hours per day

- Shortest duration: 4 hours (Households 6, 9, 12, 19, 20, 25)
- Highest reliability (12 hrs): Household 2 (Solar + Grid)

Grid users generally have longer and more reliable power than solar-only users, but hybrid systems offer the best coverage.

4. Daily and Peak Electricity Use

- All households with electricity reported regular daily use.
 - Common peak usage times: Afternoon and Night
- Solar users often use power in the Afternoon (likely due to solar availability)

5. Awareness of Electricity Costs

- Yes (aware): 12 households
- No (not aware): 8 households
- Not applicable (no electricity): 7 households

This suggests limited awareness about electricity costs.

6. Monthly Electricity Bills

- Bills range from Rs. 300 to Rs. 5000
- Highest bills: Rs. 5000 (Household 2), Rs. 4000 (Households 23, 25)
- Lowest known bill: Rs. 300 (Household 19)
- Unknown consumption and billing: Majority (due to informal or non-metered usage)

7. Monthly Consumption Data

- Only one household (Household 16) reported a unit-based consumption: 53 units.
- The rest either didn't know or had no metered consumption.

This reflects a lack of metering systems, especially and rural households using informal grid connections further majority have no access to electricity.

Key Observations and findings of table-3

1. Solar power plays a critical role in supplementing unreliable or unavailable grid supply.
2. Awareness of costs and consumption is low, especially where electricity is not formally billed and access to electricity.
3. Hybrid systems (solar + grid) offer the best access and reliability, but are rare.
4. Prolonged Load Shedding: Residents across Sanghar have reported daily power outages ranging from 12 to 14 hours, particularly during peak summer months. These outages disrupt daily life and economic activities.
5. Infrastructure Limitations: The district's electricity infrastructure struggles to meet the growing demand, leading to frequent and extended load shedding period.
6. Community Engagement: Residents should collaborate to ensure timely bill payments and report illegal connections, which can contribute to reduced load shedding.

Energy Conservation: Implementing energy-saving practices can help reduce overall demand and lessen the strain on the local grid.

Discussion: Electricity and Alternative in Ranahu and Khorī, Sanghar District

1. Electricity Supply Through Solar Energy

Ranahu and Khorī, located in the remote tehsil of Khipro within Sanghar District, face persistent issues with electricity availability due to underdeveloped infrastructure and frequent load shedding. In response, solar energy is increasingly being considered and adopted as a sustainable alternative.

In both villages, solar panels have started gaining traction—especially among households and small-scale commercial and institutional activities. Due to abundant sunlight throughout the year, solar power presents a highly viable solution. Some NGOs and government programs have initiated pilot projects providing solar kits, though coverage remains limited.

However, maintenance, cost of installation, and lack of technical knowledge are significant barriers to large-scale adoption. Villagers often rely on external support for installation and troubleshooting, limiting long-term sustainability.

2. Community Awareness and Engagement

Awareness of solar energy and other renewable sources is growing but still limited by educational and informational gaps. Community-level engagement in Ranahu and Khorī is generally informal and lacks structured platforms for collective decision-making on energy issues.

Occasionally, awareness workshops conducted by NGOs or district-level programs introduce the benefits of solar technology, including cost-saving, independence from grid instability, and environmental advantages. However, the frequency and reach of these efforts are inadequate. To promote sustainable energy practices:

Community-led energy committees can be formed.

Training sessions on solar installation and maintenance should be organized.

Micro-financing options for solar systems should be introduced, especially for lower-income households.

3. No Availability of Grid Electricity

Many remote settlements in Sanghar District—including parts of Ranahu and Khorī—either lack access to grid electricity or face inconsistent and poor-quality power supply. This severely impacts daily life, education, water supply (due to lack of electric pumps), healthcare (e.g., refrigeration for medicines), and productivity. The limited infrastructure investment in rural Sindh has resulted in vast energy inequalities. In these contexts, solar and other renewable sources aren't luxuries but necessities for basic livelihood and development.

4. Utilization of Other Alternative Energies

Aside from solar power, other alternative energy sources remain largely untapped in these villages due to resource limitations and a lack of technical capacity. Biogas has potential in agricultural areas like Sanghar due to livestock waste availability, but the technology is scarcely deployed. Wind energy, although viable in certain parts of Sindh, has not been explored in Ranahu and Khorī specifically. Battery-based systems are used where solar panels are installed, allowing limited energy storage for nighttime use.

To enhance energy access in Sanghar's rural regions, including Ranahu and Khorī:

Hybrid energy solutions (solar + battery + biogas) should be piloted.
Local cooperatives could be formed for collective investment in community-scale solar grids.
Public-private partnerships could support scaling renewable energy adoption.

Conclusion

Ranahu and Khorī represent many rural villages in Sanghar District that suffer from energy poverty. While solar energy offers a promising solution, the path to widespread adoption requires community education, institutional support, and financial assistance. Building local capacity and engaging the community meaningfully are essential to moving from awareness to action. Investing in decentralized, renewable energy systems is not only practical—it is essential for the region's sustainable development.

Review of Energy Policy

The Alternative and Renewable Energy Policy 2019 is aligned with Pakistan's pledge to a sustainable and green future. The policy encompasses ambitious targets to increase the share of renewable/ clean energy's share in the national energy map, aiming for 20% by 2025 and 30% by 2030. The primary focus of the policy revolves around four key components that include protection of environment, uninterrupted and reliable supply of energy, upgrading the competency of local industry and skilled resources. By nurturing advanced technological innovation, competitive bidding, and local manufacturing, this renewable energy policy aims to put forward clean energy more accessible, easily affordable and a leap towards a sustainable development in the country.

Pakistan's power generation relies on a mix of thermal, hydel, renewable, and nuclear sources, with thermal power dominating. The RE Policy 2006 successfully initiated the development of renewable energy (ARE) projects by offering economic incentives to attract investment, reduce barriers, and support pioneering projects. The RE policy 2006 ended in March 2018.

Structuring on its foundation, the ARE Policy 2019 aims to explore and utilize Pakistan's renewable energy capacity while fostering competitive affordability. It comes under the broader framework of National Energy Policy (NEP) and follows its legislative standing from Section 14A of the Renewable Energy Policy Act (REPA). This section mandates the development of a sustainable renewable energy sector with an increased contribution of renewable resources in the current energy consumption pattern.

The ARE Policy 2019 focuses on the use of Alternative and Renewable Energy Technologies (ARETs) for power systems. The policy primarily focuses on power generation therefore other policies cover the implementation and application of ARTs. It also outlines a detailed way forward for scaling up the renewable energy generation, ensuring its affordability, and encouraging sustainable growth in Pakistan's energy sector.

The **Alternative and Renewable Energy (ARE) Policy 2019** is aligned with the country's ultimate clean energy objectives these include **sustainability, affordability, responsibility, and availability**. The policy foresees an efficient, reliable, and environmentally responsible power industry. It promotes **indigenization of technology**, enhanced **skill development**, and improved **local manufacturing capacity** in alternative and renewable energy technologies (ARETs).

Key Objectives:

- **Environmental Protection:** To scale-up the influx of clean energy in the national energy grid.
- **Affordable Energy:** Make sure of reduced cost of power production.
- **Efficient Procurement:** To ensure quick and clear auctions for ARE projects.
- **Market Development:** Maximise the production and supply on national scale.
- **Local Capacity Building:** Promote capacity building of local manufacturers both in terms of skilled labour and adapt advanced technology.
- **Private Sector Participation:** Encourage investments for on-grid and off-grid solutions for ARE projects.
- **Reduced Public Investment Burden:** To reduce the financial burden on government for meeting the raised demands of power generation.

The policy targets to enhance renewable energy (RE) in Pakistan's energy map, ensuring sustainable and low-cost electricity access. The 20x25 and 30x30 targets set in the Alternative and Renewable Energy Policy 2019 intends to increase the stake of renewable energy (RE) in Pakistan's energy map.

20x25 Target

According to the ARE Policy, by the year 2025, at least 20% of the country's on-grid power generation capacity is generated from alternative and renewable energy (ARE) sources. This includes the below list technologies:

- Solar (PV and thermal)
- Wind (on-shore and off-shore)
- Biomass
- Ocean/tidal wave energy
- Geothermal
- Hydrogen
- Energy from waste
- Storage technologies (such as batteries)
- Hybrids of the above technologies

30x30 Target

By the year 2030, the policy further extends this target to 30% of on-grid power generation capacity to be generated from renewable resources. This target aims to achieve a sustainable developments and reduced dependency on local and imported fossil fuels, thus resulting in environmentally responsible and more reliable energy supply.

To attain the set targets of 20x25 and 30x30, the policy document outlines the following measures:

- 1. Increased Capacity Additions:** An increased number of new power generation plants will be set-up relying on ARE resources. Additionally, the capacity and efficiency of existing plants will be improved.
- 2. Competitive Bidding:** Any new project will undergo through a transparent and competitive bidding processes to make sure the affordability and efficiency.
- 3. Technological Solutions:** Advanced RE forecasting capabilities and hybrid solutions will be employed to overcome the technical shortcomings of reactive power support, base load and spinning reserve requirements.

4. Displacement of Expensive Energy: Gradual shift from non-renewable fossil fuel energy to clean and affordable ARE resources.

5. Public Utility Procurement: Federally-owned public utilities will procure RE through competitive bidding, government-to-government agreements, and unsolicited projects.

6. Non-Utility Procurement: Convenient rules and regulations and incentives including off-grid solutions and net-metering for FPU will be put in place.

7. Indigenization and Local Content: Lifting the duty exemptions from imported items that can be sourced locally to promote local manufacturing of ARET and its consumables.

This policy reflects a comprehensive approach to integrating renewable energy into Pakistan's energy mix, fostering sustainable development and energy security.

Expected Outcomes

- Improve the reliability of energy supply and its sustainability.
- Reduce the carbon emissions caused by exhausting non-renewable resources.
- Development of local manufacturing and skilled human resources for ARE technologies.
- Increase the electricity supply on affordable rates in all regions of Pakistan.

The successful implementation of these targets will reflect in a greener, more sustainable energy map for Pakistan.

Challenges in achieving the Policy Targets

However, Pakistan could face several challenges in achieving the 20x25 and 30x30 renewable energy targets:

Infrastructure and Investment

- Lack of Infrastructure: Pakistan needs more transmission capacity to move renewable energy resources to market.
- Limited Access to Investment: The government is often reluctant to invest in renewable energy due to concerns about grid reliability.

Political and Regulatory Challenges

- Political Instability: Issues in politically unstable regions, where most renewable energy potential is located, hinder investment.
- Regulatory Uncertainty: Inconsistent policies and regulatory frameworks can deter investors.

Technical Barriers

- Efficiency of Technologies: Renewable energy technologies, such as solar panels, are not always efficient due to variability in sunlight.
- Transmission Issues: Renewable energy needs to be transmitted across large distances to be used by consumers.

Financial and Economic Challenges

- High Initial Costs: The upfront costs of renewable energy projects can be high, making it difficult for investors to commit.
- Circular Debt: The energy sector's financial instability, including circular debt, poses a significant challenge.

Social and Environmental Challenges

- Access to Electricity: A significant portion of the population, especially in rural areas, lacks access to electricity.
- Environmental Concerns: While renewable energy is environmentally friendly, the development of infrastructure can have environmental impacts.

Capacity Building and Skill Development

- Lack of Skilled Workforce: Developing a skilled workforce for the renewable energy sector is crucial for the successful implementation of projects.

Policy Recommendations

Keeping an account of the above-mentioned challenges, it directs towards a well informed and collective effort from the government, private sector, general public and international partners to foster an encouraging environment for renewable energy development in Pakistan.

To overcome the challenges in achieving the 20x25 and 30x30 renewable energy targets, following solutions can be considered:

Infrastructure and Investment

- Upgrade Transmission Infrastructure: Advancement and upgradation of the existing distribution network must be promoted. Also, any faults or energy wastage caused due to inefficient distribution network must be identified and repaired.
- Attract Investment: In order to attract local and foreign investment a comprehensive and collective energy policy is required to meet the international trends. The policy must be based on local data analysis and relevant future speculations.
- Local Grids: Introduce and regularize satellite grids or detached grids to promote local corporation and reduce the cost of mega transmission projects especially in rural areas.

Political and Regulatory Solutions

- Stable Policies: The policies must be reliable and beneficial in terms of their, transparency, implementation plan and politically independent to build investor confidence and reduce regulatory uncertainty.
- Government Support: Further enforce government support especially for the renewable energy power projects. Tax rebate and subsidies must be incorporated in the budget,
- Carbon Crediting: formalizing a system to benefit from the global carbon credit market and actively seek assistance both in finance and technology to improve the current status.

Technical Solutions

- Advanced Technologies: Promote research in energy technology sector to come up with innovative and localized solutions.
- Energy Storage: Decentralization of energy storage on domestic, commercial and industrial scale must be developed.

Financial and Economic Solutions

- Financial Incentives: Utilization of renewable energy resources must be subsidized by financing schemes and grants to encourage renewable energy projects.

- Address Circular Debt: Revising the previous agreements and policies to resolve the issue of circular debt in the energy sector will improve financial stability.

Social and Environmental Solutions

- Rural Electrification: Alternate energy sources in rural areas must be focused. Projects to provide access to electricity in remote areas using renewable energy sources will improve the accessibility of energy.
- Environmental Impact Assessments: EIAs for new projects must be mandatory to minimize the negative effects of renewable energy projects on the environment.

Capacity Building and Skill Development

- Training Programs: formal and informal training programmes can play a key role in developing a skilled workforce in renewable energy sector.
- Public Awareness: Raise public awareness about the benefits of renewable energy and encourage community participation in renewable energy projects.

By addressing these challenges with a comprehensive and multi-faceted approach, Pakistan can successfully achieve its renewable energy targets and pave the way for a sustainable and secure energy future.

Alternate Energy Policy and Sindh

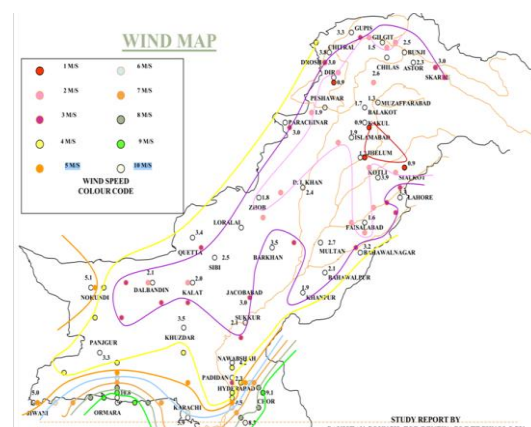
The current policies could end the relentless growth of fossil fuel use. According to the International Energy Agency, global fossil fuel use may finally stop growing this decade. Based on global commitments to policy actions and plans, fossil fuels will account for less than 75% of the total energy supply by 2030 and just above 60% by 2050. The shift to cleaner energy is picking up speed - but it needs to be faster.

Renewable energy options available today have become more mature and cost-competitive, providing more efficient energy use, cleaner energy generation, better storage and transmission modes.

Policy measures in Sind are crucial as it is rich in its renewable resources. Sindh alone can produce over a 100GW of power with an installed capacity of 5MW per Km². It has been divided into four zones namely Karachi, Thatta, Badin and Jamshoro. These can easily facilitate the study areas of Tando Allahyar and Khipro districts.



Figure 16: Map Showing the 4 Zones of Sind with High Wind Speed



Zone	District	Region	30 m			50 m			Class (30 m)	Class (50 m)
			Low	Average	High	Low	Average	High		
1	Karachi	DHA Karachi	2.9	5.0	7.4	3.6	5.9	9.0	1	2
		Hawks Bay	2.8	5.1	6.8	3.2	5.4	7.1	1	2
		Chuhar Jamali	2.9	4.6	7.4	3.9	5.8	8.0	1	2
		Gharo	3.0	5.9	9.1	3.8	6.6	9.4	2	3
2	Thatta	Jati	3.5	5.4	8.5	4.4	6.4	9.1	2	3
		Keti Bandar	4.1	6.1	9.1	4.4	7.0	10.2	2	4
		Mirpur sakro	2.8	5.2	9.2	3.6	6.4	10.7	1	3
		Sajawal	3.0	5.0	7.7	4.2	6.6	9.7	1	3
3	Badin	Shah Bandar	3.8	5.8	8.9	4.5	6.5	9.6	2	3
		Golarchi	3.2	5.1	7.5	4.3	6.7	9.4	1	3
		Talhar	2.0	4.6	7.3	2.7	6.3	10.3	1	3
		Jamshoro	3.7	6.9	11.6	5.0	8.5	13.9	4	6
4	Jamshoro	Nooriabad	3.5	6.4	9.7	4.2	7.0	10.6	3	4
		Thano Bula Khan	2.1	4.7	8.7	2.7	5.5	9.8	1	2

Table 4: Classification of four zones based on wind speed

However, due to high installation cost and lack of efficient infrastructure more convenient alternative can be the PV Solarisation. As Sindh due to its topography and geographical location it also receives an ample amount of high intensity solar radiation and has vast open spaces which can be utilized for both domestic and non-domestic uses, particularly in rural areas where on-grid electrification is not available.

Photovoltaic technology is particularly suitable for small power requirements and remote area applications. The provinces of Sindh and Balochistan, and the Thar Desert are especially suited for the utilization of solar energy through photovoltaics. About 60% of the villages are yet to be electrified. Large distances with absolutely no approach roads separate these villages. The houses are mostly 'kacha' hut type with walls and roofs made with a combination of mud and straw. Light is the main requirement for these houses. Most of the houses consist of only one room. The electric requirement for each house varies from 50 to 100 W maximum. Transmission lines are very expensive to build in these areas and there is only a remote possibility of grid connection in the near future. Also, the extension of grid lines for such small power requirements is very uneconomical. Local power generation is a possible solution to these problems.

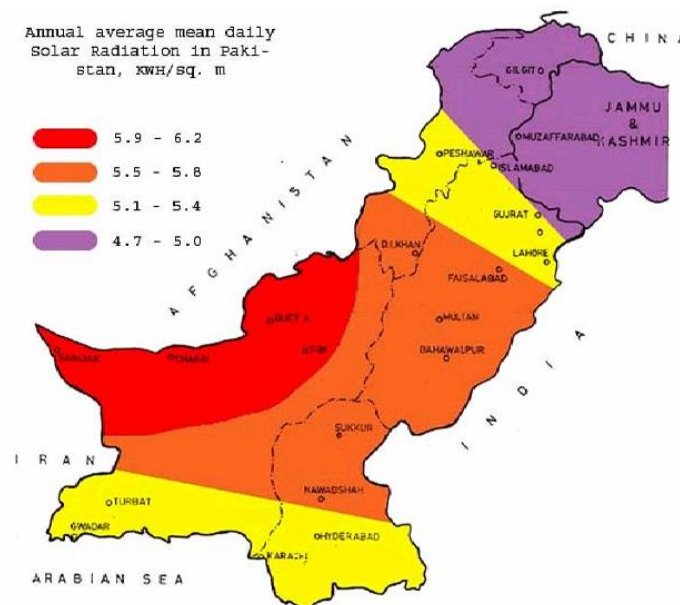


Figure 18: Solar Radiance Map of Pakistan

Proposal For Alternative Energy

In an era of rising energy demands and environmental concerns, solar energy emerges as a sustainable and cost-effective solution for both domestic and commercial users. Harnessing the power of the sun not only reduces reliance on conventional electricity but also lowers utility bills and minimizes carbon footprints. This proposal outlines a comprehensive approach to solar energy calculations, ensuring users can efficiently optimize their energy consumption while making informed decisions about installation costs, savings, and long-term benefits.

User Profile	Fans	lights	Electric appliances				Solar panels preferences in KW	Battery preferences
			T.V.	Fridge	Stitching machines	Washing machine		
Domestic User (12 persons)	6 450W	8 80W	1 100W	1 15W	1 250W	1 500W	2KW PANEL	12-VOLTS / 780AH battery
Commercial User (Tailor shop)	2 150W	8 960W	1 100W	---	6 1500W	---	5 KW PANEL	12 volts (200Ah) 9 batteries

Proposal Of Solar Energy for Domestic User

Step 1: Power Consumption Estimate

Average power ratings (may vary based on models):

1. **Fan:** $75W \times 6 = 450W$
2. **LED Light:** $10W \times 8 = 80W$
3. **TV:** $100W \times 1 = 100W$
4. **Fridge:** $150W \times 1 = 150W$
5. **Stitching Machine:** $250W \times 1 = 250W$
6. **Washing Machine:** $500W \times 1 = 500W$

Step 2: Total Daily Energy Consumption

Assuming an average usage of 6 hours per day:

1. **Fans:** $450W \times 6h = 2,700Wh$
2. **Lights:** $80W \times 6h = 480Wh$
3. **TV:** $100W \times 6h = 600Wh$
4. **Fridge:** $150W \times 24h = 3,600Wh$ (*runs continuously*)
5. **Stitching Machine:** $250W \times 4h = 1,000Wh$
6. **Washing Machine:** $500W \times 2h = 1,000Wh$

Total estimated daily consumption: 9,380Wh (9.38kWh)

Step 3: Solar Panel and Battery Sizing

Solar Panels for full solar operation, assuming 5 peak sun hours per day:
Required solar power = $9,380\text{Wh} / 5\text{h} = 1,876\text{Wh}$ (approx. 2kW solar panels)

Battery Storage for 24-hour backup, assuming 12V batteries:
Required battery capacity = $9.38\text{kWh} \div 12\text{V} = 780\text{Ah}$

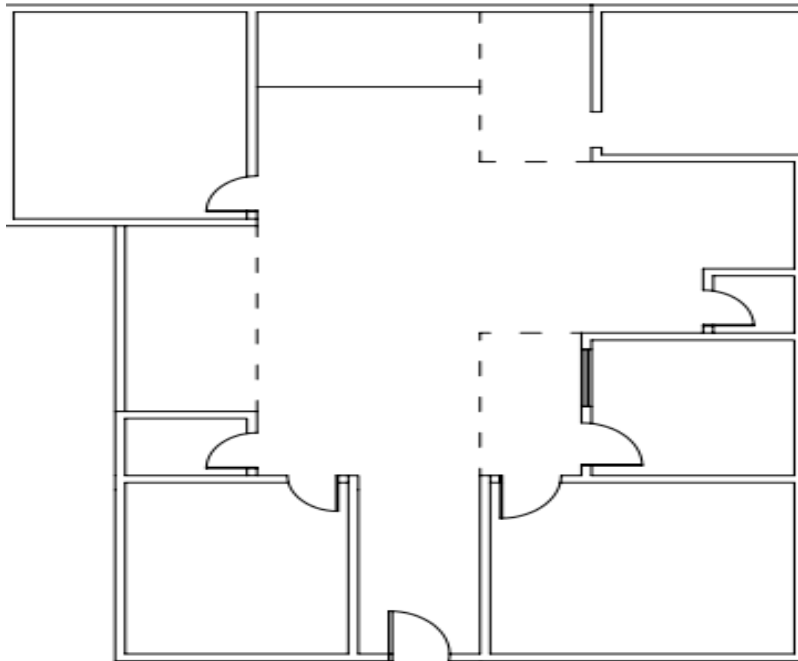


Figure-19: Plan of a Typical House in Tandoallahyar

Proposal Of Solar Energy for Commercial Users

To calculate the solar setup for your **commercial tailor shop**, let's estimate the power consumption and required solar system size.

Step 1: Power Consumption Estimate

Average power ratings (may vary based on models):

1. **Fan:** $75\text{W} \times 2 = 150\text{W}$
2. **LED Light:** $10\text{W} \times 8 = 80\text{W}$
3. **Stitching Machine:** $250\text{W} \times 6 = 1,500\text{W}$
4. **TV:** $100\text{W} \times 1 = 100\text{W}$

Step 2: Total Daily Energy Consumption

Assuming an average usage of 12 hours per day:

1. **Fans:** $150\text{W} \times 12\text{h} = 1,800\text{Wh}$
2. **Lights:** $80\text{W} \times 12\text{h} = 960\text{Wh}$
3. **Stitching Machines:** $1,500\text{W} \times 12\text{h} = 18,000\text{Wh}$
4. **TV:** $100\text{W} \times 8\text{h} = 800\text{Wh}$

Total estimated daily consumption: 21,560Wh (21.56 kWh)

Step 3: Solar Panel and Battery Sizing

Solar Panels for full solar operation, assuming 5 peak sun hours per day:

Required solar power = $21,560\text{Wh} / 5\text{h} = 4,312\text{Wh}$ (approx. 5kW solar panels)

Battery Storage for 12-hour backup, assuming 12V batteries:

Required battery capacity = $21,560\text{Wh} \div 12\text{V} = 1,796\text{Ah}$ approx. (1,800 Ah)

(200Ah) 9 batteries are required for 21,560Wh energy consumption

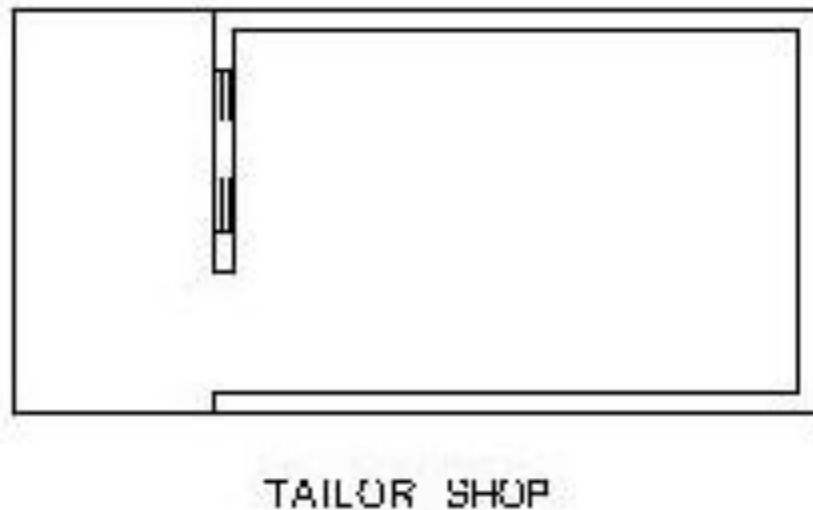


Figure-20 Plan of Tailor shop

Conclusion

In conclusion, this research on the effectiveness and challenges of clean energy solutions in rural Sindh intends to provide a broad understanding of the current state of clean energy adoption from the end-user perspective. By evaluating the effectiveness of existing solutions, identifying key challenges, and highlighting the needs and preferences of rural communities, this study seeks to fill critical gaps in the clean energy sector. The insights gained will inform the development of more effective, user-centric clean energy programs that address the specific needs of rural residents, ultimately supporting their transition to sustainable energy solutions.

The study's findings will bring insights for policymakers, energy providers, and stakeholders, ensuring that future initiatives are well-aligned with the real-world experiences of end-users. By empowering rural communities with the knowledge and resources to participate in the clean energy transition, this research aims to contribute to the overall development and well-being of the region. In doing so, it will play a crucial role in fostering a more sustainable and energy-secure future for rural Sindh.

Recommendations

Among all renewable energy sources, solar radiation is in abundance, freely available, widely distributed and can easily be converted into other forms of energy. This makes solar energy the most promising future source of energy. However, Sind is rich in wind energy as well and the wind corridor in that is formed in Thata, Keti Bandar and Badin can easily be explored to meet the energy requirements of the province. On rural scale the distribution becomes a challenge for large scale projects. Some recommendations to enhance solar, wind and other alternative energy utilization in the regions of Kipro and Thodolayar are discussed below:

- **Solar Home Systems (SHS):** Facilitate the distribution and installation of solar home systems to low-income households. Sind government has actively distribution of 500,000 solar systems to alleviate electricity expenses for low-income families. This initiative needs to be further scaled up to cover more households in these regions. These systems are very useful for meeting the energy demands of off-grid areas. The SHS can easily support basic requirements of lighting, phone charging, refrigeration, television and other low power loads.
- **For Off-Grid Non-Domestic user:** These systems can be installed for commercial and institutional facilities. Depending on the requirements it can support a wide range of applications such as water pumping, stitching unit, refrigeration of medicines and vaccines, and a wide range of low energy consuming electrical equipment.
- **Utility-Scale Solar Projects:** Utility-scale solar parks can be developed in Kipro and Tandoallahyar where the feasibility of on grid distribution is available. These are publicly owned solar parks and support the competitive selection of private sector developers.
- **Distributed Solar Systems:** Encourage the installation of solar PV systems on rooftops of public sector buildings, schools, and hospitals in Kipro and Tandoallahyar. This initiative can help local population to familiarize with the technology and its benefits.
- **Wind Energy Utilization:** Small-Scale wind turbines can be installed for domestic scale electricity generation. These turbines can facilitate localized energy generation, making them ideal for rural areas. These turbines typically range from 400W to 100kW and can power homes, farms, and small businesses. Smaller than commercial wind farms, they can be installed on rooftops or standalone towers.
- **Hybrid Wind-Solar Systems:** Sindh experiences long sunny days most of the year, while wind speeds are higher during the monsoons. Wind turbines and solar photovoltaic (PV) panels—can be employed for stable and continuous power supply. This hybrid approach is particularly effective in rural regions where grid access is limited or unreliable.
- **Biogas Energy:** Sindh has a very high number of rural populations engaged in livestock or agricultural farming both on domestic and commercial scale. If this resource is utilized the cow dung, poultry litter and crop residue can easily be used to produce Biogas. This biogas can provide 4-6 hours of gas for cooking purposes. The produced gas also will be useful for electricity generation by biogas generators.

- **Integrated Approach:** Combining resources can ensure energy reliability and sustainability. Solar energy and Biogas can be integrated for clean electricity generation and cooking fuel. Wind and Solar can be combined for energy generation in areas with variable weather patterns and can facilitate multiple units of both domestic and commercial sector.
- **Energy Cooperatives:** Local User or community- owned systems for mutual benefit must be encouraged. This implies to the initiatives led and managed by the community. This will promote resource sharing and mutual benefits, and make it affordable for larger group of population. Systems may include solar micro-grids, small scale wind turbines, biogas plants or hybrid models depending on the availability of resources.
- **Public-Private Partnerships:** Encourage public-private partnerships to attract investment in alternate energy projects. Financing aids, payment in instalments, subsidies to scale -up the power generation etc. can help to spread the system widely.
- **Awareness and Training Programs:** Implement awareness campaigns and training programs to educate local communities about the benefits of solar energy and the proper maintenance of solar systems. This can help ensure the long-term sustainability of solar energy projects in the region.

By implementing these recommendations, Sindh can harness its solar energy potential and contribute to the overall energy security and sustainability of Pakistan.

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Project: Clean Energy and Climate Resilient Housing in Rural
Sindh, Pakistan : Study on Alternative Energy Supply, Market, and Consumption in
Rural Areas of Sindh

**1- Questionnaire for Schools and Hospitals Survey on
Alternative Energy Solutions**

Institution Name: _____

Type of Institution:

- ☐ School
☐ Hospital

Location: _____

Number of Students/Patients: _____

Number of Staff: _____

Q.No.1: Do you have electricity available at your facility?

- ☐ Yes
☐ No

Q.No.2: if yes what is the source of Electricity supply?

Q.No.3: How reliable is your electricity supply?

- ☐ Very reliable (rare outages)
☐ Moderately reliable (occasional outages)
☐ Un reliable (frequent outages)

Q.No4: What are the options available to you in case of power outage?

Q.No.5: How many hours per day do you typically use electricity at your workplace?

- ☐ Less than 4 hours.
☐ 4--8 Hours.
☐ 8—12 Hours

- ☐ More than 12 hours

Q. No.6: During which times of the day do you use the most electricity? (Select all that apply)

- ☐ Morning (6AM-11AM)
- ☐ Afternoon (12:00PM-6PM)

For Hospitals and clinics:

- ☐ Evening (7PM-12AM)
- ☐ Night (12 AM-6AM)

Q.No.7: Are you aware of the cost of electricity per unit for commercial usage?

- ☐ Yes
- ☐ No

Q. No.8: What is your average monthly electricity consumption?

No of units: _____

Q.No.9: What is the average cost of your monthly electricity?

Amount Rs. _____

Q. No10: Are you aware of alternative energy solutions available for institutions like yours?

- ☐ Yes
- ☐ No

Q.No.11: Which of the following alternative energy solutions are you familiar with? (Select all that apply)

- ☐ Solar Power
- ☐ Wind Power
- ☐ Hydropower
- ☐ Biomass Energy
- ☐ Geothermal Energy
- ☐ Other (please specify): _____

Q.No.12. Do you currently use any alternative energy solutions in your institution?

- ☐ Yes
- ☐ No

Q.No.13. If yes, which alternative energy solutions do you use? (Select all that apply)

- ☐ Solar Power
- ☐ Wind Power
- ☐ Hydropower
- ☐ Biomass Energy
- ☐ Geothermal Energy
- ☐ Other (please specify): _____

Q.No.14. What were the main reasons for adopting alternative energy solutions? (Select all that apply)

Cost savings

- ☐ Energy independence
- ☐ Government incentives
- ☐ Institutional responsibility
- ☐ Other (please specify): _____

Q.No.15. What are the main barriers preventing you from adopting alternative energy solutions? (Select all that apply)

- ☐ High initial cost
- ☐ Lack of information
- ☐ Maintenance concerns
- ☐ Insufficient government incentives
- ☐ Space constraints
- ☐ Other (please specify): _____

Q.No.16. If you are using alternative energy solutions, what benefits have you experienced? (Select all that apply)

- ☐ Reduced energy costs
- ☐ Increased energy reliability
- ☐ Other (please specify): _____

Q.No.17. Are you planning to invest in alternative energy solutions in near future?

- ☐ Yes
- ☐ No
- ☐ Maybe

Q.No.18. What support or resources would help you adopt alternative energy solutions? (Select all that apply)

- ☐ Financial incentives
- ☐ Technical assistance
- ☐ Information and education
- ☐ Government policies
- ☐ Other (please specify): _____

2- Questionnaire for Commercial Users Survey on Alternative Energy Solutions

Business Information:

Business Name: _____

Industry: _____

Location: _____

Number of Employees: _____

Q.No.1: Do you have electricity available at your workplace?

- ☐ Yes
- ☐ No

Q.No.2: if yes what is the source of Electricity supply?

- ☐ Grid
- ☐ Solar
- ☐ Biomass
- ☐ Any other (specify): _____

Q.No.3: How reliable is your electricity supply?

- ☐ Very reliable (rare outages)
- ☐ Moderately reliable (occasional outages)
- ☐ Un reliable (frequent outages)

Q.No.4: How many hours per day do you typically use electricity at your workplace?

- ☐ Less than 4 hours.
- ☐ 4--8 Hours.
- ☐ 8—12 Hours
- ☐ More than 12 hours

Q. No.5: During which times of the day do you use the most electricity? (Select all that apply)

- ☐ Morning (6AM-11AM)
- ☐ Afternoon (12:00PM-6PM)
- ☐ Evening (7PM-12AM)
- ☐ Night (12 AM-6AM)

Q.No.6: Are you aware of the cost of electricity per unit for commercial usage?

- ☐ Yes
- ☐ No

Q. No.7: What is your average monthly electricity consumption?

No of units: _____

Amount of Bill: _____

Q.No.8. Are you aware of alternative energy solutions available for commercial use.

- ☐ Yes
- ☐ No

Q.No.9: Which of the following alternative energy solutions are you familiar with?

(Select all that apply)

- ☐ Solar Power
- ☐ Wind Power
- ☐ Hydropower
- ☐ Biomass Energy
- ☐ Geothermal Energy
- ☐ Other (please specify): _____

Q.No.10: Do you currently use any alternative energy solutions in your business operations?

- ☐ Yes
- ☐ No

Q.No.11: If yes, what were the main reasons for adopting alternative energy solutions?

(Select all that apply)

- ☐ Cost savings
- ☐ Environmental impact
- ☐ Energy independence
- ☐ Government incentives
- ☐ Other (please specify): _____

Q.No.12: If no, what are the main barriers preventing you from adopting alternative energy solutions? (Select all that apply)

- ☐ High initial cost
- ☐ Lack of information
- ☐ Maintenance concerns
- ☐ Insufficient government incentives
- ☐ Space constraints
- ☐ Other (please specify): _____

Q.No.13: If you are using alternative energy solutions, what benefits have you experienced? (Select all that apply)

- ☐ Reduced energy costs
- ☐ Increased energy reliability
- ☐ Other (please specify): _____

Q.No.14 Are you planning to invest in alternative energy solutions in near future.

- ☐ Yes
- ☐ No
- ☐ Maybe

**Q.No.15: What support or resources would help you adopt alternative energy solutions.
(Select all that apply)**

- ☐ Financial incentives
- ☐ Technical assistance
- ☐ Information and education
- ☐ Government policies
- ☐ Other (please specify): _____

Q.No.16: Please provide any additional comments or suggestions regarding alternative energy solutions for commercial use:

Project: Clean Energy and Climate Resilient Housing in Rural
Sindh, Pakistan : Study on Alternative Energy Supply, Market, and Consumption in
Rural Areas of Sindh

3- Questionnaire for Domestic Users

Q No. 1: General Profile of the respondent

Location: _____

Name: _____

Age: _____

Gender: _____

Occupation: _____

No. of Family Members/ Dependents: _____

No. of boys and their ages: _____

No. of girls and their ages: _____

Head of House Holds: Name: _____ **Age** _____

Q.No.2: What is your primary source of income?

- ☐ Agriculture
- ☐ Live Stock
- ☐ Small Shop
- ☐ Domestic Skill (Please Specify) _____
- ☐ Another, Specify _____

Q.No.3: How many people in your household contribute towards the household income?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more

Q.No.4: What is your secondary source of income?

Q. No.5: what is the total monthly income of your household?

- ☐ Less than 10,000
- ☐ 10,000----20,000
- ☐ 20,000----30,000
- ☐ 30,000 and above

Q.No.6: Do you have electricity in your household?

- ☐ Yes
- ☐ No

Q.No.7: if yes what is the source of Electricity supply?

- ☐ On Grid

- ☐ Solar
- ☐ Biomass
- ☐ Any other (Specify)_____

Q.No.8: How reliable is your electricity supply?

- ☐ Very reliable (rare outages)
- ☐ Moderately reliable (occasional outages)
- ☐ Un reliable (frequent outages)

Q.No.9: How many hours per day do you typically use electricity in your household?

- ☐ Less than 4 hours.
- ☐ 4--8 Hours.
- ☐ 8—12 Hours
- ☐ More than 12 hours

Q.No.10: Which of the following major appliances do you use regularly? (Select all that apply)

- ☐ Bulb and Fan
- ☐ Water pump
- ☐ Refrigerator
- ☐ Television
- ☐ Any other/ Please Specify_____
- ☐ None of the above

Q. No.11: During which times of the day do you use the most electricity? (Select all that apply)

- ☐ Morning (6AM-11AM)
- ☐ Afternoon (12:00PM-6PM)
- ☐ Evening (7PM-12AM)
- ☐ Night (12 AM-6AM)

Q.No.12: Are you aware of the cost of electricity per unit?

- ☐ Yes
- ☐ No

Q. No.13: What is your average monthly electricity consumption?

No of units: _____

Billing amount: _____

Q. No.14: What source of energy (Fuel) do you use for cooking purposes?

- ☐ Woods
- ☐ Coal
- ☐ Biomass
- ☐ Sui Gas
- ☐ Kerosene Oil
- ☐ Cylinder

Q.No.15: Do you know about alternative energy solutions?

- ☐ Yes

- ☐ No

Q. No.16: if yes, are you using any alternative energy solutions?

- ☐ Yes
☐ No

Q.No.17: if yes, which of the following alternative energy solutions are you familiar with? (Select all that apply)

- ☐ Solar energy (solar Panels)
☐ Wind energy (Wind Mill)
☐ Biomass energy
☐ Geothermal Energy

Q. No.18: Do you know about the benefits of Electrification

- ☐ Yes
☐ No

Q.No.19: Are you willing to pay for solar panel installation, its operation and maintenance?

- ☐ Yes
☐ No

Q. No. 20: If no, what are the main barriers preventing you from adopting alternative energy solutions? (Select all that apply)

- ☐ Lack of information
☐ High Initial cost
☐ Maintenance concern
☐ Insufficient government incentives
☐ Others/ please specify

Q. No.21: What is the mode of transportation available in your village?

Q. No.22: are you aware of vehicles run by electricity?

- ☐ Yes
☐ No

Q. No.23: Do you have access to fresh water at your household?

- ☐ Yes
☐ No

Q.No.24: What is the source of water available to you?

- ☐ Lake
☐ Borehole
☐ Well
☐ Rain water harvesting
☐ Others/ please specify

Q.No25: What is the quality of water available to you?

- ☐ Excellent
- ☐ Good
- ☐ Fair
- ☐ Poor

Q. No.26: Do you have any water storage solutions in place? (Select all that apply)

- ☐ Water tanks
- ☐ Bottled water
- ☐ Other (please specify): _____
- ☐ None