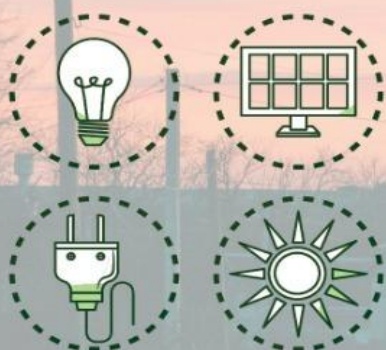




REVIEW OF PAKISTAN'S **ALTERNATIVE AND RENEWABLE ENERGY (ARE) POLICY 2019:**

**Integrating Community
Perspectives and Strengthening
Inclusive Energy Governance for
Sustainable Development**



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Project: Clean Energy and Climate Resilient Housing in Rural Sindh, Pakistan

Position Paper on Renewable Energy

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EXECUTIVE SUMMARY

The project "Clean Energy and Climate Resilient Housing" in rural Sindh, Pakistan, aimed to evaluate the solar energy market across 100 villages in TandoAllahyar and Sanghar districts. Utilizing participatory research methodologies, including Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs), the study produced a comprehensive position paper covering nine chapters. This summary is structured with title of chapter, and key points of each chapter. Below is a summarized brief of the each chapter:

Chapter 1: Introduction: This chapter highlights the global trends in renewable energy, noting that over 2.8 million people were employed in the sector worldwide in 2021, emphasizing its potential for economic growth. The chapter discusses Pakistan's supportive policies, particularly the Renewable Energy Policy of 2019, which aims for renewable sources to contribute 30% of the energy mix by 2030. Sindh is positioned for future developments, including utility-scale solar plants, rooftop systems, and hybrid projects.

Chapter 2: Renewable Energy Policies in Pakistan, 2018/19: This chapter examines the varied approaches to renewable energy policy across Pakistan's provinces. While Punjab focuses on solar energy, Khyber Pakhtunkhwa emphasizes hydropower, and Sindh leads in both wind and solar projects through public-private partnerships. Despite the overarching framework provided by the Renewable Energy Policy of 2019, challenges like land acquisition and financing persist. Sindh's 2015 renewable energy policy aims to enhance wind and solar projects, though bureaucratic and infrastructure hurdles remain.

Chapter 3: Local Solar Market and Cost Factors: Chapter Three reveals a 65% adoption rate of solar energy among villagers, driven by electricity disruptions, high grid costs, and off-grid locations. The local market features diverse solar products, with prices for solar panels ranging from Rs. 6,500 to Rs. 16,000 and complete systems costing between Rs. 35,000 and Rs. 350,000. The chapter categorizes settlements into urban, semi-urban, and rural, highlighting differing energy needs.

Chapter 4: Communities' Regular Energy Needs: This chapter categorizes the energy requirements of urban, semi-urban, and rural households, noting significant urban migration in Sindh. Energy consumption varies, with urban households needing 250–2,500 watts, while rural households require 230–1,500 watts. Per capita energy consumption in lower-income rural households averages 100–200 kWh per month, influenced by grid connectivity and income levels.

Chapter 5: Renewable Energy in Rural Development: It discusses the positive impacts of solar energy on agriculture, education, and healthcare in rural Sindh. Solar power enhances irrigation systems, provides reliable electricity to schools, and supports medical facilities. The demand for solar energy is driven by irregular power supply and rising costs, with community insights highlighting corruption as a push factor for solar adoption.

Chapter 6: Project Area's Renewable Energy Profile (Solar Energy): This chapter examines the stark disparity in electricity access between urban and rural households. While urban areas enjoy nearly universal electrification, 60% to 70% of rural households face unreliable power supply. As of 2023, about 84% of households use grid electricity, with 2.96 million adopting solar panels. Key community needs include affordable options and improved battery storage.

Chapter 7: Future Researches in Renewable Energy: Looking forward, chapter seven discusses anticipated trends in solar energy, such as increased private sector investment, advancements in technology, and enhanced energy storage solutions. Recommendations include implementing robust regulations and building local technological capacity through education.

Chapter 8: Issues and Challenges Faced by Rural Communities: This chapter identifies key challenges for rural communities in adopting solar energy, including a lack of skills for maintenance, frequent theft of equipment, short battery lifespans, high costs, and limited awareness, particularly among women. Addressing these challenges is crucial for enhancing solar power scalability.

Chapter 9: Conclusions and Recommendations: The final chapter concludes that solar energy is increasingly valued for its utility, supported by technological advancements and expanded market access. Despite improvements in daily life, challenges such as high costs remain. Recommendations include establishing training programs, enhancing security measures for solar equipment, promoting solar grid stations, supporting rural entrepreneurs with accessible financing, reducing battery storage costs, lowering the price per watt, conducting regular awareness sessions, improving conversion efficiency to 30%, and fostering community-managed solar parks.

Conclusion: Addressing the challenges and implementing the recommendations outlined in this position paper could significantly enhance the implementation and benefits of solar energy in rural Sindh, ultimately contributing to improved quality of life and sustainable development in these communities.

ABBREVIATIONS & ACRONYMS

ADB	Asian Development Bank
AEDB	Alternative Energy Development Board
ARE	Alternative Renewable Energy
BHUs	Basic Health Units
CPEC	China-Pakistan Economic Corridor
CPI	Consumer Price Index
CSR	Corporate Social Responsibility
DFI	Development Finance Institutions
ESMAP	Energy Sector Management Assistance Program
FDI	Foreign Direct Investment
IPPs	Independent Power Producers
IRENA	International Renewable Energy Agency
KIIs Key	Informant Interviews
MFIs	Microfinance Institutions
NGOs	Non-Government Organizations
PMIC	Pakistan Microfinance Investment Company
RDF	Research and Development Foundation
SHS	Solar Home System
WAPDA	Water & Power Development Authority
WBG	World Bank Group
WPMCs	Wind Power Management Companies
WTG	Wind Turbine Generator

Table of Content

EXECUTIVE SUMMARY

ABBREVIATIONS AND ACROYMS

1. INTRODUCTION	6
2. RENEWABLE ENERGY POLICY	12
3. LOCAL MARKET AND COST FACTORS	16
4. COMMUNITY'S REGULAR ENERGY NEEDS	19
5. RRENEABLE ENERGY AND RURAL DEVELOPMENT	22
6. PROEJCT AREA	24
7. FUTURE RESEARCH IN RENEWABLE ENERGY	34
8. ISSUES AND CHALLENGES FACED BY RURAL COMMUNITIES	37
9. CONCLUSION & RECOMMENDATIONS	38
10. ANNEXURES	39
- FGDs – Community	39
- KIIS – Solar Suppliers, Experts, NGOs	41
11. PICTURE GALLERY	48

CHAPTER 1: INTRODUCTION

The introduction of this position paper comprises three key sections that outline the status of renewable energy: a) the global renewable energy situation, b) the renewable energy scenario in Pakistan, and c) the renewable energy landscape in Sindh. Each subsection provides a summary of the current state of renewable energy within its respective context.

1.1 Types of Renewable Energy

Renewable energy sources are abundant. These are:

- a) **Bioenergy:** Bioenergy is derived from organic materials, such as plants, agricultural residues, and animal waste. It is considered renewable and can help reduce greenhouse gas emissions when sourced sustainably.
- b) **Wind Energy:** Wind energy harnesses the kinetic energy of moving air to generate electricity. Wind turbines convert this energy into mechanical power, which can then be transformed into electrical energy.
- c) **Ocean Energy:** Ocean energy refers to the various forms of energy derived from the sea, including tidal, wave, and thermal energy. This form of energy is abundant and has the potential to contribute significantly to sustainable energy systems.
- d) **Hydrogen:** Hydrogen is a versatile energy carrier that can be produced from various sources, including water, natural gas, and biomass. It can be used in fuel cells to generate electricity, emitting only water as a byproduct.
- e) **Biogas:** Biogas is produced through the anaerobic digestion of organic matter, such as food waste, manure, and agricultural residues. It helps manage waste and reduces greenhouse gas emissions, making it a valuable renewable energy source.
- f) **Solar Energy:** Solar energy is harnessed from the sun's rays using technologies like photovoltaic cells and solar thermal systems. Solar energy reduces dependence on fossil fuels and contributes to a cleaner environment.
- g) **Geothermal Energy:** Geothermal energy utilizes heat from the Earth's interior to generate electricity or provide direct heating. It can be harnessed from hot springs, geysers, or by drilling deep into the Earth to access hot rock.

Encouragingly, these types of energy forms are abundantly available in Pakistan and Sindh. However, there is need to harness them systematically in the light of sustainable policies.

1.2 Emergence of the renewable energy situation – Global

Without doubt, until now the lead energy sources are fossil, renewable, and fissile.¹The each broader category is divided into distinguished types. For instance, the fossil energy sources are coal, bitumen's, oil shales, tar sands petroleum, coal and natural gas. Likewise, other energy sources included solar, biomass (derived from organic materials), geothermal, wind, ocean energy and hydropower (used/ applied through water-cycle). Similarly, thorium and uranium are typed of fissile energy. The established energy sources particularly petroleum related are gradually depleted, and oil is not infinite source, and various researches indicated that global surge in oil consumption will touch its threshold in 2030s, and then it would recede.

An idea of limited or depletion of the traditional energy sources is not new. An earlier warning came from Marllthus in 1798,² and later it came from the Club of Rome in 1970s that traditional energy sources might lead towards 'limit to growth.'³However, 'sure provision of standard life for a maximum population' became a decisive factor to push the leadership for their commitment to explore alternative resources. Therefore, at the global scene most of the nations started to switch towards, 'solar-based-economy.

Table 1 Showing Surge in Solar Energy (1980-2023)

S. #	Year	Energy Consumption (inQuadrillion Btu)	Reasons of surge in Solar Energy
1.	1980	283	• Supportive policies • Investment in Research and Development • Advancement in Technology • Use-friendly • De-centralization • Scale-downed flexibility • Environmental friendly • Minimum maintenance
2.	1985	308	
3.	1990	348	
4.	1995	366	
5.	2000	398	
6.	2005	472	
7.	2010	508	
8.	2015	592	
9.	2020	596	
10.	2025	737	

¹Demirbas, A. (2009). Global renewable energy projections. *Energy Sources, Part B*, 4(2), p. 212.

² See, Malthus, T. R. (1986). An essay on the principle of population (1798). *The Works of Thomas Robert Malthus*, London, Pickering & Chatto Publishers.

³Colombo, U. (2001). The Club of Rome and sustainable development. *Futures*, 33(1), 7.

11.	2030	678	
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Sources: Author prepared table for this position paper.⁴

According to the International Renewable Energy Agency (IRENA), renewable energy accounted for approximately 29% of global electricity generation in 2020, with projections suggesting a rise to over 50% by 2030.⁵ Countries around the world are increasingly investing in wind and solar power in response to climate change and the urgent need for sustainable energy solutions. The Global Status Report (2021) indicates that over 2.8 million people are employed in the renewable sector, highlighting its potential for economic growth and job creation.⁶

1.3 Renewable energy situation – Pakistan

Pakistan has immense potential for renewable energy, with an estimated capacity of over 60,000 MW from various sources, including solar, wind, and hydropower.⁷ Despite this potential, as of 2021, only around 4,000 MW of renewable energy capacity was operational, representing about 5% of the total energy mix.⁸ The government has initiated several policies to enhance investment in renewables, including the Renewable Energy Policy of 2019, which aims to achieve a target of 30% renewable energy in the energy mix by 2030.⁹

Table 2 Pakistan's Solar Energy Projects (Provincial wise)

Province	Projects
Punjab	- Quaid-e-Azam Solar Park - Rooftop Solar Program - Future plans (Agriculture)

⁴The table is prepared on the basis of these research articles and websites: *Solar energy status in the world* (<https://doi.org/10.1016/j.egy.2023.10.022>); *Why Is Solar Energy Becoming More Popular?* (<https://campuspress.yale.edu/ledger/why-is-solar-energy-becoming-more-popular/>); Halsnæs, K., Shukla, P. R., & Christensen, J. M. (2010). The global energy scene in 2050. In *Risø energy report 9: Non-fossil energy technologies in 2050 and beyond*. Danmarks Tekniske Universitet, Risø Nationallaboratoriet for Bæredygtig Energi.

⁵Asmelash, E., and R. Gorini. "International oil companies and the energy transition, International Renewable Energy Agency, Abu Dhabi. 2021.

⁶ The Global Status Report (2021) <https://www.ren21.net/#>

⁷Pakistan Renewable Energy Policy, 2019 <https://power.gov.pk/PolicyDetail/>

⁸Ministry of Energy (Power Division).(2022). *Year book 2021-2022*. Government of Pakistan. <https://power.gov.pk/PublicationDetail/>

⁹Hydrocarbon Development Institute of Pakistan.(2023). *Pakistan energy yearbook 2022-23*. Ministry of Energy (Petroleum Division), Government of Pakistan. <https://www.hdip.com.pk/home>

Sindh	- Utility-Scale Solar Projects (Gharo and Tharparkar Solar Power Project) - Sindh Solar Energy Project (SSEP) - Off-Grid Solar Initiative
Khyber Pakhtunkhwa	- Moderate Solar Usage (Solar Home Systems and Public Sector Use)
Balochistan	- Solar-Powered Villages - Future Interventions (Quetta and the Chagai Desert)
Azad Jammu & Kashmir (AJK) and Gilgit-Baltistan	- Solar for Remote Communities - Government Initiatives (rural communities)
Islamabad Capital Territory	- Urban Rooftop Solar - Public Sector Solar Installations

Source: *This table is prepared by the author for this position paper.*

1.4 Renewable energy situation – Sindh

Sindh, as Pakistan's leading province in renewable energy development, has capitalized on its vast wind and solar potential. The Sindh Wind Corridor alone has a capacity of around 50,000 MW, with several wind farms already operational, contributing approximately 1,200 MW to the grid as of 2021.¹⁰ Solar energy has gained attraction, and it is supported by the provincial government's initiatives aimed at promoting decentralize solar energy systems.

There is significant growth in the renewable energy in compare to other traditional sources of the energy, particularly electricity. Demand is noticed at the country as well as the provincial levels. However, Sindh due to its geographical situation has due to potential to avail and develop the renewable energy. Without doubt, challenges like infrastructure issues and regulatory hurdles remain.

1.5. Potential projects/ future prospects and solar energy in Sindh

¹⁰ [Alternative and Renewable Energy Policy 2019https://power.gov.pk/PolicyDetail](https://power.gov.pk/PolicyDetail)

The potential for solar energy projects in Sindh is vast due favorable geographic and climatic conditions such as arid environment and long hours of sunlight. Thus, it could be mentioned that above reality could lead towards these potential investments/ projects and future prospects in Sindh:

- **Utility-Scale Solar Power Plants:** Sindh's vast desert areas, such as the Thar Desert and areas near Thatta and Jamshoro, Dadu, Larkana. Qambar-Shahdadkot offer significant opportunities for large-scale solar farms. These areas receive high solar irradiance, which can be harnessed for utility-scale solar power generation. In this connection, Quaid-e-Azam Solar Park in Punjab has set an example. In Sindh Gharo-Keti Bandar corridor could host solar plants in conjunction with wind farms, making it a renewable energy hub. However, the government and private sector could further develop solar farms ranging from 50 MW to 500 MW, contributing to the national grid and reducing dependence on fossil fuels.
- **Rooftop Solar Systems in Urban Areas:** Sindh's urban centers, particularly Karachi, Hyderabad, and Sukkur, Larkana, Mirpurkahr have a high demand for electricity, making rooftop solar systems a viable solution to meet energy needs. The promotion of solar panels on residential, commercial, and government buildings could reduce the load on the national grid and provide reliable electricity in areas prone to power outages. On the other hand, Government-led programs for businesses and households to adopt rooftop solar installations could accelerate this transition. Additionally, a city-wide solar policy or incentive program could encourage the proliferation of solar-powered homes and businesses, reducing energy costs and mitigating urban energy demand. However, many rural areas in Sindh suffer from inadequate access to the national grid, leading to energy poverty. Therefore, off-grid solar energy solutions can provide these areas with clean, reliable energy. It is visualized that in future various consortiums of NGOs, international development agencies, and local governments could collaborate to provide affordable solar home systems for off-grid households in rural Sindh.
- **Hybrid Renewable Energy Projects (Solar-Wind Hybrid):** Sindh has great potential for hybrid energy projects, combining both solar and wind power. The Gharo-Keti Bandar Wind Corridor is already known for wind energy potential, but adding solar components could optimize energy generation. Solar installations at the Korangi Industrial Area, SITE, and Nooriabad could reduce reliance on fossil fuels and improve energy efficiency.
- **Floating Solar Projects:** Sindh's water reservoirs, lakes, and irrigation canals could be used to host floating solar projects, making efficient use of available water bodies while producing clean energy. These projects on Manchar Lake, Keenjhar Lake, or large irrigation canals could generate significant amounts of electricity while reducing water evaporation.

No doubt, Sindh has immense potential for solar energy development, with opportunities for utility-scale projects, off-grid solutions, and innovations in agriculture and industry. It expected that new prospects include expanding solar infrastructure, fostering hybrid renewable energy systems, and ensuring the province's energy security while reducing its carbon footprint.

CHAPTER 2: RENEWABLE ENERGY POLICY, 2018/19

Renewable energy policies in Pakistan are vital for sector development, with each province adopting a tailored approach: Punjab prioritizes solar energy, Khyber Pakhtunkhwa focuses on hydropower, and Sindh leads in wind and solar projects through supportive public-private partnerships. These policies influence local market dynamics and the costs of renewable technologies. Understanding these factors is essential for the feasibility and accessibility of renewable energy systems in Pakistan as well as in Sindh.

2.1 Pakistan

The overarching framework for renewable energy in Pakistan is established through the Renewable Energy Policy of 2019. This policy aims to provide a conducive environment for investment and development in renewable energy projects. Key initiatives include fiscal incentives, streamlined project approval processes, and the establishment of a feed-in tariff system to ensure competitive pricing for renewable energy producers.

2.2 Punjab

Punjab has emerged as a key player in the renewable energy landscape, particularly in solar energy. The province has implemented the Punjab Solar Energy Policy, which promotes the installation of solar power plants and encourages public-private partnerships. As of 2021, Punjab was home to several large-scale solar projects, contributing significantly to the province's energy supply. However, challenges such as land acquisition and financing remain barriers to further expansion¹¹

2.3 Khyber Pakhtunkhwa

Khyber Pakhtunkhwa has focused on harnessing its hydropower resources, with the province boasting a potential of over 20,000 MW. The provincial government has implemented policies to promote small and medium-sized hydropower projects, facilitating local community involvement in energy generation. As of 2021, Khyber Pakhtunkhwa had developed around 3,000 MW of hydropower, making it a leader in clean energy.¹²

¹¹Punjab Energy Department, 2021. <https://energy.punjab.gov.pk/>

¹²Khyber Pakhtunkhwa Energy Department, 2021. <https://ep.kp.gov.pk/>

2.4 Sindh

Sindh's renewable energy policy, 2018/19 is characterized by its comprehensive approach to wind and solar energy development. The Sindh Renewable Energy Policy, enacted in 2015, aims to facilitate the growth of the renewable sector by providing regulatory support and financial incentives. The province's focus on public-private partnerships has led to successful wind and solar projects, although progress has been slowed by bureaucratic challenges and the need for improved grid infrastructure.

2.5 Comparison/Analysis

A comparative analysis of renewable energy policies across Pakistan's provinces reveals distinct strengths and challenges. Sindh leads in wind energy, while Khyber Pakhtunkhwa excels in hydropower. Punjab's focus on solar energy demonstrates a diversified approach, but it faces significant regulatory hurdles such as land acquisition issues, policy consistency, regulatory compliance and environmental clearances. Overall, while all provinces are making strides toward renewable energy adoption, consistent policies, better infrastructure, and enhanced investment incentives are essential for achieving national targets. The below summarized table shows the provinces' key renewable energy sources, advantages and challenges:

Table 1 Showing key renewable energy sources in provinces, along their advantages

Province	Key Renewable Energy Sources	Advantages
Sindh	Wind Energy; Solar Energy	Strategic location; Potential and large Solar range/ space
Khyber Pakhtunkhwa	Hydropower	Abundance water resources
Punjab	Solar Energy	Large solar potential due to high solar irradiance
Balochistan	Solar Energy; Wind Energy	Vast unutilized land suitable for large-scale solar farms

Source: The author has made this table for this research study

It is fact that each province has certain advantages, however there are some challenges associated to their geographies and governance. Although, some strategic challenges are described in below mentioned paragraphs:

- Sindh is notable for its wind and solar energy with a potential, benefiting from a strategic location with expansive land available for solar installations. This combination allows for significant energy generation capacity, positioning Sindh as a leader in renewable energy initiatives.
- Khyber Pakhtunkhwa excels in hydropower, thanks to its abundant water resources that support the development of hydroelectric projects. The province's natural topography is conducive to harnessing river flow for energy production, making it a critical contributor to the national energy grid.
- Punjab focuses primarily on solar energy, capitalizing on its high solar irradiance levels. This province's large solar potential positions it as a key player in the country's renewable energy landscape, with numerous solar projects already underway to harness this resource effectively.
- Balochistan is characterized by vast unutilized land, making it suitable for both solar and wind energy projects. This potential for large-scale solar farms and wind installations offers opportunities for decentralized energy solutions, particularly in remote areas where access to electricity is limited.

Overall, these provinces highlight Pakistan's diverse renewable energy capabilities, each contributing uniquely to the nation's energy mix and paving the way for a more sustainable future.

Table 2: Pakistan's major challenges regarding executing renewable energy projects

S. No.	Challenges regarding execution of the renewable energy projects
1	Geographical challenges in remote areas
2	Seasonal variability affecting generation reliability
3	Regulatory hurdles including lengthy approval processes
4	Land acquisition issues and competing land use for the solar parks
5	Security issues affecting investment and project execution
6	Lack of basic infrastructure (roads, grids)
7	The lack of an efficient transmission system

Source: *The author has made this table for this research study*

The below mentioned paragraphs portray summarizes challenges in executing renewable energy projects in rural Sindh, Pakistan. These are:

- **Geographical challenges:** In remote areas of Sindh, the rugged terrain makes it difficult for communities to develop and maintain energy infrastructure. Many potential sites for renewable energy projects are located in hard-to-reach areas which raise costs and complicate logistics. This can leave rural communities without reliable energy access, hindering their development.

- **Seasonal variability:** Seasonal changes particularly disrupts energy generation, especially for solar and hydropower projects that rely on consistent weather patterns. In rural areas, where many households depend on these sources, fluctuations in energy supply can create uncertainty and make it difficult for families and businesses to plan effectively.
- **Regulatory hurdles:** Lengthy approval processes can significantly delay the initiation of renewable energy projects, discouraging community investment. Additionally, land acquisition can become contentious when agricultural land or space for urban development is at stake. These obstacles slow down progress and can prevent rural communities from benefiting from renewable energy initiatives.
- **Security issues:** In certain areas, security concerns can make it challenging for both local and foreign investors to commit to projects. This can leave communities feeling vulnerable and limit their ability to access the resources needed for safe and effective energy solutions.
- **Lack of basic infrastructure:** Many rural areas lack essential infrastructure, such as roads and reliable grid connections. This absence complicates project implementation, making it challenging to transport materials and connect renewable energy projects to the national grid. As a result, communities may miss out on the benefits of renewable energy advancements.
- **Inefficient transmission system:** An inefficient energy transmission system exacerbates these challenges, leading to energy losses and limiting the delivery of generated power to where it is most needed. For rural communities, this means that even when renewable energy is produced, it may not reach them effectively, further perpetuating energy inequality.

Addressing these challenges is crucial for Pakistan to successfully harness its renewable energy potential and achieve a sustainable energy future.

Table 3 Provincial strengths and challenges regarding the execution renewable energy projects

Province	Strength	Challenge
Sindh	Vast area/ strategic position	Slow in execution
Punjab	Potential to use solar technologies in urban areas	Regulatory delays in approvals
Balochistan	land offers opportunities for solar and wind projects	Security issues; low investment and project development.
Khyber Pakhtunkhwa	Strategic advantage (hydropower projects); significant contribution to the national grid	The rugged terrain; susceptibility to floods

Source: *The author has made this table for this research study*

CHAPTER 3: LOCAL MARKET AND COST FACTORS

The adoption of renewable energy, particularly solar power, is gaining momentum in rural Sindh, Pakistan. The lead reasons of switching towards alternative options are long disruptions, cost of the grid-related electricity, off-grid-locations and corruption.

This section of the report highlights insights gathered from discussions with supplier and retailers of solar unit supplies, focusing on the needs and preferences of rural buyers. With a growing trend of solar adoption—reported at 65% among villagers—understanding the dynamics of this market is essential for promoting clean energy solutions.

3.1. The villagers' general understanding of solar products

Suppliers as well as retailers offer a variety of solar products, including solar plates, batteries, inverters, and accessories such as wires, chargers, and LED lights. The increasing interest among villagers indicates a shift towards renewable energy, driven by both necessity and awareness of solar technology's benefits.

3.2. Cost Considerations (Per watt, Panels, invertors, batteries, stands and wires)

No doubt pricing is a significant factor influencing villagers' purchasing decisions. For instance, the cost of solar plates varies widely:

- MJ Solar Plate (180 watts) is priced at Rs. 6,500, while other brands, such as
- Hyper and Lava, range from Rs. 8,500 to Rs. 16,000
- Interestingly, many villagers are unaware of these prices and often communicate their budget range to shopkeepers, who then guide them towards suitable options.
- The total cost of a complete solar system can reach between Rs. 35,000 and Rs. 350,000, presenting a considerable investment for households.

3.3. Warranty and Reliability

Retailers and suppliers emphasize the importance of warranty when discussing solar products. For example, Lava and Hyper Company solar plates come with a five-year warranty. However, shopkeepers clarify that accidental damage is not covered. In contrast, any technical faults are addressed through free repairs, instilling some confidence in the reliability of the products.

3.4. Solar Panels and Customer Awareness

There is a notable gap in knowledge regarding the installation and maintenance of solar equipment. Retailers report that using local wiring can lead to damage, emphasizing the need for quality components. While some villagers are informed about solar technology, many rely on shopkeepers for guidance. Concerns about price and quality remain paramount.

3.5. Battery Selection and Maintenance

Battery selection is crucial for effective solar energy utilization. Villagers inquire about reliable brands and their specifications based on household energy needs. Retailers provide information on various battery types and emphasize the importance of regular maintenance, such as timely water changes and proper installation. Prices for batteries vary significantly, with options available for different voltage requirements.

3.6. Importance of an Inverter

Inverters play a vital role in enhancing battery life by managing power consumption. Retailers actively inform customers about the benefits of using inverters, which can prevent battery burnout and extend the system's overall lifespan.

3.7. Availability of Parts and Repair Services

While customers often seek affordable products, retailers strive to balance cost with quality. Challenges related to transportation and inadequate local technician support complicates the installation process. Retailers acknowledge that the lack of skilled labor in villages can lead to improper fittings, further emphasizing the need for reliable service.

3.8. Branding and Community Engagement

Brand recognition significantly influences purchasing decisions. Retailers educate villagers about reputable brands, leveraging word-of-mouth referrals from satisfied customers. Community support is essential, as many villagers depend on solar solutions for basic electricity needs. Retailers assist by providing goods at wholesale prices, fostering loyalty and repeat business.

Looking ahead, the potential for solar adoption in rural Sindh appears promising. With rising electricity costs from WAPDA – currently at 65 PKR per unit – more villagers are likely to consider solar systems as a viable alternative. Retailers are optimistic that the

trend towards solar energy will continue to grow, leading to broader adoption for both residential and commercial purposes.

The insights gathered from retailers illustrate a complex landscape for solar energy in rural Sindh. While the demand for solar products is evident, challenges related to pricing, knowledge, and installation persist. By addressing these issues and fostering community engagement, the transition to renewable energy can be accelerated, contributing to climate-resilient housing in the region.

CHAPTER 4: COMMUNITY'S REGULAR ENERGY NEEDS

The settlements in Sindh are divided among these types: Urban Settlement, Semi-urban, Rural (Upper level, Middle level and Lower level).

4.1. Urban Settlement: Presently, due to various factors migration from rural to urban areas has surged, and people are being settled in large cities like Karachi, Hyderabad, and Sukkur, to smaller towns and municipalities. According to the 2023 Census of Pakistan: a) 30 districts in Sindh, of which 24 have significant urban populations, b) Karachi, Hyderabad, Sukkur, Larkana, Nawabshah, Mirpurkhas, and Shikarpur cities are considered urban. An average energy needs per urban household is estimated as:

Table 1 shows energy needs in various locations/ areas

Energy needs in Urban Areas (Household)	
<i>Type of Energy and usage in watts per HHs</i>	<i>Common consumption/ Appliances</i>
Electricity: 250–350 watts per hour	lighting, fans, and charging appliances
Electricity: 1,000 to 2,500 watts per hour	air conditioners, refrigerators, televisions, etc
Solar: 3 kW to 10 kW	a medium-sized household.
Energy needs in Semi-Urban Areas (Household)	
<i>Type of Energy and usage in watts per HHs</i>	<i>Common consumption/ Appliances</i>
Electricity: 240–320 watts per hour	lighting, fans, and charging appliances
Electricity: 8,000 to 2,000 watts per hour	air conditioners, refrigerators, televisions, etc
Solar: 3 kW to 10 kW	a medium-sized household.
Energy needs in Rural (Household)	
<i>Type of Energy and usage in watts per HHs</i>	<i>Common consumption/ Appliances</i>
Electricity: 230–300 watts per hour	lighting, fans, and charging appliances
Electricity: 7,500 to 1,500 watts per hour	air conditioners, refrigerators, televisions, etc
Solar: 2.5 kW to 8.5 kW	a medium-sized household.

The above mentioned tables state that per capita energy consumption compared to rural areas reveal that it falls between 100–200 kWh per month per person in lower-income households, and much higher in affluent households. However, other factors that influence the consumption are:

- Grid connectivity
- Income level
- Alternative energy sources

The technical details of solar system are considerable same, but in the project some specific are in practice. The below mentioned table show such specifications.

Table 2 below showing Technical specification of solar systems for a household (in the project area)

Solar Systems and Technical Specifications	
Solar Panel	• Type: Monocrystalline or Polycrystalline panels • Number of Panels: 3-6 panels (depending on energy needs and location) • Capacity per Panel: 300W – 400W • Total Capacity: 1.2kW – 2.4kW (average size for a small household) • Purpose: Capture sunlight and convert it to electricity.
Inverter	• Type: Pure sine wave inverter • Capacity: 1.5kW – 3kW • Purpose: Converts the DC electricity produced by the solar panels into AC electricity.
Battery Storage (Optimal but recommended for backup)	• Type: Lithium-ion or Lead-acid batteries • Capacity: 2kWh – 5kWh • Purpose: Stores excess energy for use during non-sunlight hours (night or cloudy days).
Charge Controller	• Type: MPPT (Maximum Power Point Tracking) • Capacity: 30A – 60A (depending on the system size) • Purpose: Regulates the amount of charge going to the batteries to prevent overcharging and prolong battery life.
Mounting Structure	• Material: Aluminum or stainless steel • Purpose: Holds the solar panels securely on rooftops or other locations.
Wiring and Electrical Components	• Type: Copper wiring and proper junction boxes • Purpose: Safely connects all components of the system, including panels, inverter, and battery.
Safety Features	• Surge Protectors: Protects the system from voltage spikes.

	• Fuses and Breakers: Prevents electrical overloads and ensures safe operation.
Monitoring System (Optional)	• Type: Smart monitoring app or display • Purpose: Allows users to track energy production and consumption.

It must be understood that application of solar depends upon area, economic profile, members in family and needs.

CHAPTER 5: RENEWABLE ENERGY AND RURAL DEVELOPMENT

Rural development is a broader concept that aims to improve the quality of life and economic well-being of people living in rural areas. The major components are:

- ***Agriculture Development:*** The agricultural development's major indicator is more yields per acre.
- ***Literacy, Education and Skills Enhancement:*** Access to quality education and vocational training to make them able to engage in rural workforce.
- ***Basic Health related Services:*** Access to healthcare facilities and services such as preventive care, maternal health, and nutrition related interventions.
- ***Rural Infrastructure Development:*** It indicated development of link road, farm to market roads' network, and construction of bridges and culverts.
- ***Community's Engagement:*** Local peoples' involvement in decision-making processes and implementation ensures success of the projects.
- ***Social Development:*** The social development in rural development context includes gender equality, inclusion, and empowerment of marginalized groups.
- ***Supportive Policies and Governance:*** The convenient policies and governance structures support rural development programs and play positive role in resource allocation.

These areas collectively contribute in the rural development. However, the solar power plays major part in the rural development. These are areas, where the solar power plays its role. The solar energy has proven itself an alternative energy source because it provides a sustainable, renewable, and clean way to generate power. These are some areas where it contributes. These are:

- ***Agriculture:*** These are some forms, where solar energy could play a positive role. These are some common areas, where solar energy could play a positive role in powering irrigation systems, processing and storing crops and operating solar-powered pumps and tractors.
- ***Education and Rural Schools:*** The solar power, particularly in the areas of arid zone and coastal areas has played major role. The solar energy supports education and creates more convenience environment for learning. Therefore, schools' fans are operated and students' attendance is retained or in some cases increased.
- ***Basic Healthcare Services:*** Solar energy enhances healthcare by providing reliable electricity to medical facilities. Therefore, Hospitals and Rural Health Centers),

particularly health facilities that are Off-Grid or located in Arid Zones, and coastal area depend upon the solar power.

- **Rural livelihood and Job creation:** Solar energy significantly improves rural livelihoods. It creates employment opportunities in the areas of installation, manufacturing, maintenance, and distribution of solar panels and systems. Additionally, the solar energy creates jobs in manufacturing, installation, operation, and maintenance areas related to solar technology.

Sindh's Households and Energy needs

Sindh's rural population is 25,771,071 and urban population is 29,925,076. Likewise, number of rural households is 4,744,589 and number of urban household is 5,127,031. The below mentioned shows However, energy needs of rural areas

Table 1 showing solar energy needs in Sindh¹³

Energy Needs of Rural Households	Energy needs of Urban Households
26,095,239.5 k watts	28,198,670.5 k watts

Some reasons in demand of solar energy

The usage and application in the solar energy is in demand. These are many reasons. However, most common according to community, experts and NGO professionals have shared these push and pull factors:

A. Push Factors

- Irregular power-supply from the national grid
- Rise in bills/ excessed taxes
- Long load-shedding
- Corruption in national distribution system (WAPDA)

B. Pull Factors

- Low-charges per watt in compare to electricity
- User-friendly technology
- Decentralization and conveniently managed
- Availability of solar systems and repair and maintenance services

¹³ According to relevant officials energy needs of rural household are 2.5 kW to 8.5 kW. Thus average needs generally happened 5.5 kwatts.

Almost all stakeholders are agreed that in near future more households will switch towards to the solar power

CHAPTER 6: PROJECT AREA's RENEWABLE ENERGY PROFILE (Solar Energy)

The national power electricity varies significantly between urban and rural households. Urban centers such enjoy widespread access to the national grid, with nearly all urban households electrified; Karachi, in particular, boasts almost 100% electrification.

Estimates suggest that around 60% to 70% of rural households in Sindh have access to electricity, but the quality and reliability of service are often compromised by frequent power outages and load shedding. The electrification rates in Sindh are estimated to be around 80% to 85%, encompassing both urban and rural areas.

In 2017, 87.87% of households, totaling 28.04 million, reported using grid electricity as their primary power source. By 2023, this percentage declined to 84.03%, representing 32.17 million households. Notably, in 2023, 2.96 million households reported having solar panels installed. While a comparison with previous census data would provide clearer insights into the shift toward solar energy, data on solar-powered households was not collected in the last census.¹⁴

6.1 Community Perspective on Renewable Energy (Solar Energy)¹⁵

The FGDs' discussion points were the solar energy's usage, purchase and maintenance, potential improvements, and future outlook.

Participants from the community shared that approximately 40% of households are harnessing solar energy primarily for domestic purposes. They emphasized that solar power has significantly supplanted traditional grid electricity, becoming an essential component of daily life. The shift away from the national grid distribution system is largely driven by prolonged power outages, rising costs, and issues of corruption within the energy sector. While participants acknowledged that grid electricity remains a vital power source, they noted that solar energy systems serve as valuable supplementary resources, enhancing energy security and resilience in their communities.

¹⁴Dawn, July 19th, 2024

¹⁵Two Focus Group Discussions (FGDs) were conducted in targeted villages within TalukaKhipro and District TandoAllahyar. These FGDs were conducted at KanbhooDaro and Jamal Banbhro(in Khipro);Khuda Dino Mirjat and Haji SarangeHakro(in TandoAllahyar) .

In discussions, attendees reported that around 90% of households now rely on solar energy for both domestic and other activities. This transition marks a significant advancement in rural development, as solar energy effectively replaces traditional grid electricity and empowers communities to become more self-sufficient. The increased accessibility to renewable energy fosters local economic growth, reduces dependency on unreliable power sources, and promotes sustainable practices within the community.

Villagers indicated that roughly 45% of households and businesses utilize solar energy. They expressed a strong appreciation for grid electricity, recognizing its importance; however, they also highlighted that solar systems are primarily employed during power outages, reinforcing their role as supplementary energy sources. This dual reliance on both solar and grid electricity illustrates the community's adaptive strategies in energy management, which are critical for enhancing overall quality of life and supporting community development initiatives.

6.2. The community identified needs regarding solar energy

- A 12-watt solar system, which powers a bulb, a fan, and a tap for drinking water is common purchasing/ installment item.
- Utilization of solar-powered rotor pumps for water access is common (it used for household needs and vegetable cultivation).
- The solar energy has significantly improved villagers' lives in the areas of children's education, women's engagement in earnings (in sewing)
- Solar power has improved their health and general life at the village.

Purchase of Solar Systems

- In villages with grid connections, the tendency to adopt/ purchase solar systems is heightened.
- The load shedding and the rising cost of grid electricity have compelled people to opt solar power.
- The cost of multi-units (or need to purchase more than 12 watts units) discourages village people to enjoy privacy and comfort.

Maintenance of Solar Systems

- Most participants reported minimal technical issues with solar usage.
- Solar components are readily available in local markets.¹⁶
- The small number of solar users leads to low-quality of services.

- Based on their experience villagers have developed strategies to protect their solar panels, storing panels indoors during storms to prevent damage.
- Solar energy has alleviated previous challenges with mobile charging during electricity interruption or discontinuity.

Improving Solar Systems

- Participants suggested an improvement/ efficiency in their solar systems such as incorporation of battery storage to enhance usability during nighttime or cloudy weather.¹⁷
- There was a strong call for accessible and affordable solar options, along with government or NGO interventions for financial assistance and training in solar system installation and maintenance.¹⁸

6.3. Future of Solar Energy in the Project Area

- Villagers envision solar systems becoming the primary power source, potentially eliminating reliance on the grid entirely.
- They expected that solar technology would become more affordable, more households will adopt it, especially if financial and technical barriers are addressed.

6.4. The villagers' general understanding of solar products

Suppliers as well as retailers offer a variety of solar products, including solar plates, batteries, inverters, and accessories such as wires, chargers, and LED lights. The increasing interest among villagers indicates a shift towards renewable energy, driven by both necessity and awareness of solar technology's benefits.

6.5. Cost Considerations

No doubt pricing is a significant factor influencing villagers' purchasing decisions. For instance, the cost of solar plates varies widely: MJ Solar Plate (180 watts) is priced at Rs. 6,500, while other brands, such as Hyper and Lava, range from Rs. 8,500 to Rs. 16,000. Interestingly, many villagers are unaware of these prices and often communicate their budget range to shopkeepers, who then guide them towards suitable options. The total cost of a complete solar system can reach between Rs. 35,000 and Rs. 350,000, presenting a considerable investment for households.

¹⁷This suggestion was strongly proposed by the villagers KanbhooDaro village.

¹⁸This suggestion came from the people of Jamal Banbhro village.

6.6. Warranty and Reliability

Retailers and suppliers emphasize the importance of warranty when discussing solar products. For example, Lava and Hyper Company solar plates come with a five-year warranty. However, shopkeepers clarify that accidental damage is not covered. In contrast, any technical faults are addressed through free repairs, instilling some confidence in the reliability of the products.

6.7. Solar Panels and Customer Awareness

There is a notable gap in knowledge regarding the installation and maintenance of solar equipment. Retailers report that using local wiring can lead to damage, emphasizing the need for quality components. While some villagers are informed about solar technology, many rely on shopkeepers for guidance. Concerns about price and quality remain paramount.

6.8. Battery Selection and Maintenance

Battery selection is crucial for effective solar energy utilization. Villagers inquire about reliable brands and their specifications based on household energy needs. Retailers provide information on various battery types and emphasize the importance of regular maintenance, such as timely water changes and proper installation. Prices for batteries vary significantly, with options available for different voltage requirements.

6.9. Importance of an Inverter

Inverters play a vital role in enhancing battery life by managing power consumption. Retailers actively inform customers about the benefits of using inverters, which can prevent battery burnout and extend the system's overall lifespan.

6.10. Availability of Parts and Repair Services

While customers often seek affordable products, retailers strive to balance cost with quality. Challenges related to transportation and inadequate local technician support complicate the installation process. Retailers acknowledge that the lack of skilled labor in villages can lead to improper fittings, further emphasizing the need for reliable service.

6.11. Branding and Community Engagement

Brand recognition significantly influences purchasing decisions. Retailers educate villagers about reputable brands, leveraging word-of-mouth referrals from satisfied customers. Community support is essential, as many villagers depend on solar solutions

for basic electricity needs. Retailers assist by providing goods at wholesale prices, fostering loyalty and repeat business.

Looking ahead, the potential for solar adoption in rural Sindh appears promising. With rising electricity costs from WAPDA – currently at 65 PKR per unit – more villagers are likely to consider solar systems as a viable alternative. Retailers are optimistic that the trend towards solar energy will continue to grow, leading to broader adoption for both residential and commercial purposes.

6.12. Participants key recommendations

- Increasing access to solar systems through financial support, such as subsidies or installment plans.
- Providing training on solar system maintenance and establishing local technician networks.
- Enhancing battery storage solutions to optimize solar energy usage.
- Continued engagement from government and NGOs to support renewable energy expansion in rural areas.

The FGDs highlighted a strong community demand for lower costs associated with solar systems to maximize benefits. Initial installation costs remain a barrier for some households. Furthermore, there is currently no exploration of other renewable energy types, such as biogas or wind turbines, in the Tandwalhiyar and Khipro districts. Additionally, participants noted significant improvements in daily life due to solar energy, particularly among children and women, who now enjoy greater convenience and safety. Women can sew and knit at night, while children can study late into the evening, reflecting the transformative impact of solar energy in these communities.

6.13. Experts' Opinion about the Solar Power¹⁹

The scribe of this position paper through various participatory approaches conducted in-depth interviews with the experts. Below mentioned themes were explored:

Emergence of Solar Energy and Key Factors

The scaled up interest of communities in solar energy is driven by these factors:

- Poor electricity services and frequent outages have pushed them to seek alternative energy sources.
- Surge in electricity bills have convinced them to opt for other energy sources
- Independently provision of power/energy.

¹⁹ The KIIs/ consultation meetings held with Mahesh Kumar, Faheem and Pervaiz (Solar Technologists); UmerSufian, Nisar Khan (Solar Suppliers); JunaidShaikh, JawaidHussain and NiazSiyal (NGO).

- Availability of solar system (parts) and repair and maintenance
- Communities' sensibility towards clean environment
- Decrease in the cost of solar panels and installation has made solar energy more financially feasible for individuals and communities.

Impact of Solar Energy in Rural Areas - Case Studies

Solar energy has considerably transformed rural communities, particularly in areas with limited or unreliable access to electricity. These are some individual examples:

- Uninterrupted power for lighting homes, running household appliances and supporting small businesses.
- Encouraging children to study after dark
- Enabling clinics to refrigerate medicines and vaccination particularly in far-flung areas.
- Provision of solar energy for household needs (lighting and mobile charging)
- Operation of flour mills and cold drink shops
- Power solar-based water pumps for irrigation, livestock, and domestic use.
- Support medical equipment (s).

Addressing Energy Gaps in Rural Communities through Solar Energy as an alternative sources

Solar energy provides a reliable and sustainable source of power. These are some reasons or areas where solar power has addressed the gap as an alternative source:

- The rural people could afford the cost solar energy
- The adoption of solar energy in rural areas has made them more independent.
- It provides reliable, affordable, and sustainable power solutions to the rural people.
- Inconsistent access to electricity has opened market or usage of the solar power.

Government Policies (Enhanced Usage of Solar Power)

The present provincial government has focused on promoting solar energy adoption. These are:

- Free provision of solar panels
- Training programs for technicians
- Subsidies on the installations of solar system installations.
- NGOs awareness campaigns that highlight the benefits of solar energy.

Solar Power and Community Participation

Community leaders and organizations play a crucial role in promoting solar energy adoption and driving sustainable practices within their communities. These are areas, where community organizations and their leaders have played role: These are:

- Promoted solar energy by raising awareness through educational campaigns, workshops, and public events.
- Community leaders advocated for supportive policies at local, provincial and federal level. Therefore, an enabling environment for solar energy projects was created.
- Community organizations facilitated collective action by organizing group purchasing programs for solar installations, negotiating bulk discounts, and pooling resources to make solar energy more affordable.
- Communities and NGOs collaborated with the government departments for implementing solar projects.

Barriers and Challenges to Solar Energy Adoption in Rural Areas

Several barriers hinder the widespread adoption of solar energy in rural areas, impeding the transition to clean and sustainable energy sources. These are key challenges:

- ***Financial Constraints:*** The high upfront costs of installing solar systems are prohibitive for many rural households and businesses.
- ***Lack of Awareness:*** Insufficient understanding of the benefits and technical aspects of solar technology can lead to hesitation among rural residents to adopt these solutions.
- ***Inadequate Infrastructure:*** Weak grid connections and a lack of energy storage solutions restrict the effective integration of solar power into existing energy systems.
- ***Policy and Regulatory Challenges:*** Unclear or inconsistent government support creates uncertainty for investors and developers, slowing down the deployment of solar projects.
- ***Shortage of Skilled Workforce:*** The lack of trained professionals for designing, installing, and maintaining solar systems limits the scalability and sustainability of solar initiatives.

Education and Awareness

Effectively raising awareness and educating rural communities about the benefits of solar energy requires a multi-faceted approach tailored to their unique needs. The major strategies include:

- ***Community Engagement:*** Involving local leaders, organizations, and residents in designing and implementing awareness campaigns ensures relevance and effectiveness.
- ***Communication at local level:*** Utilizing town hall meetings, community workshops, and informational sessions facilitates interactive discussions about solar energy.
- ***Demonstrations and Hands-On Experiences:*** Showcasing solar installations and organizing site visits to solar projects provide tangible examples of solar power's benefits, helping to dispel misconceptions.
- ***Partnerships:*** Collaborating with local schools, agricultural cooperatives, and community centers can integrate solar energy education into curricula and outreach programs, promoting a culture of sustainability.
- ***Digital Outreach:*** Leveraging digital platforms, such as social media campaigns and mobile apps, allows for broader dissemination of information, reaching communities with limited access to traditional communication channels.

Financial Barriers to Solar Energy Adoption

Private investment is essential for the growth of solar energy in rural areas, providing the necessary capital, expertise, and innovative solutions to accelerate solar technology adoption. Major roles of private investment include:

- ***Funding Development:*** Private investors, including solar developers and financial institutions, can fund the installation of solar systems, enabling access to clean and reliable electricity for residents and businesses.
- ***Customized Solutions:*** Investors can leverage their expertise to design tailored solar solutions that address the specific energy needs of rural communities, such as off-grid installations and solar-powered water pumping systems.
- ***Driving Innovation:*** Private investment fosters innovation in solar technology and business models, leading to cost reductions and efficiency improvements, which are crucial for scaling up solar deployments.
- ***Partnerships:*** Collaborating with local stakeholders, governments, and non-profits allows private investors to maximize the impact of solar projects, create jobs, and stimulate economic development while promoting environmental sustainability.

Social Impact of Solar Energy in Rural Communities

The introduction of solar energy in rural communities has led to significant positive social impacts, greatly enhancing the quality of life for residents. Key benefits include:

- **Improved Access to Electricity:** Reliable power for lighting and daily activities has raised living standards and enabled households to engage in productive tasks.
- **Enhanced Educational Opportunities:** Access to electricity allows students to study after dark and utilize online resources, thereby improving educational outcomes.
- **Better Healthcare Services:** Solar energy powers medical facilities, enabling the refrigeration of vaccines and operation of medical equipment, which enhances healthcare delivery and patient outcomes.
- **Environmental Conservation:** By reducing carbon emissions and promoting sustainable practices, solar energy contributes to a cleaner environment and mitigates climate change impacts.

Solar Power and Inclusiveness

To ensure solar energy initiatives are inclusive and equitable, it is crucial to involve community members throughout the project lifecycle. Key strategies for fostering inclusivity in solar energy projects include:

Community Engagement: Actively involving residents in decision-making processes from the planning stages ensures that initiatives reflect the community's needs and priorities.

Tailored Solutions: Designing energy solutions that cater to the specific requirements of various groups—such as households, schools, healthcare facilities, and small businesses—ensures equitable access to solar energy benefits.

Affordability: Developing financial mechanisms like subsidies, microfinancing, and community-based funding models can make solar technologies more accessible to low-income households.

Capacity Building: Training and skills development programs, especially for women and youth, can empower underrepresented groups and promote workforce diversity in the renewable energy sector.

Cultural Sensitivity: Incorporating local knowledge and respecting indigenous practices in project design fosters community values and enhances project acceptance.

All experts are of a similar opinion that solar electricity efficiency to be 30 per cent and beyond; and reduction and electricity storage cost will constitute a long term vision promoting solar energy at exponential rate.

CHAPTER 7: FUTURE RESEARCHES IN RENEWABLE ENERGY

No doubt, every technology couldn't expand and be useful and cost-effective until, there is investment in its advancement. It is also true with the solar energy/ technology. The below mentioned areas suggest the same.

Anticipated Trends in Solar Energy

- Private Sector Involvement: Increased investment in community solar grids.
- Advancements in Technology: Improved efficiency and affordability of solar panels.
- Energy Storage Solutions: Enhanced reliability through battery storage for nighttime use.
- Microgrid Innovations: Development of localized energy systems fostering self-sufficiency.
- Agricultural Applications: Utilizing solar energy for water pumping and irrigation to boost productivity.

Existing Barriers to Adoption

- Poor Regulatory Frameworks: Inadequate government support for solar initiatives.
- Challenging Financial Conditions: Difficulty in accessing financing for solar projects.
- Lack of Awareness: Limited understanding of solar technology among community members.

Addressing Barriers to Adoption

- Implement Robust Regulations: Establish comprehensive frameworks for solar energy adoption.
- Standardize Solar Products: Ensure quality and consistency in solar technologies.
- Build Local Technological Capacity: Through training and education, empower communities to manage solar systems effectively.

Strategies for Raising Awareness

- Integrating Solar Education: Into school curricula and community programs.
- Conducting Demonstrations: Showcasing solar technologies to enhance understanding.

- Engaging Local Leaders: As advocates to build trust and enhance outreach efforts.

Future Trends and Innovations

- Looking ahead, the installation of microgrids for electricity exchange is a trend that could significantly impact rural communities. This decentralized approach to energy distribution allows for more resilient and self-sufficient energy systems.

Role of Private Investment

- Private investment is crucial for the growth of solar energy in rural areas. Financial returns can drive innovation and competition. Government support and incentives can further encourage private investors to engage in solar projects, thereby boosting energy access.
- Support from Microfinancing: Microfinancing and community-based funding initiatives can enhance solar energy adoption by providing affordable financing options for households and small businesses. Scheduled banks can also offer tailored loan products to facilitate community investment in renewable solutions.
- The combined factors of inadequate energy services, encouraging policies, community involvement, anticipated trends, existing barriers, and investment strategies all contribute to the potential growth of solar energy in rural areas. Addressing these challenges and leveraging emerging opportunities can lead to improved quality of life and sustainable development through enhanced energy access.

All engineers, technologists, scientists; and even users are agreed that solar energy is an enormous power to be harnessed. However, there is need of more advanced technologies and systems. Additionally, it is expected that soon more technological advancement will open new vistas for its usage and application.

CHAPTER 8: ISSUES AND CHALLENGES FACED BY RURAL COMMUNITY (SOALR ENERGY)

The current research on solar energy, interviews with rural community, experts' opinions and NGOs experiences has proposed these challenges that halt the spread of the solar power.

These are some major hurdles regarding solar installation, maintenance and repair.

1. The community is less skilled in maintaining in assembly of solar panels battery repair, and related technologies. Therefore, sometimes it becomes a vital problem at the household as well as village level.
2. The law and order particularly in rural areas posed a challenge, stolen of solar panels and batteries have become regular feature in far-flung areas.
3. In most of the cases panels are installed outside the housed therefore, there are cases of snake and dog bites.
4. The life of batteries is too short, and its performance becomes less in hot weather of Sindh.
5. Still cost per watt in rural context is considerably high, and sometime people couldn't afford it.
6. Rural people, particularly women are less aware about the fully usage and application of the solar energy.
7. Still low conversion efficiency hampers the usage of the solar energy.

If these hurdles are addressed then there are chances that the solar power maybe scaled and reach maximum people.

CHAPTER 9: CONCLUSION AND RECOMMENDATIONS

RDF was given a project entitled 'Clean Energy and Climate Resilient Housing in Rural Sindh, Pakistan.' This project covers two districts: TandoAllahyar and Sanghar. The organization engaged with 50 villages in TandoAllahyar district and 50 villages in Sanghar district. The project required two position papers to be commissioned to experts and consulting firms. The present paper on 'Clean Energy Market' was commissioned to this author. The author employed various participatory tools and techniques, such as Focus Group Discussions (FGDs) with communities, two FGDs with NGO professionals involved in solarization, and two with equipment suppliers of solar systems from TandoAllahyar and Sanghar districts.

Based on this engagement and discussion, the following conclusions and recommendations are presented:

A - Conclusions:

1. Renewable energy, particularly solar energy, is gaining importance in rural areas.
2. The community finds solar energy useful and convenient.
3. Advancements in technology and cost reductions are promoting its application.
4. Increased access to the solar market has encouraged its usage.
5. The use of solar energy for domestic, industrial, small enterprises, community services, health, education, agriculture, drinking water, and tourism has risen.
6. Rural communities in Sindh, facing large-scale poverty and high costs of solar units, have limited options for full-scale usage.
7. Prior to solar power implementation in the project area, daily life ended by 7 PM. Now, children can study until 10:30 PM, and women can sew at night. Patients can identify their medicines and use restrooms properly at night.
8. In summer, the provision of solar power has eased living conditions due to the availability of fans and other services.
9. The current rate of solar energy is Rs. 28 per watt, down from Rs. 36.
10. Women drawing water from wells have found their lives significantly easier.
11. The experiences and suggestions of experts, NGOs, and rural communities largely align, indicating that more people are opting for solar power.

B-Recommendations:

1. Training programs should be established for rural people in areas such as solar assembly, battery repair, and related technologies.
2. Measures should be taken to protect solar panels and batteries from theft, and users should be safeguarded against snake and insect bites.
3. Solar grid stations should be promoted at the union council level.
4. Rural entrepreneurs should be supported through scheduled banks, and microfinance institutions should be encouraged to provide easy loans for solar units.
5. The cost of storage (batteries) should be reduced.
6. The cost per watt, currently at Rs. 28, should be lowered to Rs. 20 by reducing government taxes and duties.
7. Regular awareness sessions should be held on innovative uses of solar energy for households and rural enterprises.
8. The conversion efficiency should be improved to 30 per cent.
9. Community-managed solar parks should be promoted at the village level.

Project: Clean Energy and Climate Resilient Housing in Rural Sindh, Pakistan

Field work for Position Paper on Renewable Energy

ڪميونٽي فوڪس گروپ ڊسڪشن؛ عورتن / مردن لاءِ

(الف) سولر جو عام استعمال

1. توهان جي هن ڳوٺ (ڳوٺن) ۾ گهڻا گهر آهن؟
2. انهن گهرن ۾ ڪيترا گهر يا سيڪڙو ڪي سولر لڳل آهي؟
3. اهي سولر سسٽم ڪيتري وائيج جا آهن؟
4. توهان جي آس پاس جي ڳوٺن ۾ گهڻا سيڪڙو ڳوٺن ۾ سولر لڳل آهي؟
5. توهان سولر ڪهڙن مقصدن لاءِ استعمال ڪندا آهيو؟
6. سولر سان توهان جي روزاني زندگي ۽ ڪميونٽي ڪهڙو اثر پيو آهي؟

(ب) سولر خريد ڪرڻ

7. توهان جي ڳوٺ ۾ آمدني جو ذريعو ڇا آهي؟
8. توهان جي سولر سسٽم جي انداز ڪيتري قيمت آهي ۽ ان ۾ ڇا ڇا اچي وڃي ٿو؟
9. توهان سولر سسٽم خريد ڪرڻ لاءِ ڪهڙي شيءِ ڏسندا آهيو؟

(ت) سار سنڀال

10. سولر سسٽم ڪي ڪهڙيون شيون نقصان ڏين ٿيون؟
11. توهان سولر سسٽم ڪي ڪيئن سنڀاليندا آهيو؟

(ث) سولر جي مرمت ڪندڙ

12. توهان ڪي سولر سسٽم لاءِ ڪڏهن ڪڏهن مرمت جي ضرورت پوندي آهي ۽ ان کي ڪير مرمت ڪندو آهي؟
13. سولر جي مرمت لاءِ توهان وٽيڪنيشن موجود آهن يا نه؟

(ج) سامان جي فراهمي/ موجودگي

14. توهان سولر سسٽمڪٿان خريد ڪيو؟

15. سولر سسٽم خريد ڪرڻ وقت توهان کي ڪهڙيون تڪليفون پيش آيون؟

(ح) سولر سسٽم جو واڌاءُ

16. توهان جي علائقي ۾ ڪي سنڌ حڪومت، لوڪل گورنمينٽ يا اين جي اوز وٽ سولر سسٽم لڳائڻ جو ڪو منصوبو/ پروگرام آهي؟ جي آهي ته اهيڪهڙين شرطن تي سولر سسٽم ڏين ٿا؟

(خ) سولر جو مستقبل

17. توهان ڇا ٿا سمجهو ته ايندڙ وقت ۾ ڇا سولر سسٽم اڃا وڌيڪ استعمال ٿيندو؟
18. سولر کان علاوه ڇا هتي هوائي بجلي يا بائيو گئس جي بجلي موجود آهي؟ يا ان جو مستقبل آهي؟

(د) تجويزون

19. سولر سسٽم کي وڌائڻ لاءِ توهان جون ڪهڙيون تجويزون آهن؟

Project: Clean Energy and Climate Resilient Housing in Rural Sindh, Pakistan Position Paper on Renewable Energy

عام سمجهه

1. شمسي توانائي جي سامان ۾ ڇا هوندو آهي؟
2. شمسي توانائي جي فراهمي جي حوالي سان توهان ڳوٺاڻن گراهڪن جي خريداري جي رجحان کي ڪيئن ٿا ڏسو؟
ٽوٽل قيمت
3. شمسي سامان جي قيمت ڇا آهي - رينج وار؟

4. ڳوٺاڻن جا خريدار عام طور تي سولر انرجي سسٽم جي ڪل قيمت کي ڪيئن ٿا سمجھن، بشمول تنصيب ۽ سار سنڀال؟

5. توهان جي خيال ۾ ڪهڙا عنصر ڳوٺاڻن گراهڪن کي شمسي يونٽن جي خريداري ۾ متاثر ڪن ٿا؟

وارنٽي

6. شمسي توانائي جي سامان جي وارنٽي لاءِ ڪهڙيون شرطون آهن؟
شمسي پينل

7. ڳوٺاڻن جا سڀ کان عام خدشا ڪهڙا آهن جيڪي سولر پينلز جي حوالي سان ظاهر ڪن ٿا؟

8. توهان ڳوٺاڻن خريدارن کي مختلف قسمن جي سولر پينلز جي دستيابي ۽ انهن جي فائدين بابت ڪيئن ڄاڻايو ٿا؟

بيٽريون

9. ڳوٺاڻا گراهڪ اڪثر سولر انرجي سسٽم لاءِ بيٽرين بابت ڪهڙا سوال پڇندا آهن؟

10. توهان پنهنجي ڳوٺاڻن گراهڪن لاءِ بيٽري جي زندگي، صلاحيت، ۽ سار سنڀال بابت خدشن کي ڪيئن حل ڪندا؟

11. بيٽرين جي مختلف سائيز جي قيمتن جي حد ڇا آهي؟

انورٽرز

12. انورٽرز جي حوالي سان ڳوٺاڻن خريدارن کان توهان کي ڪهڙي موٽ ملي ٿي؟ ڇا ڪي خاص خاصيتون آهن جن کي اهي ترجيح ڏين ٿا؟

13. توهان ڳوٺاڻن گراهڪن کي انهن جي شمسي سيٽ اپ ۾ انورٽر جي اهميت کي سمجھڻ ۾ ڪيئن مدد ڪندا آهيو؟

شمسي توانائي جي حصن جي دستيابي

14. توهان ڪيئن يقيني بڻائيندا آهيو ته سولر سسٽم جا متبادل حصا توهان جي ڳوٺاڻن گراهڪن لاءِ آساني سان دستياب آهن؟

15. ڳوٺاڻن علائقن لاءِ شمسي حصن جي مسلسل فراهمي کي برقرار رکڻ ۾ توهان کي ڪهڙيون مشڪلاتون درپيش آهن؟
برانڊنگ

16. ڪيئن برانڊ تاثرات شمسي شين جي حوالي سان ڳوٺاڻن گراهڪن جي خريداري جي فيصلن تي اثر انداز ڪندا آهن؟

17. ڳوٺاڻن خريد ڪندڙن جي وچ ۾ توهان جي برانڊ تي اعتماد پيدا ڪرڻ لاءِ توهان ڪهڙيون حڪمت عمليون استعمال ڪندا آهيو؟
ڪميونٽي جي حمايت

18. توهان ڪيئن سوچيو ٿا ته پرچون ڪندڙ ڳوٺاڻن برادرين کي شمسي توانائي جي حل کي اپنائڻ ۾ بهتر مدد ڪري سگهن ٿا؟

19. ڇا اتي مقامي نوڪريون يا پارٽنرشپون آهن جيڪي توهان کي يقين رکون ٿا ته ڳوٺاڻن علائقن ۾ شمسي سڀلاءِ تائين رسائي وڌائي سگهي ٿي؟
مستقبل جا ويچار

20. شمسي سڀلاءِ جي قيمت ۾ توهان ڪهڙن رجحانن جي اڳڪٿي ڪندا آهيو جيڪي ايندڙ سالن ۾ ڳوٺاڻن گراهڪن کي متاثر ڪري سگهن ٿا؟

21. توهان هڪ پرچون ڪندڙ جي طور تي توهان جي تجربن جي بنياد تي ڳوٺاڻن علائقن ۾ شمسي توانائي کي اپنائڻ جي مستقبل جو ڪيئن تصور ڪيو ٿا؟

Project: Clean Energy and Climate Resilient Housing in Rural Sindh, Pakistan

Position Paper on Renewable Energy

Open-ended questions for Key Informant Interviews (KIIs) with Experts

Emergence of Solar Energy

1. What key factors do you believe have contributed to the growing interest in solar energy among communities?
2. Can you share any success stories or case studies/ example illustrating the impact of solar energy in rural areas?
3. What are the uses of solar energy in the rural areas?

Energy Gap in Rural Areas

4. In what ways do you think solar energy can address energy gaps in rural communities?
5. How does the lack of reliable energy affect economic activities and overall quality of life in these areas?

Government Policies

6. What specific policies or incentives by the government have you observed that encourage the use of solar energy among rural populations?
7. Are there any gaps in government support that you think need to be addressed to enhance solar energy adoption?

Community Participation

8. How can community leaders and organizations be better involved in promoting solar energy?

Future Trends and Scale

9. What future trends do you foresee in the solar energy sector that could impact rural communities?

10. What technologies or innovations do you believe will shape the future of solar energy in rural settings?

Barriers and Challenges

11. What barriers do you believe exist that hinder the widespread adoption of solar energy in rural areas?

12. How can these barriers be effectively addressed to promote solar energy use?

Education and Awareness

13. What strategies do you think are necessary to raise awareness and educate rural communities about solar energy benefits?

Investment and Financing

14. What role do you see for private investment in the growth of solar energy in rural areas?

15. How can microfinancing or community-based funding initiatives or the scheduled banks support solar energy projects?

Social Impact

16. What social impacts have you observed with the introduction of solar energy in these communities?

17. How can solar energy initiatives be designed to ensure they are inclusive and equitable?

Long-term Vision

18. In your opinion, what is the long-term vision for solar energy in rural areas?

19. How can stakeholders work together to ensure sustainable growth and implementation of solar energy solutions?

20. How the cost of solar energy will reduce in long-term?

Project: Clean Energy and Climate Resilient Housing in Rural Sindh, Pakistan

Position Paper on Renewable Energy

Interviews with NGOs

Name of the NGO:

Legal status/ Registered with/ Registration No.

Name of Interviewee:

Contact #:

1. Have you worked in solar energy support projects for a rural community? Yes/No

If yes please brief about it?

2. What support you provided to the communities or individuals in a solar system project?

(In cash (loan, grant, or linked with the projects' scheme/ in kind (Provided full system/ parts of system ~ names of components)

3. For what purposes, rural house-holds install solar system in your project areas?

4. What are the crucial needs for solar energy in the community?

5. How NGOs integrate solar energy support in their programs?

6. What funding challenges NGOs have to face for solar access?

7. What technical things NGOs manage in rural community development projects?

8. What operation and maintenance system of solar energy NGOs develop in the projects?

9. How communities participate in solar energy projects and what challenges they face in implementing solar projects?

10. What lessons you have learnt in solar system support?
11. What is your working experience with poor house-holds regarding solar projects?
12. How solar systems' cost could be reduced?
13. What are challenges or threats to the solar system in the rural areas?
14. What are the solar system's impacts in rural areas?
15. Please share your suggestions regarding promotion of solar system in the rural areas?

PICTURE GALLERY

