Prospects of Sustainable Energy for Rural Off-Grid Energy in Pakistan
A Policy Review

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List of Abbreviations

ADB Asian Development Bank

AEDB Alternate Energy Development Board

KP Khyber Pakhtunkhwa

MoWP Ministry of Water & Power

NEPRA National Electric Power Regulatory Authority

OGRA Oil and Gas Regulatory Authority

PEPCO Pakistan Electric Power Company

SHS Solar Home Systems

SE4ALL Sustainable Energy for All

USAID United States Agency for International Development

UNDP United Nations Development Program

WAPDA Water and Power Development Authority

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Abstract

61.7% of Pakistan's 190 million population resides in rural areas while more than 50% of these people are deprived from electricity (World Bank 2014). This percentage of the nation is not only denied the basic necessities of human life but is also not contributing to the economic potential of the rural regions through advanced electric farming techniques and small scale industries possible through the advent of electric power. This research presentation aims to highlight the reasons for electricity shortage in the country, analyze available technologies for sustainable rural electrification and evaluate the most feasible option with respect to current implementations in the region. It shall then suggest policy synthesis and implementation for the problem in lieu of existing bodies and governing structures of the country.

1.0 Introduction

1.1 Background

The electricity crisis in Pakistan has been a single drain on its economy and has contributed to a decrease in the living standards and prosperity of its nation. The problem was initiated around two decades back when the fuel-mix transformation took place and the country's reliance on thermal power generation exceeded the hydropower production. The increased generation cost along with line losses contributed to an increase in tariffs which started the vicious cycle of loss for power generation, transmission and distribution

companies. These factors have led to slippage in bill payment, delays in payments to furnace oil and reduced operation of power generation plants which laid the foundation for a phenomenon known as circular debt (Aftab 2014). Moreover, energy subsidies and a lack of focus on renewable energy expansion of the government led to an electricity shortfall of almost 7000 MW in the year 2014. (ADB 2010) The population of Pakistan exceeded 190 million in 2015 and 55% of it still remains detached from the national grid. (Yazdanie 2010) With excessive burden on current power generation utilities and no investment in alternatives to fulfill the load demand, the government has not focused on expanding the electricity distribution to the largely off- grid rural areas which in turn face political and economic problems along with social exclusions in the region. Rural population in Pakistan was last measured at 61.70 % in 2014, according to the World Bank, and falls majorly in the off-grid areas of the country (World Bank 2014). Most of these people live in distant, topographically difficult and remote areas of the country which makes the provision of basic utilities such as electricity difficult for the government in such regions. (Trading Economics 2015) Aziz *et al.* (2010) quantify the prohibitive cost to the economy of energy shortages, and convincingly demonstrate how these shortages are impeding Pakistan's economic development. They estimate that, as a result of power shortages in the industrial sector alone, the loss to the economy was over $3.8 billion in 200, about 2.5 percent of the gross domestic product (GDP). Half a million jobs and exports worth $1.3 billion were lost and the problem has only worsened in the past 5 years. Figure 1 shows the electricity utilities in the country with power distribution centered around them.

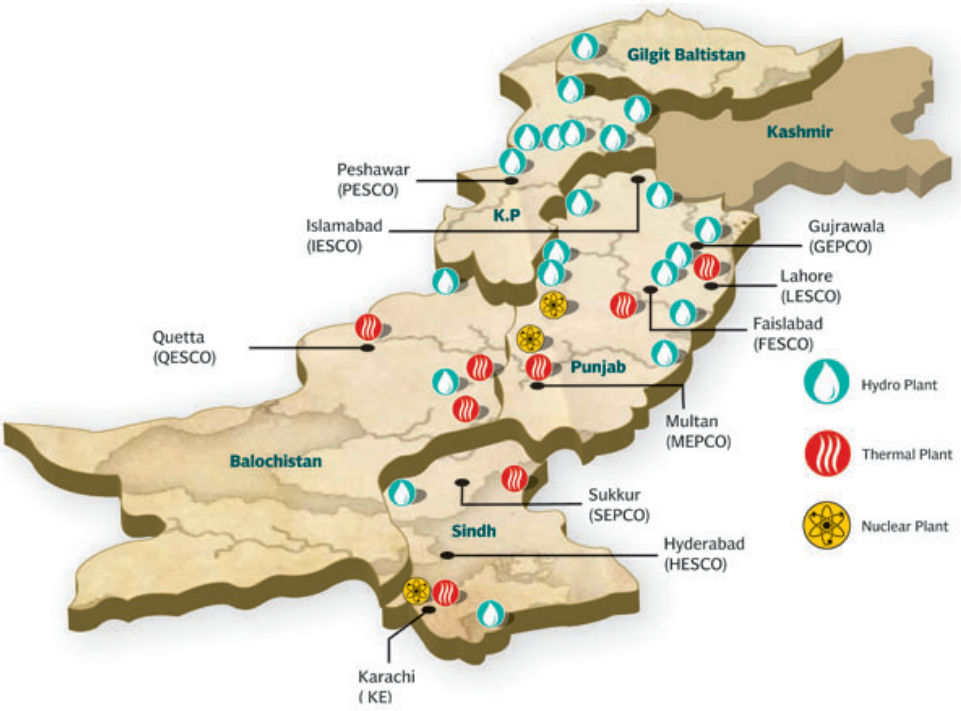


Figure 1 (Citation)

Figure 1 illustrates the need for not only a review in the existing power policy but also the need to expand the existing infrastructure to the untapped rural population of Pakistan with sustainable renewable energy technologies amidst the fluctuation in oil prices and the government's decreased capacity to meet the financial needs of the fossil fuel energy production sector.

1.2 Literature Analysis

The literature used as reference in the formulation of this paper comes from a diverse range of types from books on the electricity crisis of Pakistan to journal publications, United Nations and NGO reports, legislative documents and newspaper articles. The background and theoretical understanding of the subject was formed through journal

publications while reports from UNDP, USAID, ADB, World Bank and Sustainable Energy for All provided a quantitative analysis of the issue and were complemented by exiting legislative reports from PILDAT. Reports on policies and similar initiatives in other developing countries were also analyzed and these together assisted in formulating the results and policy recommendations.

2.0 Methodology

Providing access to modern energy source like electricity to villages which remained un-electrified so far despite several programs (ongoing and past) is a challenge and needs innovative and approach based on vision and learning from past and leveraging on evolving supportive conducive policy and regulatory environment by government. Therefore, the methodology adopted for this paper relied on both primary research and literature analysis along with an approach of visioning, strategizing and critically laying down practical steps to curb the problem.

The initial background research was done by a literature analysis of existing renewable technologies and their possible application in off-grid electricity. Then an overview of existing policies in the country for renewable energy was done which involved a critical analysis of the National Power Policy of 2013 and Policy for Development of Renewable Energy for Power Generation formulated in 2006. This phase helped me understand the institutional organization of the power sector of Pakistan (Appendix A), identify important stakeholders and evaluate the gaps in existing legislation. This understanding was then further strengthened by going through present and past initiatives in the area by the government and the Alternative Energy Development Board (Appendix C).

The theoretical understanding of the foundations of the problem was then enhanced by primary research through consultation with stakeholders in the Water and Power ministry along with an interview with an energy microfinance entrepreneur Fiza Farhan. These interactions gave me a practical side to the issue and helped me identify the logistical and institutional challenges faced by the country in the development of renewable energy. Resources suggested by these stakeholders along with discussion with the head of the Sustainable Energy for All initiative at a conference directed me to legislative documents and a diagnostic report by SE4All on the energy crisis of Pakistan which formed the basis of quantitative analysis of my research.

The report conducted a series of regional level consultations with the help of the Ministry of Finance and other government departments such as Planning Commission and Ministry of Water & Power (MoWP). These regional consultations facilitated by UNDP Pakistan were held in all four provinces of the country and included participants from government departments, private sector, civil society and development partners. Each consultation workshop for the report was designed to discuss the role played by these regions to deal with the energy crisis along with a discussion of past and present energy initiatives, future plans and a discussion on their existing energy sources. The thoroughness and quantitative basis of this report played a major role in the formulation of my results and findings. (SE4All 2014)

Primary research combined with the literature analysis and discussions with social workers in the area along with my indigenous understanding of the region helped me to critically analyze existing legislation and provide cohesive and practical policy

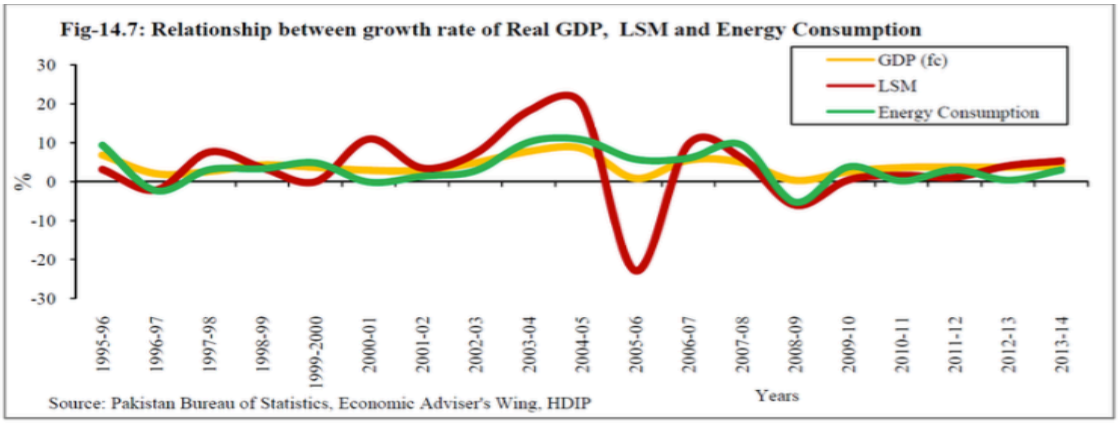
recommendations to deliver sustainable electricity in the rural off-grid regions of Pakistan.

3.0 Results and Findings

Holistic research has revealed the following key findings regarding the potential of renewable energy development for the off-grid areas of the country:

3.1 Link Between Economy and Energy Consumption

The economic survey of Pakistan in 2014 revealed a direct link in the improvement of GDP with higher Energy Consumption by the country. Figure 2 illustrates the link with patterns from 1995 to 2014. This shows that for the economic and consequently social prosperity of the rural regions of the country, it is imperative to provide them with off-grid sources of electricity.



Source: Economic Survey of Pakistan 2013-14

Figure 2 (SE4All Report, 2014)

3.2 Potential of Renewable Energy in Pakistan

The literature analysis revealed that Pakistan has an immense untapped potential for the development of renewable energy in off-grid regions. AEDB with the help of renowned

international experts /agencies such as United States National Renewable Energy Laboratories (NREL), GIZ from Germany and Risoe from Denmark has identified the Renewable Energy potential in Figure 3:

Source	Potential
Solar	2,900,000 MW
Hydroelectric (Small Scale)	3,100 MW
Biogas	2,300 MW
Wind	340,000 MW
Geothermal	550 MW

Figure 3 (USAID Report, 2014)

A detailed explanation of the Renewable Energy source potential in the country in contrast to the current energy mix can be found in Appendix B.

3.3 Existing Framework for the Potential of Sustainable Energy in Pakistan

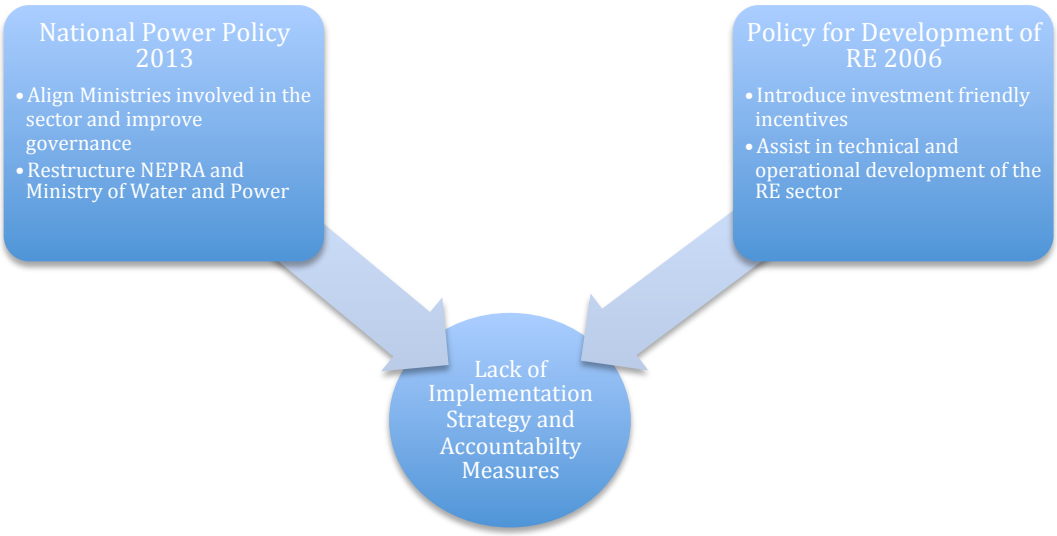


Figure 4 (Author)

Figure 4 shows that currently the National Power Policy (2013) and Policy for Development of Renewable Energy for Power Generation (2006) are the only legislative measures that exist in the area. (p. 15) Both efforts highlight the existing issues but fail to provide implementation strategy and progress evaluation for projects and steps suggested. This paper shall highlight the shortcomings of both the legislations and shall address the concerns as policy recommendations later on.

3.4 Challenges for Renewable Energy in Pakistan

Discussion with stakeholders and a review of existing literature has revealed the challenges highlighted in Figure 5 for the development of sustainable rural electricity in the country.

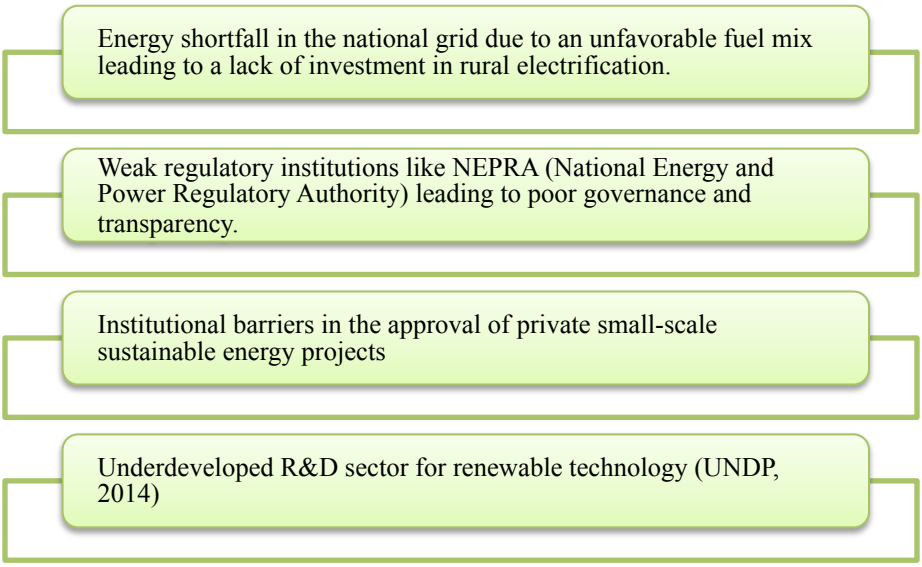


Figure 5 (Author)

3.5 Key Solutions

The literature analysis and primary research shows that an overall circular debt in the national grid, along with a lack of focus on rural areas for economic development has

been the major reason for a lack of development in off-grid electricity. Figure 6 depicts the key findings for solutions to the problem through my research.

Figure 6 (Author)

4.0 Discussion

4.1 Current State of the Energy Policy Framework

National Power Policy, 2013

Figure 7 (NPP, 2013)

The National Power Policy of 2013 aims to reduce the circular debt in the national grid with improving the fuel mix of electricity generation, identifying the need for conservation and reducing electricity theft along with enhancing the governance strategy through re-organizing regulatory authorities such as NEPRA and stream lining the tasks of the Water and Power Ministry. It succeeded in highlighting the dependence of the electricity generation sector on the volatile price of oil, the gaps in governance structures and the need to have specialized institutions for alternative energy development.

Policy for Development of Renewable Energy for Power Generation, 2006

The main objectives of this policy initiative were: a) Energy Security b) Economic Benefits c) Social Equity d) Environmental Protection

Strategy

1. Increase the deployment of renewable energy technologies (RETs) in Pakistan so that RE provides a higher targeted proportion of the national energy supply mix, i.e., a minimum of 9,700 MW by 2030 as per the Medium Term Development Framework (MTDF), and helps ensure universal access to electricity in all regions of the country.
2. Provide additional power supplies to help meet increasing national demand.
3. Introduce investment-friendly incentives, and facilitate renewable energy markets to attract private sector interest in RE projects, help nurture the nascent industry, and gradually lower RE costs and prices through competition in an increasingly deregulated power sector.
4. Devise measures to support the private sector in mobilizing financing and enabling public sector investment in promotional, demonstrative, and trend setting RE projects.
5. Optimize impact of RE deployment in underdeveloped areas by integrating energy solutions with provision of other social infrastructure, e.g., educational and medical facilities, clean water supply and sanitation, roads and telecommunications, etc., so as to promote greater social welfare, productivity, trade, and economic wellbeing amongst deprived communities.
6. Help in broad institutional, technical, and operational capacity building relevant to the renewable energy sector.
7. Facilitate the establishment of a domestic RET manufacturing base in the country that

can help lower costs, improve service, create employment, and enhance local technical skills. (PDREP, 2006)

This roadmap intended to initiate lenient policy measures and investment in this relatively new business area, remove existing barriers to project implementation, and 'hand-hold' reasonable- sized pioneering projects through to successful commercial operation. It was hoped that business confidence and domestic industry capacity would grow; the policy environment would graduate into a more competitive and deregulated RE market environment, with significantly expanded scale of activities envisioned in the medium and long terms. (SE4All Report, 2014)

Analysis of Existing Policies

The National Power Policy (NPP), 2013 and Policy for Development of Renewable Energy for Power Generation (PDRE), 2006 succeed in identifying the gaps in the development of renewable technology in the country but fail to provide an implementation strategy to counter the problems. The NPP highlights the need to reduce financial debt by reducing line losses along with recommending restructuring of institutions but fails to specify stakeholders to carry out the task. Similarly, PDRE suggested to incentivize private sector financing in RE but could not lay down a strategy to do so. Moreover, both policy efforts did not highlight the need for the development of RE for off-grid regions or grid expansion for economic prosperity. Therefore, despite the existence of previous power generous policies, there is a need to re-examine them and lay down stream-lined implementation plans with specific stakeholders highlighted to re-energize the renewable energy sector of Pakistan.

4.2 Renewable Energy Technologies

In order to promote AREs in the country, AEDB has undertaken various supportive measures. These measures have resulted in creating enabling environment, building confidence of investors, developers and lenders and establishing linkage among the provincial and federal government departments to undertake integrated approach for promotion and development of AREs. An overview of projects initiated by AEDB in this regard is given in Appendix C.

Pakistan like various developing nations in the region is an energy deficit country which is heavily reliant on fossil fuels despite a geographically favored location and topography for renewable energy utilization. With more than 12 hours of sunshine on an average day for solar energy, a network of rivers for hydroelectricity and a potential for wind power in the plains, Pakistan requires investment in these sustainable means of energy production to expand the access of electricity to all the parts of the country in a sustainable and a cost efficient manner. (Raza Hayat, 2009)

The following options are currently available for rural electrification in Pakistan:

(i) Investment in Hydro Micro Grids

Pakistan has an extensive network of rivers initiating from the Himalayan and Hindu Kush region till the southern Indus Basin. These rivers and streams receive a high amount of water flow each year which favors micro hydro projects along with the high altitude streams in the northern regions of the country. With existing large-scale hydro projects, Pakistan has the technical expertise and resources to establish micro hydro grids for rural electrification the country. These projects are less costly than dams because of the

simpler civil works requirements and have a higher stability with water flow predictions with respect to sources like wind. Apart from this, a hydro-micro grid has a life of approximately 40 years, is highly efficient and has a lower cost per kilowatt-hour with respect to fossil fuel sources such as coal and oil (Farhan 2014). Nonetheless, these plants are susceptible to variations in the rainfall or water flow which reduce or even cut off potential power output during periods of drought and with climate change and unpredictable rainfall in the region, such a technology is likely to face extreme variations in power production capability throughout the year. (Farhan 2014) At present 128 MW of Micro-Hydro is operational in the country, 877 MW is under implementation and around 1500 MW is available for development. (SE4All Report 2014)

(ii) Integration of the telecom industry boom with electricity generation policy and initiate Pay as You Go Stand Alone Solar Systems in the region via microfinance.

Pakistan in recent years has seen an extensive telecom boom with over 70 percent cellular coverage throughout the country. This cellular expansion coupled with micro-financed stand alone solar systems by the government can help implement the Pay As You Go (PAYG) Solar Model enables the customer to acquire a solar panel over installments in a certain period of time through mobile top-up. It has been popular among various energy expansion enterprises and has the potential to disrupt the energy sector the way it did with the telecommunications industry with its flexibility and would fit well within the existing economics of the energy poor customer (Ashden 2013). Based on a report by CGAP, “there are at least 25 companies actively deploying a PAYG solar solution across Africa, Asia, and Latin America. To date, at least 150,000 PAYG solar products have

been sold globally and another 100,000 customers will access modern energy through a PAYG solar product by the end of 2014. In the next five years, at least 3 million PAYG solar systems will be sold globally, demonstrating the potential for such models to disrupt the energy access sector" (Ashden 2013). These findings depict a promising future for PAYG solar systems, however, there is a need to analyse the technical expertise required by customers to operate the systems and the social acceptance of such a technology in some of the least educated rural areas of Pakistan.

(iii) Establishment of Solar Micro-Grids for Rural Electrification

Technological advances and improvements in monitoring, controlling, and payment collection for solar micro-grids have changed the tools available to provide energy services dramatically as a result, solar micro-grids today have enormous potential to provide electricity access to the 1.2 billion people who currently do not have access to electricity (Oxfam, 2012; Palit et al., 2013; International Energy Agency, 2012). Governments, private developers, and NGOs throughout the world have been pursuing micro-grids to electrify communities that are unlikely to be served by extensions of traditional centralized, grid systems. As a result, the number of micro-grids being developed is increasing rapidly. These micro-grids provide a range of services, from residential lighting alone to entertainment, refrigeration and productive commercial uses like milling. Depending on the number of customers served, the types of services provided, and the type of generation technology used, the installed capacity of a solar micro-grid ranges from as little as 1 kW to as large as a few hundred kilowatts. Their relatively easy installation and high intensity of sunlight in most Pakistani regions

throughout the year presents a promising future for them in the rural electrification of the country. (Schnitzer et al 2014)

(iv) Development of Waste to Energy

Organic waste including bagasse from the sugar industry and manure from agriculture form a promising prospect of development for electricity in rural areas. Sugar industry is already deploying bagasse to generate electricity to meet its electricity demand while a few of them are also considering installing captive cum grid spill over power plants. 2 sugar industries have installed 35 MW capacity power plants and supplying surplus electricity to the grid. A few more projects are in process of development. (SE4All Report, 2014)

(v) Installation of Wind Turbines

The North-Western Part of Kyber Paktunkhwa and the western region of Balochistan with their topography and weather provide conditions suitable for the development of Wind Power in off-grid regions. Currently, 33 Wind Power Projects of around 2350 MW capacity are in process of development. 2 projects of cumulative 106 MW are commercially operating, 3 projects of 50 MW each are under construction and nineteen projects of cumulative 1290 MW are expected to achieve financial close by 2013/14.

(SE4All Report, 2014)

Further illustration of the renewable energy potential of the country can be found in Appendix B.

4.3 Key Considerations for Renewable Energy Policy Framework

There are some key economic, political and social factors that need to be taken into account before devising a framework for the implementation of a sustainable energy production system for rural electrification in Pakistan.

Economic Factors

Power shortfall in Pakistan has led to a slippage in bill payment, delays in payments to furnace oil and reduced operation of power generation plants which has jeopardized the industry and the economy of the country. The lack of electricity expansion in rural areas has also affected the small-scale industry of the region which has a potential to contribute around 30% to the annual GDP of the country and increase employment in the region (USAID 2007). Scarcity of electrical power has also hindered the modernization of agricultural techniques which has decreased the annual production of the agricultural sector in the country with respect to its potential (Rasool 2012). All these factors have contributed to a lack of substantive contribution by the rural areas in the economic growth of the country and have had an adverse effect on the cottage and farming industries.

Political Factors

Every government in Pakistan over the past decade has pledged to solve the electricity crisis of the country but has mostly failed in its promise. One of the major factors has been a lack of focus on expanding electricity to rural areas and a trend of investing more into fossil fuels for energy due to massive energy shortfalls in urban areas and a scarcity of expertise in the renewable energy field. A shift to small-scale sustainable rural

electrification options shall assist the political parties to achieve their 'zero load-shedding' agenda and will help them increase the living standards of the people. Moreover, electricity will generate economic activity and more surveillance in the distant areas of the country to monitor terrorist activities and law and order situations.

Social Factors

The rural region of Pakistan caters to a diverse set of people from different ethnicities, tribes and social norms. A lot of such populations are not open to new technologies invading their lives, hence, an awareness campaign will have to be conducted to train the these people and help them adapt to the Solar Micro-Grid system (Abbasi et al 2011). Once this barrier has been overcome and electricity is integrated into their lives there shall be an improvement in their standard of living with an easier provision of basic necessities such as water, education and medical facilities by the government. It could open an array of economic opportunities for the residents which could transform the socio-dynamic roles of the region.

Environmental Factors

With rising risks of floods and melting glaciers, Pakistan needs to craft a plan to cut its planet-warming emissions under a new global climate deal agreed in Paris in December. At present, the country's emissions are increasing at an annual rate of 6 per cent, or 18.5 million tons of carbon dioxide (CO2) equivalent. Emissions were 147.8 million tons of CO2 equivalent in 2008 and are expected to reach 400 million tons of CO2 equivalent (per year) by 2030 if the current trend continues. (Dawn 2014) The energy sector currently contributes 50% to the total carbon emissions by the country and calls for a

need to invest in environmentally friendly energy production technologies. Expansion of innovative sustainable technology will not only improve environmental conditions but will also enhance the standard of living of the people by improving air quality and living conditions. (Dawn 2014)

4.4 Evaluation Criteria

The criteria I have selected for evaluation of the policy alternatives rests upon 5 basic measures: effectiveness, efficiency, financial viability, equity and accountability. *Effectiveness:* The extent to which a policy recommendation mitigates the problem of provision of electricity to the region to raise the living standards of the people.

Efficiency: The ease by which the option can be implemented with existing institutions and its technological efficiency in terms of electricity generation and production life.

Financial Viability: The extent to which an option is economically feasible.

Equity: The extent to which an option justly caters to the needs of the entire population.

Accountability: In the past efforts to solve the electricity crisis of Pakistan, lack of accountability and corruption has been the key reason for its failure. An option that ensures frequent reporting, auditing and transparency of the process is essential for the success of the aimed policy objectives (Sadiq 2015).

4.5 Case Studies

According to the estimates by International Energy Agency around 22 % population across the world does not have access to electricity. (UNDP, 2014) Countries, across the world, have taken measures to encourage the rural electrification in their province. This

section highlights the policy framework prevailing in Brazil, China, and South Africa as shown in Figure 8 and then elaborates the key lessons learnt from off grid electricity implementations in the three countries. A detail of these projects can be found in Appendix D.

Country	Off Grid Electricity Project	Year
Brazil	PRODEEM	1994
	Luz no Campo	2002
	Luz para Todos	2003
China	County Hydro Power	2010
	Power to All	2010
	Golden Sun	2009
South Africa	INEP	2001

Figure 8 (ABPS Infra, 2011)

Key Lesson Learnt – International Perspective

Separate Institution to promote Rural Electrification

A dedicated institution to address the issues is a key to success and promotes rural electrification. It has been observed that most of the successful rural electrification programs have a separate institution or authority, rural electrification authority (Bangladesh); setting up rural electric cooperatives (Costa Rica); allocating rural electrification to a new department in the national distribution company (Thailand); or delegating it to a specialized office within the utility (Tunisia), which looks after the electrification of rural areas/community. (ABPS Infra, 2011, p.65)

Commitment from the Government

In order to make any program a success, the continuous support from the government is of extreme importance and it has also been observed in South African Off-Grid Electrification program that because of the lack of support and commitment from the

government the program has not achieved desired success. On the other hand support from the government has led to more than 99 per cent electrification in China. Thus, without firm policy support from the Government the probability of success is less for the electrification process. (ABPS Infra, 2011, p.65)

Subsides for grid expansion capital costs

In most successful programs, a substantial proportion of the investment has been obtained at reduced or low interest rates or in the form of subsidies/grants. However, an oversight on the agencies/authorities implementing the program was found necessary to make sure that the fund is utilized for the desired purpose and penalties were imposed for unsuccessful implementation. Therefore, the capital subsidy provided for rural electrification may be translated into interest bearing loans if it is found that the implementing authorities are not utilizing the funds properly. (ABPS Infra, 2011, p.66)

Tariff and Collection

The price to be charged for supplying the electricity should be dealt appropriately. Further, a proper mechanism for collection of charges towards supply of electricity should be in place. Such collection shall be used to meet operational and maintenance cost required in the process of rural electrification. (ABPS Infra, 2011, p.66)

Involvement of Local Community

Research showed that the rural electrification programs benefit greatly from the involvement of local communities and suffer because of its absence. The involvement of local community instills the sense of ownership while the development of local

community through appropriate training can reduce the operational and maintenance cost of the implementing agency. Such involvement can also reduce the dispute and damage in the process. (ABPS Infra, 2011, p.67)

Participation of Private Sector Players

The private sector participation, across the world in various rural electrification programs has shown positive results. Involvement of private sector through transparent mechanism not only creates competition in the market but also increases the coverage of the program. The participation of private sector was found important when providing access to electricity to remotely located population through developing off grid generating system or stand-alone systems, however, in order to safeguard interest and increase the participation from private sector, a strong commitment from the government is necessary. (ABPS Infra Report 2013)

4.6 Stakeholders

The main institutional actors who will be responsible for scaling up off-grid rural electrification are expected to be the Alternative Energy Development Board (AEDB), National Electric Power Regulation Authority (NEPRA) and Water And Power Development Authority (WAPDA) at the federal level, provincial and district authorities where the projects will be carried out, PPAF on the community-based projects, and PCRET to provide Research and Development and technical standardization support. It is recommended that the mandates of these organizations for implementation be as follows:

Alternative Energy Development Board

The key role of AEDB would be providing overall leadership to expand energy access to rural communities through Renewable Energy infrastructure, monitoring of supplied technology, installations and maintenance of systems before it is handed over to provincial authorities. It should also provide programmatic support for community-based solar, hydro and wind grids and design and oversee a subsidy program to support privately owned infrastructure. (World Bank 2008)

National Electric Power Regulation Authority

The role of NEPRA is to adequately provide tariff and regulation guidelines regarding each form of power generation and facilitate the project approval process for off-grid initiatives throughout the country. (SE4All 2014)

Provincial Government

The role of the provincial government would be to identify off-grid electrification needs in districts, monitor operation and maintenance of solar-micro systems and carry out an environmental and regulatory approval process for the systems. It should also monitor supply reliability and evaluation of reasonableness of tariff in privately owned solar-micro electricity systems. (World Bank 2008)

Pakistan Poverty Alleviation Fund

The PPAF should manage a program to provide subsidy support to privately owned rural electrification efforts and include energy activities in future portfolios of community infrastructure projects. (World Bank 2008)

The Pakistan Council of Renewable Energy Technologies

The PCRET should provide R&D support for local manufacture of renewable energy infrastructure and needs to assist the government in setting up technical standards and establishing test centers and testing methodologies as per international standards. It also has a role to play in the training for capacity building of equipment manufacturers and operators. (World Bank 2008)

There is also a need for substantial investment into capacity building of institutions. Capabilities will need to be enhanced of all major stakeholders including AEDB, Provincial and District governments, FFC, PPAF, NGOs, PCRET and equipment supply companies. Once their capacity and efficiency has been enhanced only then can they coordinate and execute an integrated plan. (Win-Rock International 2008)

4.7 Policy Recommendations

Policy Steps

With roles and responsibilities of each stakeholder highlighted, the following steps should be taken in order to flourish renewable energy for off-grid electrification in Pakistan.

<u>Short Term</u>

1. **Make the region wise Alternative Energy Resource data available**

   Stakeholders: AEDB, PCRET

   On ground renewable energy resource mapping has not been done for most parts of rural Pakistan which hinders prompt project initiation. AEDB, in conjunction

with PCRET should map the data and make it available to the private sector for business opportunities.

2. **Provincial Governments Should allocate sites for small off-grid projects for the private sector**

   Stakeholders: Governments of all 4 provinces

   Projects cannot be encouraged or initiated unless land sites are not allocated for alternative energy in renewable areas to attract a competitive market.

3. **Upfront Tariff be announced for all forms of renewable energy**

   Stakeholders: NEPRA

   NEPRA is yet to announce upfront tariff for solar, micro-hydro and biomass energy projects which makes it difficult for projects to make budget forecasting. Hence, NEPRA should immediately devise a tariff scheme.

4. **Subsidies should be allocated to emerging micro-financing projects in the area**

   Stakeholders: Ministry of Finance, Pakistan Poverty Alleviation Fund

   Non Governmental Organizations such as Buksh Foundation are assisting the distribution of solar panels in rural areas with the agenda of gender empowerment. By providing tax reliefs and subsidized equipment to these organizations, the process of expanding rural electrification projects could be catalyzed. (SE4All Report, 2014, p.60)

<u>Medium Term</u>

1. **Establish an Alternative Energy Development Fund and attract donors from local and international sources.**

Stakeholders: Ministry of Finance, Water and Power Ministry, NGOs

The government should establish an Alternative Energy Development Fund with social development in off-grid areas as its primary aim in order to encourage donations from local and international organizations.

2. **Strengthen the involved institutions and take capacity building measures at both national and provincial level.**

   Stakeholders: NEPRA, AEDB, Ministry of Water and Power

   With acute shortage of electricity in the national grid and financial problems, the government institutions lack manpower and expertise to adequately cater to renewable off-grid electricity. Specialized training and formation of specific task groups within these institutions could improve their functioning and coordination with other departments.

3. **Establish an Institute for Alternative Energy Renewable Technologies which undertakes research in the area.**

   Stakeholders: Ministry of Water and Power, PCRET

   Currently, PCRET is the only council that coordinates renewable energy research amongst academics, however, there is no designated institution for research and development of renewable energy technology along with training in order to build capacity in the area. (SE4All Report, 2014, p.59)

<u>Long Term</u>

1. **Mandatory inclusion of Alternative Renewable Energy in the grid for at least 30% by 2026**

   Stakeholders: AEDB, Water and Power Ministry

Pakistan cannot attract sufficient investors in clean energy for off-grid areas until the government establishes itself as a potential market in the world. With examples available in China and India, achievement of this milestone could attract international co-operations for large-scale off-grid electricity projects.

2. **Introduce a Green Energy Tax**

   Stakeholders: Ministry of Finance

   Availability of funds for the development of renewable energy is limited in the country. Therefore, the government could impose a tax on the use of fossil fuels on the commercial sector and allocate the income in the development of clean technology for rural areas.

3. **Introduce Carbon Credits that could encourage organizations to use green energy while the credits could be an added income for the rural population using renewable energy.**

   Stakeholders: Ministry of Finance, Pakistan Poverty Alleviation Fund

   Devising a long-term strategy for giving carbon credits to large and small scale energy users could encourage corporations to invest in green energy and catalyze its acceptance in the country while the credits could also serve as an added income to the clean technology using rural population. (SE4All Report, 2014, p.58)

The above mentioned policy recommendations identify the main stakeholders involved in the issue, highlight major problems faced by the sector and provide a cohesive yet streamlined response for developing sustainable electricity for the off-grid regions of Pakistan.

4.8 Indicators for Evaluation and Assessment

In order to monitor the progress of above suggested policy measures, a quantitative and qualitative assessment of the following factors needs to take place:

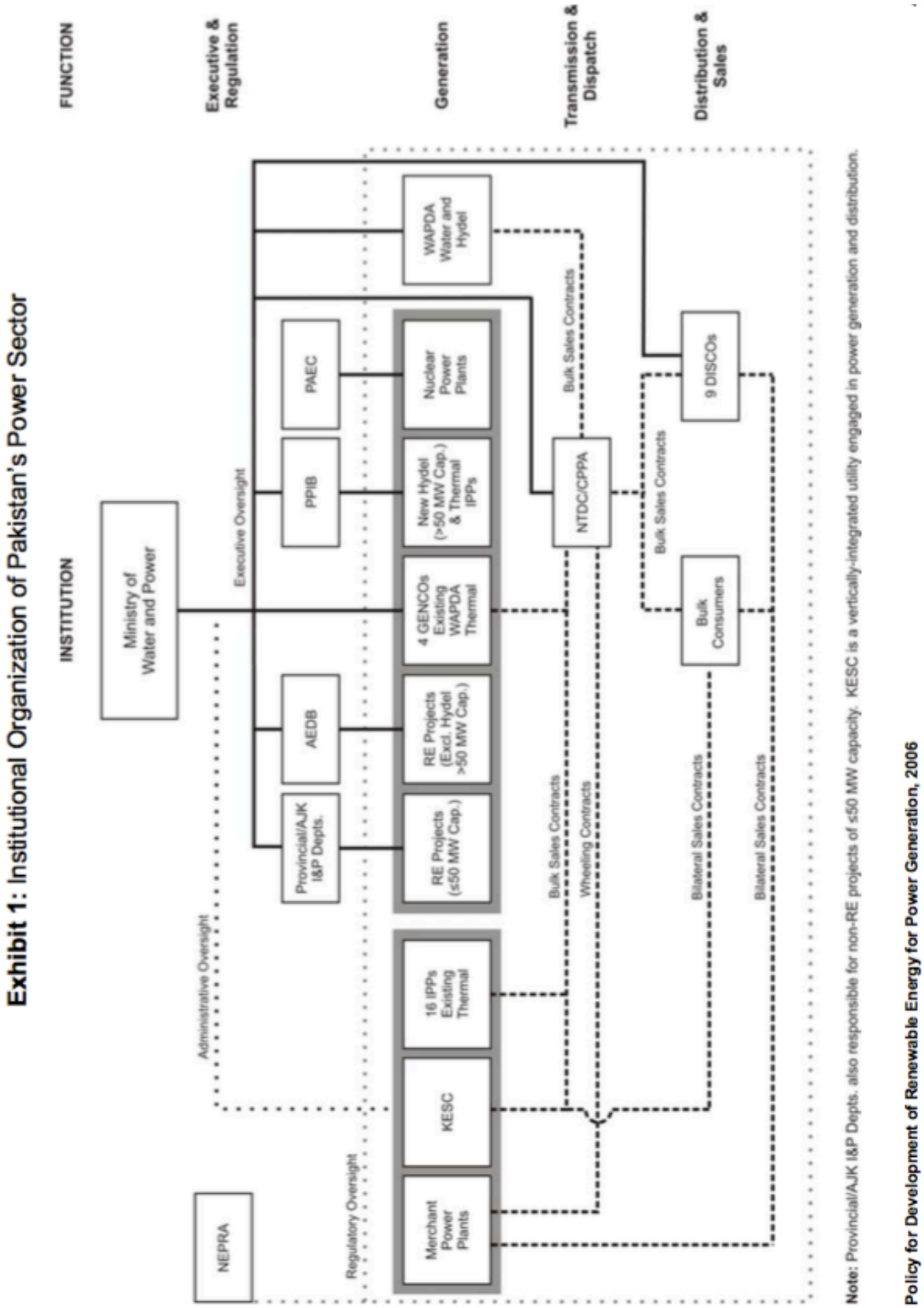
- The percentage of population provided with electricity in comparison with economic investment to evaluate the effectiveness of the flood mitigation aspect.
- The amount spent in rupees per person for rural electrification in an area along with a qualitative assessment of provision of basic needs in the region through electricity to ensure equity.
- The frequency and extent of reporting by stakeholders involved in order to safeguard accountability.

5.0 Conclusion: The Way Forward

With an acute shortage of electricity prevailing in Pakistan and more than one third of the population off-grid, the need for electrical sustainability and consolidation is imperative for the prosperity of the country. The rural population of Pakistan provides an untapped potential that can not only increase the contribution of the agricultural sector through electricity in the annual GDP but can transform the economy of the country through small scale enterprises. Pakistan has various sustainable options for rural electrification, however, geographical, political, social and economic factors in the country make sustainable electrification challenging and call for innovative technologies and policy frameworks. With a huge renewable energy potential, the unprecedented advancement in the solar and hydro industry and an in depth analysis of similar efforts in developing nations reveals that a cohesive approach between the government, the local community and large enterprises is necessary for effective and viable electricity for rural areas in the

country. Investment in the technology by private organizations in the country make it logistically less challenging and call for a cooperation between the public and private sector for an integrated approach towards solving the electricity crisis. This paper reveals the complexity and gravity of the nature of the problem of rural electrification in the region, evaluates existing policies, highlights inherent barriers and presents a cohesive approach for its solution with stakeholders from the public and private sector to elevate the standard of living of the people of Pakistan in every corner of the country.

Appendix A



Policy for Development of Renewable Energy for Power Generation, 2006
Government of Pakistan

Appendix B

Renewable Energy Potential in Pakistan

Wind
• Wind Energy potential of Sindh and Balochistan is more than 50,000 MW. • AEDB has issued 47 LOIs with capacities in the range of 5-350MW for wind power projects. • Pakistan's First 50MW Wind Power project of FFCEL has been inaugurated in Dec 2012 • Another 56.4 MW Zorlu Energy project is expected to be inaugurated. • Four (04) Projects of 50MW (each) have achieved Financial close. • Five (05) projects 50MW (each) have signed Energy Purchase Agreements (EPA) with CPPA and Implementation Agreements (IA) with AEDB. • Seventeen (17) wind power projects 50MW (each) capacity have secured Generation License from NEPRA. • Fourteen (14) projects 50MW (each) have received Tariff for their projects from NEPRA.
• AEDB expects 900MW capacity wind power projects would become online by 2014-2015.
Hydro
• Current installed capacity: 6,555 MW (including 1,400 MW Run of the River) • Realizable potential: 17,000 MW, of which 12,000 MW is reservoir based hydel and 5,000 MW is run off river based power generation
Solar
• Potential of over one million megawatts of capacity • Convert all gas water heating to solar • Off grid solar solution for remote villages

Source: The Pakistan Economic Forum Report on Energy, 2013.

Figure 3 (Pakistan Economic Forum Report, 2013)

Wind Energy Potential in Pakistan

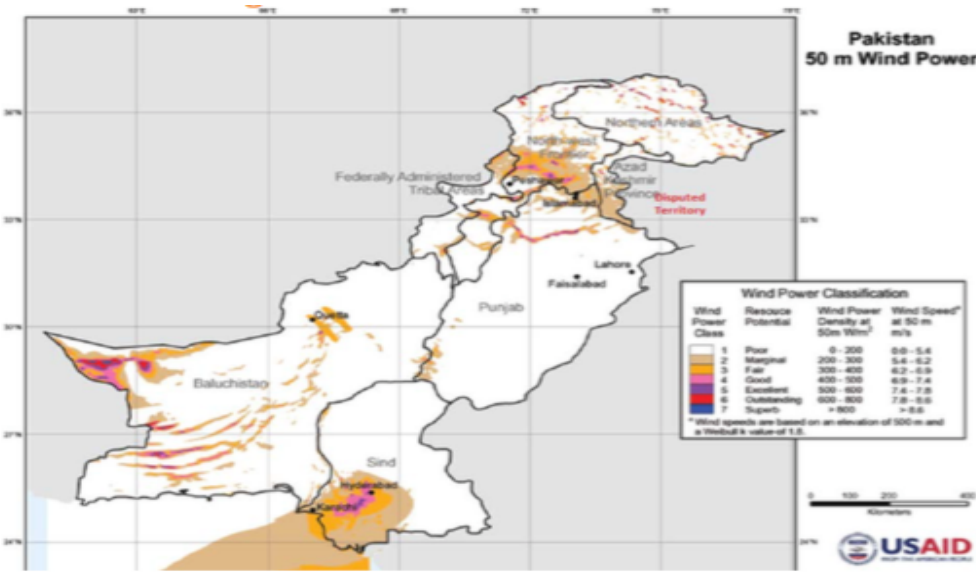


Figure 4 (USAID Report, 2014)

Solar Energy Potential in Pakistan

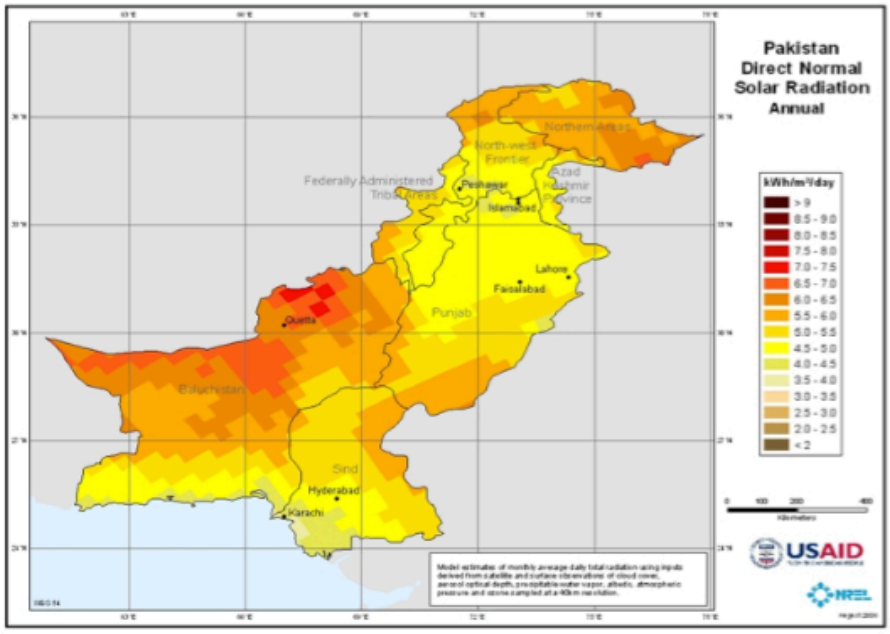


Figure 5 (USAID Report, 2014)

Micro-Hydro Potential Areas in Pakistan

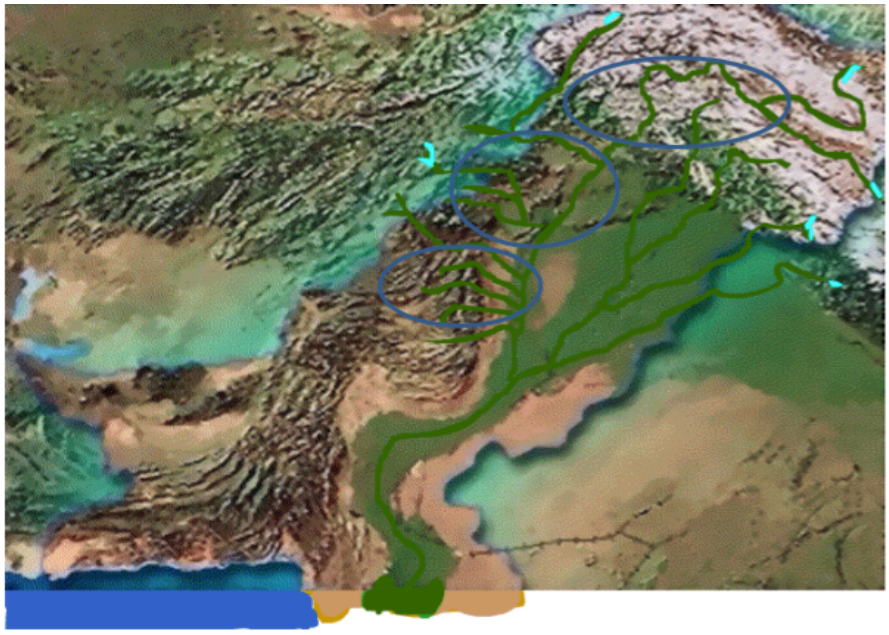


Figure 6 (USAID Report, 2014)

Waste to Energy Potential of Pakistan

Figure 7 (USAID Report, 2014)

Summary of Merits and Demerits of Existing RE options

Parameter	Solar PV	Gasifier	Micro Hydro	Solar Wind Hybrid
Maturity Level	High	Medium	High	High
Penetration Level	High	Low	Medium	Low
Advantages	Low O&M, Easy Installation & Maintenance	Easy Installation, Indigenous Tech.	Low O&M, Easy Installation & Maintenance	Low Installation Cost
Dis-advantages	High capital cost Battery replacement (5yr)	Capacity building needed. Difficulty in sustained biomass supply	Mostly inaccessible Reduced output during lean period	High investment
Minimal requirement	~4-5kWh/d/m2 solar insolation	1.5-2 kg biomass per kWh	For 1kW: 30m head 4L/s flow	Start-up wind speed 2.5m/s
Cost (Rs/kW)	150-180,000	40-50,000	90-100,000	~250,000
Typical unit size	1-10kWp	10,20,50,100kW		1-10kW
Application	Lighting alone	Lighting plus productive loads		Lighting

(Source: ABPS Infra analysis)

Figure 8 (ABPS Infra Report, 2014)

Current Energy Generation Mix of Pakistan (2012)

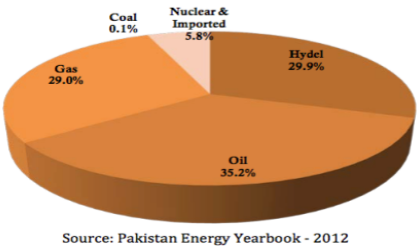


Figure 9 (SE4All Report, 2014)

Appendix C

Current Renewable Energy Projects in Pakistan

The above energy projects are being controlled/administered by the following federal agencies:

	Energy Projects		Capacity (MW)
Hydel			
Short Term/Current Energy plans			
WAPDA	05 Dams - Under construction		?
	03 Canal projects - Under construction		?
	05 Hydropower projects		5,788 MW
	12 small & medium dams		43.35 MW
PPIB	New Bong Escape Hydropower Project		84 MW
AEDB	08 small hydro projects		80 MW
Medium Term Energy plans			
WAPDA	03 projects		377 MW
Long Term Energy plans			
WAPDA	4 dams		?
PPIB	12 projects		6,571 MW
Thermal			
Short Term/Current Energy plans			
PPIB	Commissioned Projects	27 IPPs	6,935
		KAPCO	1,638
	Upcoming Projects	Uch II Power Project	414.5 (2014)
		Grange Holdings Power Project	163 (2015)
		Star Power Project	134 (2016)
		Kandra Power Project	120 (in process)
Long Term Energy plans			
PPIB	Sindh Engro Thar Coal Power Project		1,200
Other Renewables			
Short Term/Current Energy plans			
AEDB	**Wind:** 34 IPPs at various stages of development - 2013 (FFC and Zorlu (Turkey) commissioned - 2014 - 2015 - 2016 - 2017 **Total**		 106 MW 150 MW 380 MW 500 MW 789 MW **1,925 MW** *Potential Capacity for Wind is 340,000 MW.*
	Bio Energy: bagasse to power plants operational *15 Projects* in advanced stages *04 LOIs* issued to Biomass & Waste to Energy IPPs *05 LOIs* issued under Co-Generation (Biomass/Bagasse) *01 LOI* under process.Potential: 1,500-2,000 MW in 2		 34 MW 294 MW 48 MW 143 MW

Figure 1(SE4All Report 2014)

Appendix D

Overview Of Rural Electrification Policies In International Perspective

Rural Electrification is a process which enables access to electricity to households/villages located in rural and/or remote areas. According to the estimates by International Energy Agency around 22 % population across the world does not have access to electricity. Countries, across the world, have taken measures to encourage the rural electrification in their province. This section elaborates the policy framework prevailing in Brazil, China, and South Africa. (ABPS Infra Report, 2011)

4.1 Initiatives for Rural Electrification in Brazil

The Government of Brazil, in order to provide access of electricity to rural communities and areas, has initiated several programs. In 1994 with an objective to electrify the rural communities, the Brazilian Government initiated (PRODEEM - *Programa de Desenvolvimento Energético de Estados e Municípios*). Further, in 2000, Luz no Campo (LnC or Light in the Countryside) was initiated. During 2003, PRODEEM and LnC were merged into Luz para Todos (LpT or Light for All). (ABPS Infra Report, 2011)

4.1.1 PRODEEM

With an objective to promote the supply of energy to the rural community which are distant away from the conventional electricity grid, the Brazilian Government, during 1994, has initiated Program for Energy Development of States and Municipalities (PRODEEM - *Programa de Desenvolvimento Energético de Estados e Municípios*). The program was coordinated by National Energy Development Department (DNDE). The initiative aimed at utilising renewable sources of energy to provide electricity to rural communities. PRODEEM focused on community level electrification rather than providing electricity for households. It involved three types of standalone systems i.e. PV electric energy generation systems, PV water pumping systems, and PV public lighting systems to improve the quality of life of rural communities. From 1996 to 2000 photovoltaic panels of around 3MW were distributed to 3050 villages which benefited more than six (6) lakh people. PRODEEM is no more in existence and is superseded by

Luz para Todos (LpT or Light for All). (ABPS Infra Report, 2011)

4.1.2 Luz no Campo

In 1999, the Government of Brazil has initiated *Luz no Campo* (LnC or Light in the Countryside) with an objective to provide electricity to one million rural households in three years which was expected to benefit a population of around five (5) million. In 2002, the program covered around 480000 connections. Under this program the rural consumers are supposed to pay the full cost of connection typically spread over a number of years. The program has a provision to provide 75% of the investment as loan on easy terms at 6 per cent rate of interest, with a two-year grace period and a five to ten year repayment period to the energy companies implementing such projects. The program is superseded by Luz para Todos (LpT or Light for All) during 2003. (ABPS Infra Report, 2011)

4.1.3 Luz para Todos

In November 2003, the program *Luz para Todos* (LpT or Light for All) was initiated with the objective to provide access to electricity to twelve (12) million people who are not connected with the electricity grid. The program was implemented through partnership between the Federal Government, the State Government and the energy companies. The program aimed to improve rural electrification through expansion of network, distributed generating systems with isolated networks or individual plants, with renewable energies also used for generating electricity. The program superseded earlier rural electrification programs initiated by the Government. (ABPS Infra Report, 2011)

It has been observed that earlier schemes were unable to reach significant progress and accordingly authorities formulated the idea of universal electricity access program that would supply electricity to all rural communities within the five year span. The Brazilian Electricity Regulatory Agency, ANEEL, shall have the oversight for authorisation of concessionaries and other service providers along with setting and verifying the targets set under LpT. The Ministry of Mines and Energy is responsible for coordinating the program and setting its general policy. The operational implementation of the LpT

involved three options i.e. extension of grid, decentralised generation in isolated grids and standalone individual systems. Despite of have three options, it has been observed that the LpT model was primarily based on the extension of the electricity grid for providing access to rural communities. (ABPS Infra Report, 2011)

Initially, the renewable energy resources were not utilized for rural electrification however, the program identified that solar, wind, mini hydro and in some instances natural gas as most practical solution to provide access to electricity even in far remote areas. The community witnessed improvement in social programs related to health services, education, water supply and sanitation among others which strongly affect the HDI with the arrival of electricity. During 2009, the scheme has achieved two (2) million connections which translated to more than ten (10) million beneficiaries.

The key parameters for success of 'Light for All' are identified as,

- Strong political will, the LpT is treated as key component of the national strategy for poverty reduction and sustainable development

- Community to be the part of the process which translate to improve the effective and prompt responsiveness of the electrification model

- Well defined guidelines for transfer of responsibilities from Government to the implementing agencies. The compulsory completion of specific and prioritized targets has promoted development of projects.

- Key issues related to efficiency, quality and costs of service to be appropriately addressed. (ABPS Infra Report, 2011)

4.2 Initiatives for Rural Electrification in China

The evolution of rural electrification in China may be divided into three phases. During the first phase spanning 1949 to 1977, the rural electrification efforts were mainly attributed to the rural communities. During the second phase (1978 to 1997), the efforts were taken by the Governments at various levels, Both, Central and Local Governments, played pivotal role in the rural electrification. In the last phase that started in 1998,

Central Government played a key role in the rural electrification. It has been observed that the rural electrification process in China has slowed down, not because of lack of support by authorities but because of universal electrification which has crossed the mark of 99 per cent. Various prevailing schemes and programs are elaborated in the paragraphs below: (ABPS Infra Report, 2011)

4.2.1 Brightness Program and Township Electrification Program

With an objective of providing access to electricity to 23 million people living in remote rural areas through decentralized energy systems based on renewable energy, the State Development Planning Commission, in 1996, initiated the 'Brightness Program'. Further, as a part of Brightness Program, Township Electrification Program (2002 – 2005) with an investment of Chinese Yuan 4.7 billion was initiated with the support from Central and Local Government funds. The Township Electrification Program is one of the largest renewable energy based rural electrification program in the world and it aimed to provide access to electricity to a population of approximately 1.3 million. (ABPS Infra Report, 2011)

4.2.2 County Hydropower Construction of National Rural Electrification

The program aimed to provide access to electricity to a population of 880,000 and to 4.85 million people, through utilising hydro power, by 2010. By the year 2008, around 45,000 small hydro power stations were installed with an installed capacity of 51GW which supplied electricity to a population of around 300 million. (ABPS Infra Report, 2011)

4.2.3 Power to all

The program 'Power to all' was initiated by the State Grid Corporation which aimed to provide electricity to 4.5 million people by 2010 in 26 provinces. It has been observed that by the end of 2007, the program has achieved around 99.66% electrification of villages and around 99.87% in terms of providing access of electricity to households. (ABPS Infra Report, 2011)

4.2.4 China Southern Grid Electrification Efforts

The program aimed to have completed the construction of power grids at the county level by 2010, for the supply of electricity to 410 000 households through extension of electricity grid. The program has achieved success rate of 99.94% and by the end of 2008, out of a total of 63249 administrative villages, only 37 were remain un-electrified. Further, in terms of electrification of rural households the program as achieved 99.51% success rate and provided electrification to more than 47million rural households. (ABPS Infra Report, 2011)

4.2.5 Golden Sun Program

The Ministry of Science and Technology (MOST), the Ministry of Finance (MOF), and National Development and Reform Commission (NDRC), during 2009, had announced support the deployment of up to 500-600 MW of large-scale solar PV in both on-grid and off-grid areas by 2012. The program aims at all provinces with a cap of 20 MW per province. The Government proposed to provide a Capital subsidy for grid connected solar power projects to the extent of 50% and for off-grid systems around 70% of the total investments. (ABPS Infra Report, 2011)

The keys to the success of rural electrification in China are mentioned below,

- Strong commitment by the Government has proven primary role to the success of electrification

- Flexibility in selection and utilization of wide range of technologies

- Involvement of community to generate sense of ownership among individuals

- Involvement of private sector for implementation through competitive bidding. (ABPS Infra Report, 2011)

4.3 Initiatives for Rural Electrification in South Africa

The emphasis on rural electrification in South Africa has been given serious consideration only after announcement of Integrated National Electrification Program in 2001. Prior to the announcement of the scheme, the electrification was concentrated only

to urban areas. It has been observed that during 1993 the around 30 per cent of households were electrified which has increased to around 75 per cent by 2009. The electrification was mainly achieved through extension of the electricity grid. (ABPS Infra Report, 2011)

Before 1994, the ESKOM – the national power utility was responsible for electrification in the country. In 1994, the parliament approved the plan to provide access to electricity on equal basis and appointed National Energy Regulator to develop and manage the implementation of Integrated National Electrification Program (INEP). The INEP aims to provide access to electricity to all households by 2012. The program has been running since 2001 and during April 2002 the Department of Minerals and Energy took over the responsibility for implementation and managing of the program. (ABPS Infra Report, 2011)

A special allocation of funds, on an average of US$160 billion per annum since 2003, has been made in the National Budgets for the electrification program. The INEP envisages supply to even remotely located areas through extension of grid and plans to achieve full scale electrification by 2014. However, in remote rural areas where extension of grid was found not feasible, the provision is made to provide Solar Home Systems (SHS). The Off-Grid electrification is carried out through engaging private sector participation through bidding process. Under the Off-Grid electrification, the rural consumers purchase electricity from the service provider who is also responsible for the maintenance of the SHS. (ABPS Infra Report, 2011)

Key lesson learnt from the electrification program in South Africa are discussed in the following paragraphs,

- It has been observed that the installed generation capacity is insufficient to meet the demand for electrification. The installed generation capacity in South Africa is around 40GW. There are now national plans to expand the generation capacity and double it by 2025. This shall aid to successful electrification in urban as well as rural areas.

- It has been observed that the tariff offered by the national power utility had become one

of the reasons for capping the installation of new generation capacity in the country. For example, it has been found that, during 2005, the ESKOM has sold the electricity at US$0.027/kWh and imported from the neighbouring country at price of around US$0.007/kWh which has made the installation of new generating capacities in the country non profitable. There was very less generation margin which led to endless power cuts and load shedding. Owing to such fact it has been decided that the tariff shall be doubled within a span of three year period. (ABPS Infra Report, 2014)

- In past, supply of power at low tariff led to use of energy in inefficient manner. During 2005, the Government announced first national strategy towards energy efficiency. However, with increasing shortage of supply, the nationally mandated energy efficiency targets were introduced.

- Off Grid electrification program involved private sector participation. However, it has been observed that lack of political will and government support has led to the defeat of the program. (ABPS Infra Report, 2011)

- The poor deployment of renewable energy was attributed to the lack of requisite policy framework. During 2009, the first national feed in tariff scheme was established. In spite of having the best solar radiation across the world, the Solar Home Systems were viewed as temporary solution until the extension of the grid. The authorities had to arranged campaigns and community development programs to change the perception towards renewable energy. (ABPS Infra Report, 2011)

- Owing to non payment of electricity bills, the prepaid meters are now made part of all the installations for all new connections under the INEP. (ABPS Infra Report, 2011)

Appendix E

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