SMART VILLAGES
New thinking for off-grid communities worldwide

Smart Villages in Pakistan: Islamabad Workshop Report

Workshop Report 10

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Smart Villages

We aim to provide policymakers, donors, and development agencies concerned with rural energy access with new insights on the real barriers to energy access in villages in developing countries—technological, financial and political—and how they can be overcome. We have chosen to focus on remote off-grid villages, where local solutions (home- or institution-based systems and mini-grids) are both more realistic and cheaper than national grid extension. Our concern is to ensure that energy access results in development and the creation of 'smart villages' in which many of the benefits of life in modern societies are available to rural communities.

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Summary

Pakistan has substantial experience of deploying micro-grids based on micro-hydro systems in rural communities. The Smart Villages Initiative, supported by the Rural Support Programmes Network, Pakistan organised a workshop in Islamabad, Pakistan on 6 October 2015 to consider Pakistan's experience of developing enabling frameworks for the dissemination of micro-grids. The workshop was an important event in the Smart Villages Initiative's ongoing programme of engagement in South Asia.

The workshop garnered substantial interest from a wide-range of stakeholders, including representatives from the public sector, donor community, non-governmental organisations (NGOs), private sector, and academia. Participants in the workshop were informed about the efforts of rural support programmes in Pakistan to ensure community ownership and involvement in the planning and execution of off-grid renewable energy projects. This is especially true in the case of micro- and mini-hydro power projects.

The success of distributed energy projects in the country has been a result of long-term involvement of NGOs like the Aga Khan Rural Support Programme and the Sarhad Rural Support Programme with local communities. The rural support programmes under the ambit of the Rural Support Programmes Network have been actively involved in supporting self-help initiatives through the formation of village- and community-level organisations.

Micro-grids can supply electricity to clusters of dispersed communities in rural areas and can augment supply to the national grid if there is

Map of Pakistan

a connection. However, there is a lack of institutional support and buy-in within the public sector. Recently, public sector organisations, especially the Alternative Energy Development Board, have been working to increase the share of renewable energy in Pakistan's energy mix. But the main focus of government efforts remains on large scale projects supplying the national grid. There is an urgent need to develop the necessary policy and institutional frameworks to support off-grid energy initiatives. The regulatory mechanisms developed by the government are highly centralised with minimal input from other stakeholders, especially the private sector. The lack of buy-in within the public sector also contributes to the lack of implementation of existing regulations.

Lack of access to finance and capital also constrain the development of micro-grids. Ensuring access to finance is a necessary, but not the only, pre-condition to overcoming constraints to the deployment of micro-grids. Financial support needs to be accompanied by efforts to attract skills and expertise from the private sector.

Pakistan has a long history of deploying micro- and mini-hydro power projects. There have been substantial successes and some failures along the way. It is important to learn from these examples to ensure the sustainability of micro-grids in the future. There is a need to ensure that projects aimed at improving energy access have a component supporting the development of enterprises that can use the electricity productively. These enterprises can have a positive impact on the rural economy and contribute to sustainable economic development. Developing local markets is also important as remote villages are likely to have fewer opportunities to engage profitably in commercial ventures. Linking micro-hydro plants to form micro-grids that supply electricity to a cluster of villages is also likely to contribute positively to the local economy and to provide energy for growth.

Extensive community mobilisation and stakeholder dialogue is a major strength of the country's rural areas, and these resources can benefit the development of distributed grids. The importance of skill development at the local level also came to the fore, especially since communities are often responsible for the day-to-day operation and maintenance of the power plants and the allied infrastructure. At the donor level, there is a need to better coordinate funding activities and for donor harmonisation in supporting off-grid energy projects in rural areas.

Introduction

The Smart Villages Initiative continued its regional engagement in South Asia with a workshop held in Islamabad, Pakistan on 6 October 2015. The workshop focused on Pakistan's experience of developing enabling frameworks for the dissemination of micro-grids* in the country. The workshop was organised with the support of the Rural Support Programmes Network (RSPN), Pakistan.

The workshop brought together a cross-section of stakeholders that are active in the off-grid sector in Pakistan. It provided a forum for animated and fruitful discussions with important learning points for the Smart Villages Initiative and the participants. This report summarises key points arising from the presentations and discussions. Copies of the presentations are available on the Smart Villages website (www.e4sv.org). A background paper was prepared by the Smart Villages team for the workshop summarising key aspects of the energy situation in Pakistan. This report can also be accessed on the website. Annexes 1 and 2 of the report provide the workshop agenda and the list of participants along with their organisational affiliations.

* *The terms micro-grids and mini-grids are both used in the report. While some contributors to the workshop made a distinction between them according to their capacity, there was no consistent differentiation between them. Hence the terms tend to be used interchangeably through the report.*

Session 1: Introductory Presentations

Welcome Address

Shoaib Sultan Khan, RSPN

Shoaib Sultan Khan gave a brief overview and background of the Rural Support Programmes Network (RSPN) and its work over the years. The RSPN is the largest development network in Pakistan, with an outreach to over 38 million rural Pakistanis. It comprises 12 member Rural Support Programmes.

Shoaib Sultan Khan highlighted the importance of improving people's lives through the effective implementation of development programmes. Social mobilisation is vital for rural development and the success of the Rural Support Programmes in Pakistan since the formation of the Aga Khan Rural Support Programme (AKRSP) in 1982 has been due to the active participation of the poor and marginalised communities living in rural areas. The initial implementation of the AKRSP programme in the Northern areas of Pakistan, including Gilgit-Baltistan and Chitral, rested on three principles:

- It is better to help the rural poor and marginalised communities as part of a collective as opposed to individually.
- Communities should generate their own capital through savings to attract capital from external sources.
- Programmes should be developed in a way that unleashes the latent potential of poor and marginalised segments of society in rural areas.

Local communities had to fulfil certain responsibilities related to organisation, capital generation, and human resource development before the Programme helped out. Initially, there was scepticism regarding the success of such an approach; however, multiple evaluation reports by multilateral institutions like the World Bank showed the success of such an approach to rural development. The RSPN and its constituent organisations currently support six million households in the country located across 121

Shoaib Sultan Khan delivering the welcome address

districts (Currently there are 131 districts in Pakistan) through almost 350,000 community organisations.

The Rural Support Programmes have actively supported off-grid renewable energy projects, especially micro- and mini-hydro plants in the northern parts of the country. The main challenges associated with such projects initially were:

- Training local human capital to maintain the infrastructure
- Providing the tools and other physical infrastructure to maintain the equipment
- Ensuring the long term sustainability of electricity supply by motivating community members to pay for the cost of electricity

Once systems were developed to address these challenges, the number of micro- and mini-hydro power plants increased substantially. Support has been provided by other Rural Support Programmes like the Sarhad Rural Support Programme. The history of supporting off-grid energy projects means that there is tremendous interest in further improving energy supply to remote rural areas.

Shoaib Sultan Khan finished his address by reiterating the importance of off-grid energy solutions for rural communities. He assured the continuing support of the RSPN in finding and developing models to deploy off-grid solutions in rural areas with the support of local community organisations.

The Smart Villages Concept

John Holmes, University of Oxford

John Holmes introduced the Smart Villages Initiative and observed that there are more than one billion people who do not have access to electricity, while almost three billion continue to use biomass-based, inefficient cook stoves to meet their cooking and heating needs. There are consequently over four million premature deaths due to smoke inhalation every year because of this dependence on inefficient cookstoves throughout much of the developing world. The United Nations, through the Sustainable Energy for All (SE4All) initiative, has recognised the lack of access to energy as a key issue and has set the target of achieving universal access to electricity

by 2030. This target has now been adopted as the 7th of the United Nations' 17 Sustainable Development Goals (SDGs).

To meet the goal of universal energy access by 2030, a study by the International Energy Agency (IEA) concluded that for the majority of rural areas, electricity provision through local decentralised solutions are more economic than national grid extensions. The Smart Villages Initiative focuses on these localised, off-grid solutions. It aims to provide policymakers and other relevant stakeholders with an insightful 'view from the frontline' of the chal¬lenges of village energy provision for develop¬ment and how they can be overcome.

In smart villages, energy acts as a catalyst enabling the provision of key services such as health, education, clean water, and sanitation, and supports the establishment of new rural enterprises. This is extremely important as rural areas account for almost 50% of the world's population and 70% of the poor. Smart villages can be seen as a rural analogue to smart cities with certain common features across different parts of the world such as:

- Education and health services are improved when they are supported by modern information and communication technologies.
- Entrepreneurship in the provision and productive use of energy services is fostered.
- Communities capture a bigger share of agricultural value chains.
- Communities become more resilient and are better able to respond to shocks.

Such features help to shift the balance of oppor¬tunities between cities and villages, allowing people to choose to stay in villages rather than migrate to cities.

The Smart Villages Initiative is undertaking a series of engagement programmes across six regions in Asia, Africa, and Latin America. These engagements bring together frontline actors and stakeholders involved in energy access projects in different countries located in these regions. Their aim is to identify barriers to the provision of village-level energy services for development and to improve understanding of how those barriers can be overcome. Learnings from these engagement events are used to inform policymakers and development bodies engaged in rural energy provision at national, regional and global levels.

Talking about the Sustainable Development Goals, John Holmes informed workshop participants that while Goal 7 focuses on energy access, achievement of many of the other goals that constitute the SDGs is dependent on ensuring access to energy. With reference to the SDGs, he shared a few preliminary findings from previous engagements of the Smart Villages Initiative.

Investment in infrastructure is key to achieving the SDGs; however, current investment levels fall well short of the amounts required. Village-level energy access projects face difficulty in accessing alternative sources of capital like climate funds. Exploring ways to improve access to finance is one of the focus areas for the Smart Villages Initiative.

Stable policy and regulatory frameworks, coupled with a reduction in bureaucratic red tape, are necessary to attract private sector investment in rural energy access projects. Governments and development agencies can harness the potential of local energy service providers and entrepreneurs through business incubation and by setting-up business advisory services to support their activities.

And governments and development agencies continue to play a key role in supporting the establishment of mini-grids which, at present, need some form of subsidy to achieve economic viability. Progress is being made in reducing the cost of power from mini-grids and innovative business models are being developed.

In the case of solar home systems and pico-solar lighting systems, lessons from East Africa and Southeast Asia show that a tipping point has been reached as commercial business models have emerged. However, access to working capital is an important constraint faced by many entrepreneurs seeking to scale-up the deployment of solar home systems and pico-solar lighting systems.

The success of many local energy projects depends on the ownership of the local communities. Therefore, it is extremely important to invest in understanding the cultural sensitivities, gaining the community's buy-in, and building on existing relationships. Capacity building of local communities is necessary for the success of energy access initiatives. John Holmes also highlighted the importance of better coordination and information sharing between development agencies and funders, which is necessary to maximise the impact of development interventions.

There are tremendous developments taking place on the technological front. The energy escalator approach shows that for solar home systems, people often buy-in at the basic level of access, paying by instalments, and then move-up the energy ladder. There are also moves to develop low-power domestic appliances using direct current, and there has been a move towards developing low-voltage direct current nano-grids. Technological progress has also been instrumental in the reduction of the cost of components like solar panels, and it is expected that costs are likely to reduce further in future. One of the key stumbling blocks have been batteries; the rate of progress has been much slower. Improving the reliability of batteries and reducing their cost is extremely important for the growth of off-grid energy systems.

There is an urgent need to foster closer linkages between researchers based at universities and entrepreneurs involved in off-grid energy provision. Another major issue in many developing countries is the poor quality of products, especially pico-solar lighting systems and solar home systems. To deal with these problems, effective quality assurance mechanisms need to be developed along with consumer awareness programmes.

Keynote Address

Amjad Ali Awan, Alternative Energy Development Board, Ministry of Water and Power, Government of Pakistan

Looking back over the history of the power sector in Pakistan, Amjad Ali Awan proposed that societal changes and developments are pushed by need. In the 1960s and 1970s, the power sector in Pakistan was vertically integrated. Subsequently, it was unbundled, and in more recent times, the private sector has become increasingly involved in electricity provision as state investment in the sector has reduced. Initially, the focus was on the availability of electricity supplies, and subsequently on sustainability, affordability and environmental impacts. Within the country's power system there has been a major focus on developing generation sources, at the expense of developing transmission and distribution systems. In some situations, for example in hospitals and for security installations, availability and stability of electricity supply is a key consideration.

Private micro-grids could be a way forward to supply electricity to clusters of villages in

Amjad Ali Awan delivering the keynote address

the Northern Areas and other areas that are not connected to the national grid. Micro-grids can also augment electricity supplies to the national grid. The National Electric Power Regulatory Authority Act provides some guidelines allowing the deployment of localised grids; however, institutional support from the state has not evolved. The lack of policy frameworks at the national and provincial levels hampers the development of micro-grids.

To develop off-grid energy systems for rural villages, the communities need to be prepared. One of the reasons for the failure of off-grid electricity initiatives in the past has been the lack of preparedness at the state, regulatory, and community levels. This has hampered the adoption of distributed electricity systems in the country. An important role for the Alternative Energy Development Board is to recover trust in renewable energy systems with stakeholders within the public and private sectors.

Pakistan is gifted with good renewable energy resources. For example, there is an excellent wind corridor with 40 GW of potential capacity in the south of the country. But, so far, only 50 MW of installed wind capacity has been realised. There has not been enough focus on renewable energy. Over the next ten years, the government's aim is to generate 25% of electricity in Pakistan from renewable energy sources. Recently, solar PV standards have been put in place and equipment can only be imported if it meets the standards. There are also moves to develop standards for equipment utilised in solar-wind hybrid systems and micro-hydro power plants.

The issues and solutions in respect of renewable energy sources need to be conveyed to the top policymakers, and the benefits need to be communicated to rural populations. The allocation of responsibilities is important, and policies are now in place in Pakistan that define the roles of the various stakeholders.

Session 2: Developing an enabling framework for decentralised micro-grids—Lessons from Pakistan

Syed Aqeel Hussain Jafri, Alternative Energy Development Board, Ministry of Water and Power, Government of Pakistan

Pakistan has taken a number of steps to create an enabling environment for the promotion of distributed electricity systems. The first policy framework for renewable energy was put in place in 2006, and the Alternative Energy Development Board developed policies for large-scale applications of wind and solar resources. There was, however, recognition that small independent schemes could also make a good contribution, and regulations have been created to support their implementation. Initially there was some reluctance from the distribution companies and the national regulator.

Solar home systems are incentivised by government, but there have been problems with sub-standard products and second-hand equipment coming into Pakistan. With the support of GIZ, the international development agency of Germany, quality standards have been developed and quality assurance centres established. These quality standards have been approved by the government and the Alternative Energy Development Board has imparted training to other public sector agencies. There is no import duty on equipment for renewable energy systems, but they are subject to strict checks on quality.

Off-grid solutions like solar water pumping and solar water heating are gaining traction in Pakistan, and there are plans to support the dissemination of these technologies. Syed Aqeel Hussain Jafri further highlighted the magnitude of the challenge for Pakistan: there are 60 million people without electricity. They are unlikely to get it through grid extension within the next 10 years. Micro-grids and other renewable energy solutions like solar home systems, biomass, etc. can meet the basic energy needs of people based in rural areas. It is also important to promote energy efficiency and to support the productive use of energy in off-grid communities to ensure sustainable development.

Shaukat Ali, Renewable Energy Unit, Pakistan Poverty Alleviation Fund

The Pakistan Poverty Alleviation Fund (PPAF) is a private sector organisation sponsored by the government of Pakistan and by the World Bank. It supports provincial governments in establishing electricity systems for communities at the bottom of the pyramid. All PPAF projects respond to the demands of communities. The Fund does not implement projects directly. Instead, it works with NGOs such as the Aga Khan Rural Support Programme and Sarhad Rural Support Programme. Funding is provided through grants and loans to partner organisations. PPAF has a dedicated unit focusing on renewable energy systems and on capacity building with partner organisations and local communities. There is also an emphasis on ensuring quality standards of renewable energy projects.

PPAF has funded over 3600 projects based on hydro, solar, and wind since 2003, initially focussing on micro- and mini-hydro power projects that were implemented by the Aga Khan Rural Support Programme. Shaukat Ali informed the audience that PPAF started funding community-based solar systems and solar home systems in the Southern parts of the country in 2006. Since then, PPAF has been involved in many off-grid power projects across the country, including some pilot schemes focusing on solar-wind hybrid systems in the coastal areas of Pakistan.

Typically, micro-hydro schemes are the cheapest if the hydro resource is available. Micro-grids may provide electricity to more than one village, and larger mini-grids may focus on supplying electricity to economic hubs. Electricity for lighting is not enough: there should be an emphasis on supporting the productive use of energy and on developing rural enterprises.

Shaukat Ali also stressed the need to improve consolidation and collaboration between donors. The lack of coordination means that while several donors may be working in a similar area at the same time, they might not know of each other's activities, duplicating effort and wasting resources. GIZ has proposed a collaborative platform for donors to prioritise funding areas.

Parvaiz Naim, KfW Development Bank

The first independent private power project in present day Pakistan was commissioned in 1925, Pervaiz Naim explained. He noted that energy projects have been financed by local commercial banks in Pakistan since the 1960s. By 1993/94 Pakistan had an installed capacity of mini- and micro-hydro schemes of 20 MW. The number of such projects in the country was much higher than that in neighbouring countries like India and Nepal.

Successes of micro-grids have included solar water pumping without batteries and micro- and mini-hydro schemes supporting rural electrification, including small-scale commercial and industrial use. Failures have included solar-powered micro-grids supplying villages in Sindh and Balochistan. They buckled when some users plugged-in appliances that put too much load on the system and damaged micro- and mini-hydro schemes due to poor design and civil works, resulting in short operating lifetimes.

Lessons learned for implementing sustainable micro- and mini-hydro schemes include that they should support productive use (lighting only stretches the working hours of women) and should be designed for winter flow (i.e., when water flows are at their lowest). Communities need financial and technical help for community-led schemes to be sustainable, and success comes with robust design, good quality equipment, and regular maintenance.

Solar home systems work better as stand-alone units, but batteries remain the weakest link. Equipment needs to be well-matched to customer needs, properly installed, and regularly maintained. Hybrid systems work better. For all solar systems financial and technical support is needed. In the future, he expects to see more stand-alone systems and micro-grids using more efficient energy storage devices.

Khanji Harijan, Department of Mechanical Engineering, Mehran University of Engineering and Technology

Khanji Harijan pointed to problems with the Pakistan national electricity grid. It has low efficiency, reliability, and power quality, and high maintenance and variable costs. In contrast, micro-grids have higher efficiency because transmission losses are lower, levels of reliability and power quality are higher, maintenance requirements are lower, and use of renewable sources makes them more sustainable than fossil fuel-based central generation. They can consequently be a better alternative to centralised and environmentally unfriendly electricity generation systems, particularly for people living in remote areas who are otherwise unable to benefit from centralised electrification initiatives. Micro-grids can help communities achieve local resilience for vital services and create independent community assets.

Pakistan is an agricultural country, and 62% of its 200 million population live in rural areas. Most do not have 24/7 access to electricity, and

Participants at the Workshop

many remote villages have no access to electricity at all. Providing electricity to such communities can help improve farm productivity and efficiency through improved irrigation systems and can help create small-scale rural industries that can increase the share of non-farm income for households. Around 12,000 villages in the province of Sindh were electrified between 2008 and 2014 under the government's rural electrification programme, but nearly 12,000 villages in the province remain without electricity.

Q&A

Participants expressed concern that rural people may not be aware of the benefits of renewable energy systems and there needs to be a concerted effort to raise awareness. Experience of renewable energy interventions suggests that when something works, villages will go for it. For example, solar water pumping has been operating reliably since the 1970s. Failures occur when people are sold something that does not work. For very dispersed communities, solar home systems may be the appropriate approach.

To reach remote communities, it is important to meet with them regularly, to participate in their meetings and develop a trusting relationship, and to speak in their language. Often rural communities are repositories of tacit local knowledge, and development practitioners need to learn from this wisdom. Attention needs to be given to reaching out to the poorest of the poor and to understanding their lives. Agents have an important role to play in reaching the poor and a range of approaches are available for social mobilisation, which is key.

In one initiative, five people have been trained in each village to repair solar home systems. Villagers are already organised in Pakistan: they just need the right products. In the case of solar home systems, further improvements in battery technology are necessary to overcome storage problems.

There needs to be a focus on quality; seven-year warranties would give consumers more confidence in the product. Pakistan is a junkyard of redundant and low-quality systems and people are getting fed up with this.

To support the development of rural communities, the Alternative Energy Development Board is arranging meetings with other ministries to promote productive enterprises facilitated by energy access.

Session 3: Community mobilisation and models for effective deployment of micro-grids

Sohail Ameer Marwat, Sarhad Rural Support Programme

The Sarhad Rural Support Programme (SRSP) was established in 1989 and is the largest NGO in Pakistan. It is a gender-responsive, environmentally-friendly, and poverty-focussed organisation. It has a presence in 24 out of 26 districts in the Khyber Pakhtunkhwa province. Sohail Marwat gave a presentation that outlined some of the benefits of the SRSP's micro-hydro power projects. Micro-hydro power plants have recently been classified as being below 100 kW capacity. They have good operational flexibility.

There is a series of steps required for project implementation including: desk study, initial site assessment, survey visit, pre-feasibility study, feasibility study, detailed design, and then implementation. Other factors that need to be studied during the initial project planning phase for small hydro projects are: flow rates and pressures, topographic maps of the catchment area, general climatic and hydrological conditions, local demand data, access to the project site, and estimates of construction costs.

It is important to gauge the various components of community demand and the local context before embarking on a project. Micro-hydro offers a number of advantages compared to other technologies, and the installation of such power plants can have a positive impact on the domestic economy. Some components of plants can be locally manufactured and the system can be locally assembled. Villagers can also be trained to manage and maintain the system. Typically, the costs of organisation and management are lower than for other technologies. The electricity produced can support productive uses – agro-processing, timber sawing, pulping, packaging, transportation and pumping, and consumptive uses – such as cooking and lighting.

To date, the Sarhad Rural Support Programme has implemented 166 micro-hydro projects with a cost of 1.25 billion Pakistani rupees (PKR) (12 million USD) with 100 million PKR (1 million USD) established in the form of 'sweat equity' (Sweat equity refers to the contribution to a project or business in the form of effort and toil). These plants have a total generation capacity of 9.6 MW and benefit 275,000 people.

Introducing the PEACE (Programme for Economic Advancement and Community Empowerment) project, Sohail Marwat informed the audience that the main donor is the European Union. As part of the project, by 2016 SRSP aims to establish 422 units in Malakand Division with an overall cost of 3.42 billion PKR (US$32 million) Other major donors include the government of Khyber Pakhtunkhwa and the Pakistan Poverty Alleviation Fund.

The micro-hydro projects are run as social enterprises, with surplus generation being invested back into the respective communities with a focus on women and children, preserving cultural heritage, and supporting teacher salaries. Uninterrupted electricity supply provides an enabling environment for education. Productive use of renewable energy is also an important focus area of the project. An example is fruit drying with hydro-powered electric dryers or non-electric solar dryers. There are 15 Business Interest Groups with 260 members in total, most of whom are women. An independent assessment of the members of these business interest groups showed a net increase in income of 156% in the PEACE project area. The micro-hydro projects also

provide effective greenhouse gas abatement, with a current CO_2 equivalent emissions reduction of 29,000 tonnes per year, and nearly 100,000 tonnes per year anticipated by 2016.

The SRSP is implementing a two-pronged strategy for operation and maintenance of the systems. For those systems with less than 100 kW capacity, they are handed over to the community to run, with SRSP only providing technical support where necessary, for example in helping to calculate tariffs. For those over 100 kW, they are run as social enterprises by the SRSP. Sohail Marwat provided further details on how these enterprises are run.

There are a number of challenges to address in implementing projects such as lack of awareness of communities, insufficient site studies, lack of operating capability, design of efficient power plants, lack of staff exposure to the relevant technologies, geological constraints, and weather constraints. These challenges have been dealt with through a variety of means, such as: social mobilisation and awareness workshops, formation of maintenance and ordnance (mapping) committees, and procurement of surveying and load testing equipment.

In concluding, Sohail Marwat noted the benefits of the projects to the communities and stated that organisations should provide long-term support of not less than three years to the beneficiary villages. This should include refresher training and overall monitoring of the micro-hydro scheme, including tariff management, plant operator performance, and productive end-use beneficiaries.

Nauman Amin, Aga Khan Rural Support Programme (AKRSP)

The AKRSP is a pioneer in providing community level sustainable energy to people living in the remotest areas of Pakistan, like Gilgit-Baltistan and the Chitral district of Khyber Pakhtunkwha. In his presentation, Nauman Amin gave a detailed account of AKRSP's experiences of working in these areas.

The AKRSP has 191 operational renewable energy schemes spread over Gilgit, Skardu, and Chitral Districts with a total generation capacity of 14.35 MW. Mini- and micro-hydro plants have been found to be the best solutions because water is abundantly available. Funding has come from a variety of donors, including the Pakistan

Nauman Amin, Aga Khan Rural Support Programme (AKRSP)

Poverty Alleviation Fund, the government of Khyber Pakhtunkwha and the Swiss Agency for Development and Cooperation. The AKRSP uses a community-driven approach for the construction and maintenance of their projects. It uses a 'three-dialogue process': need identification, project planning, implementation, and monitoring. Key achievements can be summarised in numbers by the 5,000 community organisations and over 80,000 activists trained in marketable technical and management skills (65% women).

The AKRSP has a new strategy for hydro-power development that involves scaling up (in size and efficiency) by connecting smaller units into larger (i.e., valley-wide) mini-grids. Entrepreneurship models are also introduced in regions where the mini-grids are present. The new strategy also involves building a robust after-sales services network of third party local service providers by developing contractual obligations between community-owned micro-hydro plants and service providers, involving women in each step of the process. The presentation gave details of the scaling-up process currently being carried out in the Laspur and Yarkhun valleys.

The transformation of informal management systems to formal community-owned business models is aided by the formation of new utility companies. These companies' jobs can be made much easier by the use of prepaid meters in some instances. Other important aspects are transparent and simple billing and strong monitoring at all levels.

Inspired by the community approach of AKRSP, the government of Khyber Punkhtankwha is constructing 256 hydro projects in seven districts. There are a number of unique challenges identified with the projects detailed above. These include natural disasters, high construction costs due to remoteness, and unavailability of service providers in the project regions.

Ehsan-Ullah-Khan, Society for Biogas Promotion

The Society for Biogas Promotion is a non-profit organisation that promotes the scaling up of the biogas sector in Pakistan. Its mission is to work with multiple stakeholders to construct 125,000 biogas plants for domestic and agricultural purposes by 2025. Ehsan-Ullah Khan outlined some of its programme of works and activities as well as the benefits of biogas.

Biogas can save money when used for cooking and improve the rural environment by discouraging deforestation. Larger plants can also be used for power generation. The Society's members have installed over 7,000 plants in the last six years. It has also undertaken a large awareness-raising campaign amongst farmers for better use of bioslurry to reduce the need for chemical fertilisers and to increase profits.

Members of the Society for Biogas Promotion have been trained as part of the Pakistan Domestic Biogas Programme that was implemented by the Rural Support Programme Network with support from SNV, a Dutch NGO. Biogas coordination committees have been set up as part of the project, each of which involves around 20-40 people. These committees comprise stovemakers, plumbers, labourers, and supervisors. The Society has a quality control committee that can impart fines to members for non-compliance. Aftersales service for biogas is very important, and the Society gives a warranty of four years. Ehsan-Ullah Khan also gave a number of positive examples of biogas and its by-products including bioslurry used as fish feed, biogas for water pumping, and biogas for cooking.

Ehsan-Ullah-Khan talking about the Pakistan Domestic Biogas Programme

Session 4: Public-private partnership models to develop micro-grids

Mohammad Imran Ashraf, Delegation of European Commission Mission to Pakistan

The European Union has been actively engaged in projects to develop micro- and mini-hydro projects in Pakistan, and from 1989 to 2005 it funded 42 micro-hydro power projects in the country. During this period, the European Union worked with local partners including NGOs like the AKRSP and public sector organisations including the Forest Department and Wildlife Department, Khyber Pakhtunkhwa (KPK) province to build these micro-hydro plants.

Imran Ashraf observed that the European Union continues to support energy access projects in Pakistan. It has partnered with the Sarhad Rural Support Programme to build 247 micro-hydro plants in the Malakand Division, Swat as part of the PEACE project. The total power output of these plants will be around 21.7 MW. It is envisaged that electricity generated by these projects will be utilised for lighting purposes and for productive enterprises including modern industrial uses. The project also aims to link micro-hydro plants to form a micro-grid system. Imran Ashraf emphasised that linking the micro-hydro plants is necessary for the development and growth of productive enterprises in rural areas, and this can spur the growth of small- and medium-sized industries in the region.

Regarding the challenges to deploying micro-grids, he observed that the system perspective has to be in place at the planning stage of such projects, and it is very difficult to make changes at the implementation stage. Other challenges include the difficult terrain to install the required infrastructure, dealing with the different communities and cultural sensibilities, distributed population over harsh terrain, and transmission power losses. There is also a lack of good data required for deploying mini-grids including the size of the demand and geographical parameters.

Ensuring the quality standards of the micro-hydro power plants is another issue, and there is a lack of standardisation at the design stage

which complicates the deployment of micro-grids. There is also a need to put in place suitable institutional arrangements and develop viable business models. The 2006 Pakistan Renewable Energy Policy provides a good starting point. However, the policy needs to be developed further and weaknesses in implementation need to be removed.

Public-private partnerships in the power sector are necessary to access much-needed investment in upgrading the country's power infrastructure. Lessons from success stories across the developing world, including from countries like Kenya and Tanzania, can inform the development of such models in Pakistan. For their part, multilateral donors like the German Development Bank KfW can develop financing instruments to support the development of a mini- and micro-grid distribution system in rural areas in Pakistan.

Muhammad Nadeem Zakir, PCRET, Ministry of Science and Technology, Government of Pakistan

The Pakistan Council for Renewable Energy Technologies (PCRET) is a research organisation working on renewable energy technology and falls under the leadership of the Ministry of Science and Technology. Elaborating further on PCRET's mandate, Nadeem Zakir informed the audience that the organisation is focusing on four renewable energy technologies: solar, biogas, micro-hydro and wind.

There are 30,000 villages in Pakistan that do not have access to electricity. The power shortage affecting the country means that there are regular power outages facing many of the rural areas that are connected to the national grid. Power shortages have a negative impact on economic growth and development; ensuring access to reliable energy is one of the biggest challenges facing Pakistan. Increasing the use of renewable energy in the power mix could provide a way to alleviate the power shortage. Estimates have shown that in Sindh province the Keti Bandar wind corridor could potentially generate 43,000 MW of electricity.

Nadeem Zakir also highlighted some of the off-grid rural electricity projects in which PCRET has been involved. One such project was executed in a village in Dukki Tehsil in Loralai District, Balochistan in the early 2000s. PCRET provided solar panels and the rest of the equipment, including batteries and inverters, were sourced by the local community.

Muhammad Darjat during his presentation

This was an example of a successful partnership between PCRET and the local community.

PCRET has also been involved in developing and installing solar-diesel hybrid systems in a village in Gawadar District of Balochistan. After installation, a local committee comprised of community members was set up for the day-to-day operation and management of each system. These committees are responsible for collecting electricity charges from those connected to the system. PCRET has also been involved in electrification projects for schools, hospitals, and other communal places like mosques.

Muhammad Darjat, PEDO Micro-Hydro Project (MHP), Aga Khan Rural Support Programme (AKRSP)

The government of Khyber Pakhtunkhwa province started a policy reform process in 2014 whereby they aimed to establish 356 micro- and mini-hydro plants across 12 districts in the northern part of the province. Muhammed Darjat is responsible for 55 of these plants located in Chitral district, the largest in the province. Despite good hydro potential, electricity generation in Chitral district remained limited.

Over the last two years, the Sarhad Rural Support Programme and the AKRSP have both undertaken projects with funding from different sources to develop micro- and mini-hydro projects in the district. By the end of 2016, the aim is to generate more than 6 MW of electricity through the micro- and mini-hydro power projects executed in the district by the AKRSP. This will augment the off-grid generation capacity of 9 MW already installed in the district that provides electricity to almost 40% of the population. Funding for the majority of the installed capacity has been provided by multilateral and bilateral donor agencies like the KfW, CIDA, JICA, DfID, etc.

Muhammed Darjat informed the participants that community partnerships form the bedrock of most of the projects executed by NGOs at the grassroots level. However, this is the first time that the government has shown its willingness to work with the local communities. There is increasing acceptance in policy circles that communities can manage the operation and maintenance of micro- and mini-hydro power plants. For the past 17 years, most of the projects executed by NGOs like the AKRSP and the SRSP have been managed and operated successfully by local communities which have institutionalised systems at the village level for tariff collection. Micro-hydro power plants have also emerged as a source of employment for the local people.

Clear guidelines exist for site selection for micro-hydro plants executed under the ambit of the PEDO micro-hydro project. Potential sites have to meet a number of pre-conditions. In Chitral district alone, the team received over 200 applications from village organisations interested in building micro-hydro systems in their villages, of which 55 were selected. Villages selected under the project are all off-grid. Ensuring the cost-effectiveness of a potential site was an important criterion to ensure the optimal use of limited capital. Muhammed Darjat stressed the importance of community participation and contribution in kind in the form of labour services to ensure local ownership of these projects. The sustainability of the micro-hydro projects depends on this sense of ownership and buy-in at the village level. There is also a need to engage in a process of constant dialogue with local people and make them active stakeholders, not passive observers, in energy provision projects.

There are a number of challenges facing the successful implementation of the project. Muhammed Darjat observed that the most pressing challenge was ensuring delivery of all micro-hydro projects within the stipulated time

Participants at the Workshop

period with a high level of community involvement. The harsh weather and terrain of the project area means that the climate emerges as an important variable in the success of the micro-hydro projects. Floods in 2014 had a massive impact on the existing power generation infrastructure in the district, and the micro-hydro projects currently being built have to be able to withstand the impact of changing climatic conditions. Finally, another important challenge is maintaining support the public sector to work with the local communities to meet their energy needs is also an important challenge for the project. Changes in political dynamics also have significant effects.

Zareen Gujjar, Community Member, Serai Development Organisation

Zareen Gujjar represented the community from the village of Serai located in the Upper Swat valley in KPK's Malakand Division. A micro-hydro power plant was built in the village by the Sarhad Rural Support Programme with funding provided by the European Union in 2014. Zareen Gujjar informed participants that he reached out to the local office of the Sarhad Rural Support Programme after hearing about an off-grid village electrification project in the nearby Kalam area. The micro-hydro plant has had a positive impact on the local environment as it has helped conserve local forests that were being depleted as a fuel source for light and heat. Educational outcomes and school enrolment levels in the village have also witnessed a positive trend as students have more time to study due to access to better lighting. There is also a sense of achievement in the local community; many other areas in Swat valley do not have electricity. People in Serai have access to electricity as a result of a partnership between the local community, NGOs, and donors.

He observed that village organisations like the Serai Development Organisation have a vital role to play in working with stakeholders such as NGOs for executing development projects. He highlighted an example: to improve access to the village through infrastructure development, the organisation mobilised 450 people to build an 8 km road on a self-help basis. The lack of infrastructure in the form of roads presents a serious challenge for the community as it hinders access to healthcare facilities. It also constrains opportunities for local people to engage in productive enterprises to generate income.

Session 5: Breakout sessions

After the presentations, the participants divided into two groups. Two moderators were selected from the participants: Ghulam Moeen-ud-din from the Department of Mechanical Engineering, University of Engineering and Technology, Lahore and Abdur Rehman Cheema from the Rural Support Programmes Network. The topic of discussion in the breakout session focused on the challenges of financing micro-grids and the importance of developing micro-grids. To structure discussion, participants were provided a list of questions as follows:

- What are the main problems faced in establishing micro-grids in rural communities in Pakistan?
- Which are the most important actions (regulatory, financial, skills, etc.) that need to be taken to overcome these problems?
- How should projects be financed (commercial models, government/donor support, community ownership, etc.)?
- How can we ensure that electricity access for villages supports the creation of productive enterprises and increases incomes?

Breakout Group 1

Moderator: Ghulam Moeen-ud-din, Department of Mechanical Engineering, University of Engineering and Technology, Lahore

The breakout session commenced with a discussion of some of the key constraints facing the development of micro-grids in remote, off-grid communities in Pakistan. Participants stressed that it is important to understand the definition of micro-grids; it is a concept that is not well understood in the country. An example of a micro-grid is connecting a cluster of micro-hydro power plants to form a grid that can then supply electricity to a number of households to meet their lighting requirements. It can also provide energy for productive enterprises. Hybrid off-grid systems like solar, wind, and micro-hydro systems are examples of micro-grids.

Participants agreed that micro-grids need to be deployed to provide energy to a cluster of villages; providing electricity to a single village may not make economic sense. An important aspect from the consumers' point of view is to ensure reliability and stability of electricity supply. It is also important to develop mechanisms for load sharing according to changes in demand. Outside technical support and training has to be provided to document and institutionalise load sharing arrangements based on varying demand levels. Developing such mechanisms requires implementing agencies to run training programmes for local operators to develop their skill-set. Continuous training of local operators is extremely important to ensure the sustainable operation of these systems.

Participants observed that there is often a lack of communication between local communities that hampers the development of off-grid energy projects. To ensure effective communication, NGOs have an important part to play as facilitators and change agents. There is also a chronic lack of coordination between the activities of different agents engaged in off-grid energy provision. These agents and actors include donors (multilateral and bilateral), implementation agencies such as NGOs, public sector organisations, and local communities. Access to finance and capital also constrains the deployment of micro-grids. These systems need access to subsidised capital because the cost of electricity generation and transmission is usually higher than the national grid.

Participants agreed that ensuring access to finance is necessary but is not the only pre-condition to overcoming some of the constraints highlighted above. Access to finance has to be accompanied with efforts to attract skills and expertise from the private sector. The regulatory mechanism seems to be developed by the government in a vacuum without input from the private sector. There is also a problem with the implementation of existing regulations. Other participants had a negative view of government regulations and their impact on village level energy access programmes. These participants observed that most regulations implemented by the government are aimed at centralised electricity generation and supply and are not in sync with the requirements of decentralised power distribution systems. From the point of view of private sector investment in off-grid energy supply systems, participants observed that mechanisms have to be implemented that reduce the risk of free rider problems in energy supply systems so as to ensure adequate returns on investment.

Participants argued that financing mechanisms have to be context dependent. In rural areas near urban centres where there is ready access to a large market, local people can take advantage of energy supply to develop productive enterprises. In these situations, investment from the private sector and investment banks could be more forthcoming. In other villages that are off-grid and located in remote regions, the private sector would not be interested in investing in energy supply projects. In this case, funding will have to be provided by donors and the government.

Participants also stressed that the government needs to develop and regularly update a list of off-grid villages. Stakeholder consultation should be carried out to identify villages where there is no chance of grid extension for the next 20 years. For such villages, electricity access should be prioritised using off-grid solutions, and 100% of the cost should be borne by the government with funding coming from the public sector development programme. The government could also contribute through investments in developing last-mile distribution infrastructure to support private investors willing to invest in micro-grids.

While electricity access is vital for the growth of productive enterprises, it has to be accompanied by other development initiatives so that local communities can take advantage of energy access. Projects for off-grid energy provision should include evaluation of the potential impact on income generation opportunities for local communities at the feasibility stage. Strategic analysis of development interventions is vital. Along with energy, projects have to focus on providing the enabling infrastructure required for the growth of productive enterprises such as roads and other modes of communication. It is also necessary for the government to utilise policy tools to galvanise private sector investment in these villages. In sectors like eco-tourism, local handicrafts and small- and medium-sized enterprises engaged in the processing of agricultural commodities, private investors can enter into partnerships with local communities and spur local development.

Breakout Group 2

Moderator: Abdur Rehman Cheema, Rural Support Programmes Network

The second breakout group highlighted the lack of local organisation at the community level as a critical constraint to the development of micro-grids in rural areas. Participants pointed to the importance of the long-term engagement of external stakeholders such as NGOs in developing mechanisms to deal with co-ordination problems at the community level. There are also practical concerns regarding the allocation of land for setting up micro-grids. Often, members of the community are unwilling to give their land free of charge for such projects. To deal with this issue, compensation mechanisms need to be built into the cost at the project planning stage. Access to finance was also identified as a bottleneck to the development of micro-grids in rural areas.

There is a lack of private sector interest in investing in such ventures; they are viewed as high risk with low returns. The lack of policy frameworks for decentralised energy solutions also inhibits private sector interest in micro-grid projects. Public-private partnerships coupled with strong community involvement and outreach programmes could provide a model to deal with financing constraints. Government guarantees for micro-grid projects could reduce the cost of borrowing for entrepreneurs and alleviate financing bottlenecks. Alternatively, access to subsidised capital resources from donors and the public sector for community owned/operated projects could play an important role in alleviating capital constraints.

The project should remain community-owned rather than run by government agencies. Participants were of the opinion that communities have an interest in ensuring access to improved energy resources, and they are therefore more likely to develop mechanisms for regular tariff collection and to enforce electricity supply rules. The public sector is ill-equipped to deal with such distributed energy systems and the chances of rent seeking are greater if public sector electricity utilities are involved.

Such projects are also delayed by bureaucratic red-tape. Participants observed that there is an urgent need to develop the legislative and policy framework required for decentralised micro-grids in the country. They highlighted that the problem is related to policy formulation as well as policy implementation. Political influences can also hamper the establishment of localised grids. The development of grassroot local bodies could help deal with the political interference as they could safeguard the interests of local communities. The lack of human capital and technical skills in rural areas is another factor that inhibits the development and sustainability of micro-grids. There is a need to train and foster local technical expertise to ensure long-term sustainability in rural areas.

Participants also stressed the need to incorporate income generating activities in projects aimed at establishing micro-grids in rural areas. Promoting rural entrepreneurship and the productive use of electricity requires investment in the necessary infrastructure such as roads and communication facilities that link remote rural areas with urban centres and markets. Access to electricity through micro-grids could spur the development of small-scale industries, especially those related to processing agricultural produce. Sustainable energy access can also improve rural incomes by increasing agricultural yields and helping to reduce post-harvest food losses through investment in food storage facilities. Households can also benefit from access to energy by investing in small-scale cottage industries that manufacture local handicrafts. Taking advantage of the opportunities offered by access to electricity requires access to training facilities to upgrade local skills.

Session 6: Closing remarks

Summary

John Holmes, University of Oxford and Co-Leader, Smart Villages Initiative

John Holmes thanked the workshop participants for their active engagement throughout the day. He also stressed the value of continued engagement in future to explore avenues of mutual interest and collaboration. One of the key learning points to emerge from the workshop was the importance of community mobilisation and continued engagement with local people for the successful installation, operation and sustainability of off-grid energy projects in Pakistan. While this corroborates findings from the engagement of Smart Villages in other regions, the importance of community mobilisation really came through strongly in the workshop.

Working with the community requires long-term engagement and a sustained dialogue process with village groups both at a technical and a social level. The importance of skill development at the local level also came to the fore, especially where communities are responsible for the day to day operation and maintenance of the power plants and the allied infrastructure. At the donor level, there is a need to better coordinate funding activities and for donor harmonisation in supporting off-grid energy projects in rural areas.

On the technical side, presenters and participants repeatedly stressed the need for quality assurance mechanisms for equipment and off-grid energy systems. The quality of products supplied is vital for the continued use and adoption of off-grid energy solutions by villagers. Energy storage, especially weak batteries, remains a major challenge for off-grid energy systems. More research needs to go into improving the operation of batteries and in reducing their costs.

In terms of next steps, John Holmes informed the audience that after the Pakistan workshop, Smart Villages is going to organise workshops in Sri Lanka and India as part of the ongoing South Asia engagement. Learnings from all the workshops in South Asia will be synthesised and will culminate in a regional workshop in Spring 2016. The workshop will bring together high-level policymakers from across the region, including a few participants from Pakistan. There is also need to share knowledge across different regions, and the Smart Villages Initiative offers an ideal platform for the cross-pollination of ideas across different regions of the world.

Khaleel Ahmed Tetlay, Rural Support Programmes Network

The workshop ended with a closing statement from Khaleel Ahmed Tetlay, the Acting Chief Executive Officer of the Rural Support Programmes Network. He thanked all the stakeholders who had participated in the workshop and made it a success. Ensuring access to energy remains an extremely important development challenge in Pakistan and energy poverty constrains the choices available to marginalised communities based in remote rural areas. Poverty reduction initiatives also need to focus on reducing energy poverty to improve the opportunities available to those based in rural areas.

Annex 1: Workshop Programme

Wednesday, 26 October

0930 **Registration**

0940 **Tilawat e Quran**

0945 **Session 1: Introductory presentations**

Welcome address

Shoaib Sultan Khan, RSPN

The Smart Villages Concept

Dr. John Holmes, Senior Research Fellow, University of Oxford

1030 **Break**

1100 **Keynote Address**

Amjad Ali Awan, Alternative Energy Development Board, Ministry of Water and Power, Government of Pakistan

1130 **Session 2: Developing an enabling framework for decentralised micro-grids**

Syed Aqeel Hussain Jafri, Alternative Energy Development Board, Ministry of Water and Power, Government of Pakistan

Shaukat Ali, Renewable Energy Unit, Pakistan Poverty Alleviation Fund

Pervaiz Naim, KfW Development Bank

Khanji Harijan, Department of Mechanical Engineering, Mehran University of Engineering and Technology

Question and Answer Session

1230 **Session 3: Community mobilisation & models for micro-grid deployment**

Sohail Ameer Marwat, Sarhad Rural Support Programme

Nauman Amin, Aga Khan Rural Support Programme (AKRSP)

Ehsan-Ullah-Khan, Society for Biogas Promotion

1315 **Lunch**

1415 **Session 4: Public-private partnership models to develop micro-grids**

Mohammad Imran Ashraf, Delegation of European Commission Mission to Pakistan

Muhammad Nadeem Zakir, Pakistan Council for Renewable Energy Technologies (PCRET), Ministry of Science and Technology, Government of Pakistan

Muhammad Darjat, PEDO Micro-Hydro Project (MHP), Aga Khan Rural Support Programme (AKRSP)

Zareen Gujjar, Community Member, Serai Development Organisation

1515 **Break**

1600 **Session 5: Breakout sessions**

The challenge of financing micro-grids and the importance of enabling frameworks

1715 **Session 6: Closing remarks**

Summary

John Holmes, University of Oxford and Co-Leader, Smart Villages Initiative

1730 **Closing Remarks**

Khaleel Ahmed Tetlay, Rural Support Programmes Network (RSPN)

Annex 2: Workshop Participants

Name	Organisation
M. Mudassar Maqsood	Associate Co-ordinator, International Centre for Integrated Mountain Development (ICIMOD)
Zahid Khan	Project Manager (PEACE), Sarhad Rural Support Programme (SRSP)
Sohail Ameer Marwatt	Project Manager, Micro-hydro Projects, SRSP
Malik Abdul Wadood	Chairman MHP Kalam, SRSP
Haji Zarin Gujjar	President UC Balakot, SRSP
Akhtar Ali	UC Bara Broo, SRSP
Rab Nawaz	Field Engineer (Electrical), SRSP
Ehsan-Ullah-Khan	General Secretary, Society for Biogas Promotion
M. Darjat	Project Director, Aga Khan Rural Support Programme – Pakhtunkhwa Energy Development Organisation Project
Nauman Amin	Manager, Aga Khan Rural Support Programme (AKRSP)
Dr. Abdul Qayyum Awan	Chairman, Haji Abdul Hakeem Trust
Air Commodore (Retired) Qamar-ud-Din	Country Director, Winrock International
Dr. M. Mohsin Iqbal	Adviser, Global Change Impact Studies Centre
Shoaib Sultan Khan	Chairman, Rural Support Programmes Network (RSPN)
Yasmin Khan	Project Manager-GAD, AKRSP
Imran Ashraf	Development Adviser, European Union
Imran Zaidi	Programme Officer, Ministry of Climate Change, Government of Pakistan
Michael Price	University of Cambridge, UK
Giacomo Miserocci	Development Adviser, European Union
Fazal Ali	Monitoring and Evaluation Specialist, RSPN
Abrar Ahmad	Programme Management Specialist, USAID Office of Energy Pakistan
Muhammad Saeed	Technical Adviser, GIZ Renewable Energies and Energy Efficiency Project, Pakistan
Tauseef Iqbal	Biodiesel Co-ordinator, Renewable Energy Association of Pakistan
Adnan Adil	Chief Financial Officer, Solar Tech. International
Rashid Bajwa,	Chief Executive Officer, National Rural Support Programme
Syed Aqeel Jafri	Director (Policy), Alternative Energy Development Board (AEDB), Ministry of Water and Power, Government of Pakistan
Engineer Suresh Kumar	Assistant Director, Alternative Energy Development Board, Ministry of Water and Power, Government of Pakistan
Engineer Nayyer Hussein	Assistant Professor, Department of Mechanical Engineering, Mehran University of Engineering and Technology, Jamshoro

Dr. Khanji Harijan	Professor, Department of Mechanical Engineering, Mehran University of Engineering and Technology, Jamshoro
Niaz Ahmed Janjhi	Deputy Director (Solar On-grid), Directorate of Alternative Energy, Energy Department, Government of Sindh
Shaukat Ali	General Manager (Renewable Energy), Pakistan Poverty Alleviation Fund
Dr. Ulrich Frings	Adviser, Pakistan Poverty Alleviation Fund
Rehmat Tareen	Community Member, Society for Biogas Promotion
Amjad Ali Awan	Chief Executive Officer, Alternative Energy Development Board, Ministry of Water and Power, Government of Pakistan
Khaleel A. Tetlay	Acting Chief Executive Officer, RSPN
Zia-ul-Qamar	Administration Officer, RSPN
Dr. M. Tayyab Safdar	University of Cambridge, UK
Farhana Yasmin	Procurement and Administration, RSPN
Sama Tariq	Administration Officer, RSPN
Sohail Manzar	Project Manager, National Rural Support Programme
Parvaiz Naim	Country Adviser, KfW Development Bank
Roomi S. Hayat	Chief Executive Officer, Institute of Rural Management, National Rural Support Programme
Farid Khan	Manager (Biogas), RSPN
Irteza Haider	Project Manager, National Rural Support Programme
M. Ikhlaq Munir	Finance Officer, RSPN
M.R. Kayani	Project Manager (Diarrhoea Prevention and Control Project), RSPN
Fahad-ullah-Khan	Finance Officer, RSPN
Dr. Ghulam Moeen-ud-Din	Assistant Professor, Department of Mechanical Engineering, University of Engineering and Technology, Lahore
Misbah Jatoi	Research Associate, RSPN
Tahira Tarique	Research Associate, RSPN
Muhammad Tahir	Research Associate, AKRSP
Abdul Hadi	Project Officer (Information Technology), RSPN
Professor Tauseef Aized	Department of Mechanical Engineering, University of Engineering and Technology, Lahore
Zaheer Khan	Monitoring Officer, RSPN
M. Nadeem Zakir	Head of Photovolatic Division, Pakistan Council of Renewable Technologies (PCRET), Ministry of Science and Technology, Government of Pakistan
Meher Jabeen	Research Associate, RSPN
Engineer Adnan Umar Khan	Department of Electronic Engineering, International Islamic University, Islamabad
Savaila Hunzai	Research Associate, RSPN
Dr. John Homes	University of Oxford, UK

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SMART VILLAGES

New thinking for off-grid communities worldwide

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