PPAF
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ACCESS TO ENERGY:

OPTIONS & OPPORTUNITIES

GREEN ENERGY FOR IMPROVED RESILIENCE

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According to UNDP, conventional energy production is the main source adding to climate change being responsible for about 60 percent of global greenhouse gas emissions.

Pakistan makes a tiny 0.04 percent contribution to total global greenhouse gas emissions responsible for global warming and thus climate change[1] but it is among the countries most vulnerable to climate change. Its survival resources particularly water and soil are depleting fast due to its effects.

Globally consensus is developing that climate change is the greatest threat to humankind in modern times and has serious consequences for its socio-economic such as health, food, energy consumption and natural resource management. There is a worldwide consent now that the answer to significantly offset the negative impacts of climate change its adaptation. Provision of affordable energy has been considered an important factor contributing to adaptation and improving resilience to climate change.

There has been a lot of research and development experiences available emphasizing the role of energy in addressing poverty alleviation in the developing countries. However, little has been discussed in the context of access to affordability of energy while opting for adaptation[2] to climate change. The available literature on the subject suggests synergy between access to energy and climate change adaptation i.e. access to energy helps reduce vulnerability and improves resilience to climate change. Socio-economic benefits of access to energy can mean diversifying livelihoods that strengthen the adaptive capacities of communities vulnerable to climate change.

Adaptation to climate change is thus strongly linked to development and should be treated as a development issue. Although, energy is core enabler to achieve sustainable development, increased consumption of energy derived through conventional methods particularly the use of fossil and oil can have implications for greenhouse gas emission level. According to UNDP, conventional energy production is the main source adding to climate change being responsible for about 60 percent of global greenhouse gas emissions. Thus, alternate green energy sources such as solar energy, wind energy, water power and biogas, also known as green energy, can play a vital role in reducing greenhouse gas emission. It will also reduce the use of fuel wood consumption and pressure on forests.

The most marginalized and poor communities greatly depend on environmental assets to meet their basic requirements. These assets include forests for energy, materials as well as food, while land for growing crops and water for domestic use and irrigation. As natural assets are most vulnerable to climate hazards so are the communities depending on natural assets. The IPCC[3] (2014) argued that climate hazards further aggravate existing pressure on the environment having direct implications for poor communities through impact on their livelihoods, reduced crop yields, low livestock productivity, poor access to water or destruction of homes that limits their capacity to recover from climate hazards.

There is a growing realization amongst development experts and researchers that there exists a strong link between access to energy as an enabler factor and enhanced communities' livelihood and wellbeing. This recognizes the fact that lack of access to energy could be a cause of poverty and a key constraint in building the resilience of most vulnerable to climate change.

The availability of renewable energy as part of improving resilience against climate change is becoming a popular intervention throughout the developing world. Renewable energy sources are generally carbon-free and important amongst those are hydro power plants, wind power and solar photovoltaic (PV) devices. There exists a tremendous potential for renewable energy in Pakistan. The cost of solar photovoltaic (PV) devices has significantly decreased over the last decades that made it affordable for even poor communities to solve their immediate energy needs. Solar mapping conducted by National Renewable Energy Laboratory USA has indicated a potential of 2.9 million MW in Pakistan. Munawar A. Sheikh (2009) and www.defence.pk also argued that on average

solar global insolation 5–7 kWh/m2 /day, wind speed 5–7.5 m/s with 20,000 MW potential, Biogas 14 million m3 /day, hydro potential of more than 75000 MW exists in the country. Thus, Pakistan should increase its investment to tap renewable energy sources to meet the energy requirements that would have a lasting impact on resilience as well as adaptation to climate change. There should be support to universities to further research on improving production efficiency of green energy. Local level adaptation plan of action is required for each district to address appropriate adaptation measures in line with each district's vulnerability scenario and opportunity position.

[1] a change of climate (rise in average surface temperatures on Earth) that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (UNFCCC).
[2] adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects that moderates harm or exploits beneficial opportunities (UNFCCC).
[3] Intergovernmental Panel on Climate Change.

ENCASHING ON RENEWABLE ENERGY INVESTMENTS IN CPEC

Nazish Shekha | Consultant, Sustainable Development

The 'China Pakistan Economic Corridor' represents the largest foreign direct investment which Pakistan has received since its inception. This comes at a critical time in Pakistan's history when Pakistan ranks 129 out of 143 on the Global Competitive Index (2014-2015). Two key factors highlighted in the lack of competitiveness are underdeveloped physical infrastructure and electricity. As the 'one belt one road' slogan suggests, it will lead to the upgrading of Pakistan's physical infrastructure from Khunjerab, at the Pakistan Chinese border to the Gwadar Port in Balochistan. Additionally, as part of CPEC project, Pakistan will be able to add an additional 13,530 MW to the grid by 2020. With 2 million youth seeking employment every year in Pakistan, the provision of electricity is a vital need for livelihood development in these regions.

Whilst investments have largely been made to establish coal power plants which will run on both indigenous Thar lignite and imported coal, the energy portfolio also includes low carbon renewable energy generation. A number of large hydropower projects have been identified in the energy portfolio receiving a large share of the investment. The CPEC investments to establish wind farms in the Gharo –Jhimpir corridor will lead to the addition of 300 MW to the grid, whilst a 1000MW solar farm is under construction in Sahiwal. It is envisaged though the need for rural electrification is larger than the energy added to the grid through these investments.

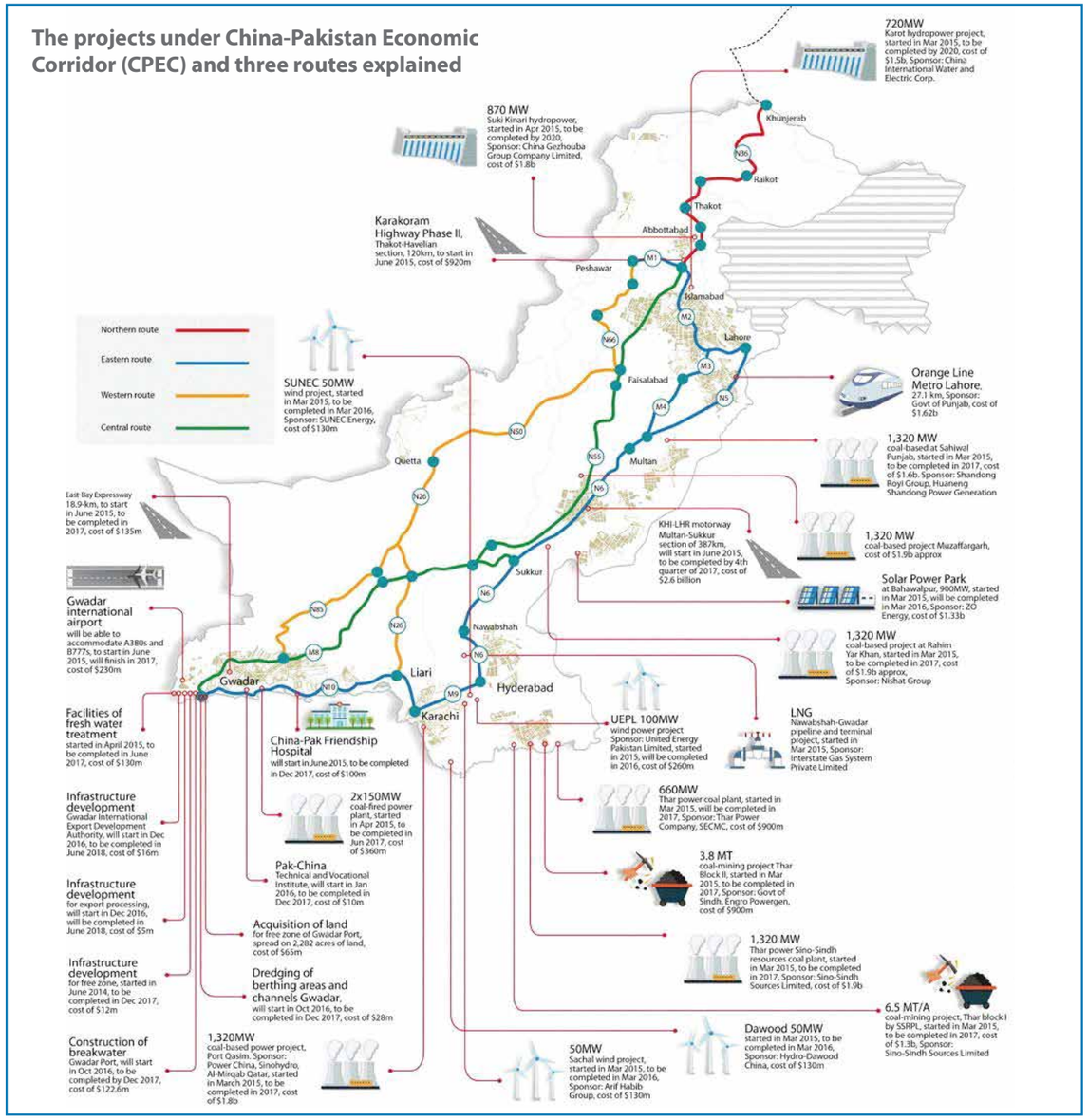
This comes at a critical time in Pakistan's history when Pakistan ranks 129 out of 143 on the Global Competitive Index (2014-2015).

In terms of the rural sector, the investments in renewable energy under CPEC need to be looked upon as opportunities beyond power generation. There is an opportunity to generate both livelihood and technology transfer. Solar farms are generally easy to establish and provide the opportunity for the provision of electricity to remote locations which are not currently connected to the grid. Grid connectivity is a costly and time consuming process which due to resource constraints can only lead to a certain degree of electrification per annum.

Solar farms present an alternative which could lead to rural electrification at a faster rate. Solar panels are light and easy to transport and with the advent of CPEC – costs for importing from China will be cheaper. Technical training to local community members could increase the livelihood opportunities and creation of local community run utilities which help provide power to villages.

'The transfer of knowledge can be achieved from this cooperation with China in the renewable energy domain, provided the state has adequate policies facilitating the flow of knowledge to the local industry' reports LEAD Pakistan. Once people from specific regions are trained to provide installation, operation and maintenance of the solar systems, businesses can be developed to promote electrification. A number of 'Pay as you go microfinancing models' are already selling solar panels to rural communities, but the canvas is vast if we consider the communities which need to be connected to electricity.

A similar transfer of technical knowledge can be taken advantage of in the installation of wind turbines. Pakistan produces 10 million fans per year and contributes 0.15 % to GDP growth. If the technical capacity of the fan industry is increased, wind turbine production can take place in Pakistan providing an opportunity to produce locally which can be modeled to Pakistan specific climatic conditions.



Source: http://3.bp.blogspot.com/-uGqPzrV9SqY/Vddc6cgy VI/AAAAAAAAHD8/PeW-Hkoajas/s1600/CPEC%2BProjects.jpg

CPEC's main purpose is to provide a logistic solution to China through the 'One belt One Road' strategy. Logistic solutions along the route present an opportunity for Pakistan to truly jump on the bandwagon of renewable energy. The new storage warehouses which will be established can be run on solar power which can be managed by local communities. Lighting on various points on the road can also be run on solar power, as well as the service stations – providing livelihoods to local community. The coastal winds at Gwadar Port are also an untapped source of energy which can be captured by wind power.

The examples present an opportunity for Pakistan to move the new development towards low carbon development. Whilst investments into physical infrastructure may give a push to Pakistan's emerging economy, investment into human capital is needed to turn this input into a viable and sustainable long term opportunity. This can be only realized if the government has in built transparent policies which provide incentives to investors to move towards both cleaner energy and build local capacity through the transfer of technical knowledge. The transfer of technology through capacity building and investment would clearly benefit from inclusion in the governments discussion regarding CPEC.

ENERGY OF THE FUTURE

IDEAS FOR A SUSTAINABLE PLANET

Uzma Nomani | Sr. Manager, Quality Assurance, Research and Design, Pakistan Poverty Alleviation Fund

Fusion Power - the Process Nature Prefers to Energize the Universe

Fusion power is the nuclear reaction that lights up the sun and the heavens. It is the secret of the stars - the unlimited and eternal energy source. The fuel for this power comes from ordinary seawater. An 8-ounce glass of water is equal to the energy content of 500,000 barrels of petroleum. The power is generated by fusing hydrogen atoms with great heat until they transform into helium, releasing cosmic amounts of energy and leaving very little waste. Attempts to harness energy by fusion have been going on since 1951, but with no success. Every 20 years scientists claim that in another 20 years the fusion power will be mastered. There is hope for the planet if they can do so within the next 20 years!

Physicists have come up with several approaches to achieve fusion including laser beam and magnetic field. The National Ignition Facility (NIF) in the United States of America employs fusion by firing giant laser beams. The NIF was completed in 2009 and is operational. One of its key research areas is blazing the path to a clean, safe, carbon-free energy future.

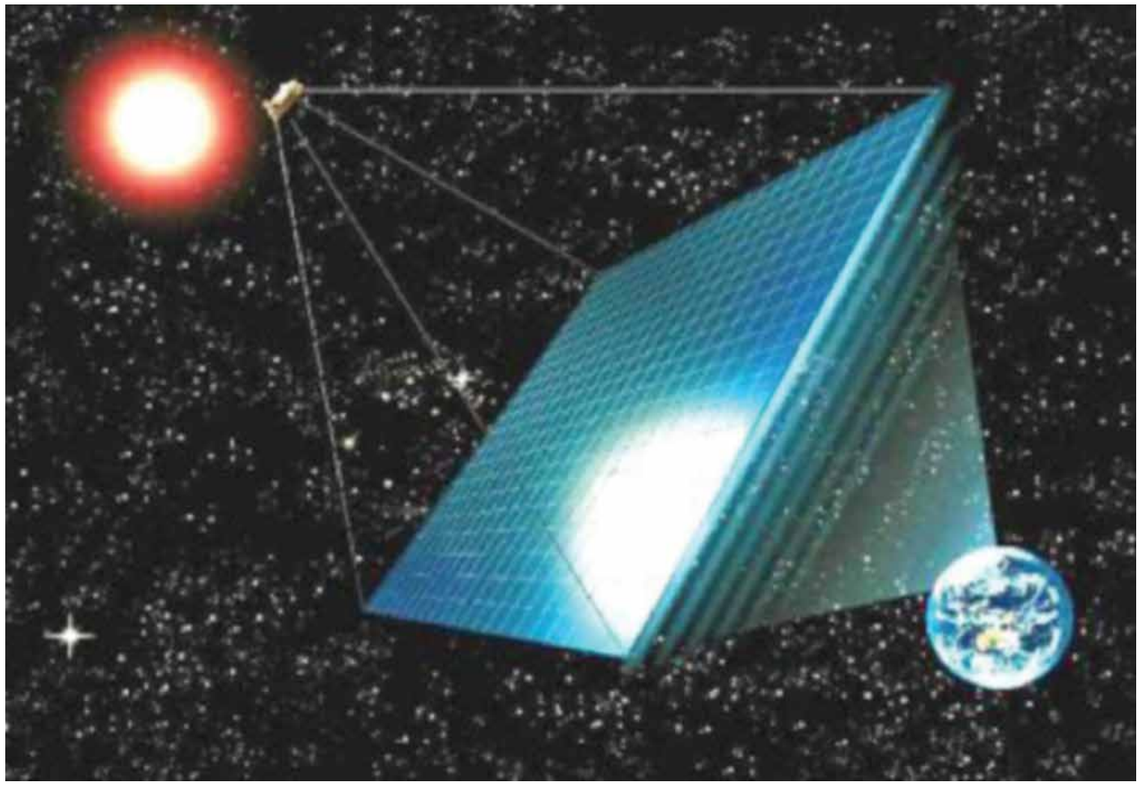
France has the International Thermonuclear Experiment Reactor (ITER) which aims to attain fusion using huge magnetic fields to compress hydrogen. The ITER is designed to produce 500 MW of fusion power for 50 MW of input power. It will heat hydrogen gas to 270 million degrees Fahrenheit, going well beyond the 27 million degrees Fahrenheit heat found at the center of the sun. The estimated date for the beginning of operations of this reactor is 2025.

Some thoughts for Pakistan:

ITER will cost 10 billion euros and the cost is shared by 35 countries (including European countries, USA, India, Japan, Korea, and Russia) over a 35 year period. Working opportunity at ITER is limited to citizens of member countries only. Sadly, Pakistan has shown no interest and has made no investment in what is one of the largest international scientific endeavours! Can we bring ITER into focus now?

Space Solar Power - Beaming Endless Energy to Earth

There is eight times more sunlight in space than on the surface of the earth. Space Solar Power (SSP) is the concept of collecting energy from space and beaming this energy back to the earth. Satellites as big as a mile across will be sent in orbit 22,000 miles above the earth – a place where the sun never sets - absorbing radiation from the sun and transmitting this in the form of microwave radiation to the earth. Each satellite would generate 5-10 gigawatts of energy and cost about eight to ten cents per kilowatt hour which is the same as that of conventional coal-fired plants. This idea was proposed in 1968 but the engineering and economic aspects are daunting challenges to overcome. From time to time NASA has funded small scale studies of SSP. Several countries are digging deeper into harnessing space solar power. Since 2008, the Japanese Space Agency (JAXA) has been working hard to develop technologies to transmit electricity wirelessly. The goal of the Space Solar Power Systems (SSPS) is to be able to transmit energy from orbiting solar panels by 2030. A group of Japanese companies are planning to initiate a $10 billion programme to launch a solar power station into space that will generate a billion watts of power. In March 2016, Mitsubishi Heavy Industries, Ltd. (MHI) successfully conducted a ground demonstration test of wireless power transmission- a technology that will serve as the basis for the SSPS. In the test, 10 kilowatts of electricity was successfully transmitted via a microwave unit.



Source: Japan Space Systems

Pakistan began its space programme in 1961, the year when the Soviet Union sent the first man into space. Since then, beginning in 1990, Pakistan has sent three satellites into space by using launching pads of other countries. In 2011, Pakistan launched its first fully functional Paksat-1R communication satellite, but this too wasn't indigenously built. The third satellite was sent in 2013. Still Pakistan has not yet developed indigenous capability to build and launch satellites locally. By 2012, India had launched 60 satellites even though it started its space programme eight years after Pakistan. UAE began its Space Programme in 2014 and in February 2017 launched a nanosatellite that was among 104 satellites that Indian Space Research Organisation (ISRO) sent into space. India holds the record of sending most satellites in one mission that was previously held by Russia which launched 39 satellites in one mission in 2014. UAE now plans to build the first city on Mars as part of the 2117 Mars programme.

Some thoughts for Pakistan:

By 2040, Pakistan Space and Upper Atmosphere Research Commission (SUPARCO) plans to be able to make, produce and launch our own satellite. By this time, the world would have perhaps made round trips to Mars. Pakistan was the pioneer of the space programme in South Asia and was the third in Asia after Israel and Japan. What went wrong afterward? Can developing capability to design a mile wide satellite for space power and launch into orbit above the earth in the near future come on Pakistan's policy radar? To fill the energy gap, our dreams need to be more grand and pursuit more intense.

THE SMART VILLAGES INITIATIVE

Dr Muhammad Tayyab Safdar | Fellow, Department of International Development, London School of Economics and Political Science

Dr John Holmes | Co-Leader, Smart Villages Initiative and Senior Research Fellow, University of Oxford

Access to modern energy services can have a positive impact on socio-economic development and can be a catalyst for sustainable poverty alleviation. Lack of access to electricity has been linked to high rates of poverty and low agricultural and economic productivity (Karekazi et al., 2012). Ensuring even modest access to electricity can have a significant and positive impact on health and education outcomes. Furthermore, it has been evidenced that good access to electricity can improve rural incomes and stimulate the local economy.

Despite the potential for modern energy services to transform the lives of the poor across the world, estimates of the International Energy Agency (IEA) highlight that there are 1.3 billion people without access to electricity across the world and another billion who receive electricity intermittently (IEA, 2012). Energy poverty is not related to electricity access alone and 2.7 billion people across the world remain dependent on traditional biomass for daily activities like cooking. The majority of those without access to modern forms of energy are based in rural areas where 70% of the world's poor live. Growth in rural economies is likely to play a major role in overall economic growth of developing countries (Ravallion 2008; IFAD 2016), and the development of rural communities will play a central role in achieving the Sustainable Development Goals.

While access to improved energy is important, it is not the end itself and needs to be seen as as a means to an end. The Smart Villages Initiative (SVI), a three-year project which started in 2014, brought together researchers from the Universities of Cambridge and Oxford to focus on off-grid energy access in rural areas. The project began with the proposition that providing electrical energy to off-grid villages by deploying innovative technologies and business models 'could' act as a catalyst for human progress when coupled with other initiatives as part of a holistic development strategy. In isolation, the meagre provision of electricity is unlikely to have an impact on local development. The Smart Villages Initiative aimed to

identify framework conditions necessary for the provision of energy services to villages to enable the livelihood opportunities, provision of services (healthcare, education, clean water and sanitation) and empowerment embodied in the Smart Villages concept. Such framework conditions include policies and regulations, the business environment, access to finance, and skills.

In terms of policies and regulations, learnings emanating from the project brought to the fore the importance of high-level political commitment to improving rural energy access using off-grid energy solutions. While there are many governments that advocate such solutions, there is a lack of appropriate policy and regulatory frameworks to support the transition. Furthermore, a lack of regulatory consistency, lack of access to information coupled with bureaucratic delays hampers private sector investment in rural energy projects, especially mini-grids. Evidence generated during the project further shows that instead of a one-size-fits all solutions, appropriate business models will vary depending on local conditions as well as the technology used, for example, solar-home-systems versus mini-grids. This further amplifies the need to have a robust and adaptable policy and regulatory regime. One of the biggest impediments to improving off-grid energy access is lack of access to affordable finance across the chain including the end customers. Governments and development agencies need to undertake systematic reviews to identify potential financing bottlenecks, reduce transaction costs and provide targeted subsidies where required.

A consistent lesson throughout the project has been the chronic lack of skills (technical and business) and institutional capacity as major impediments to improving energy access in rural areas and ensuring the sustainability of existing/planned energy schemes. Systematic analyses of all the stages in value chains are needed to identify shortfalls in skills and capacity.

Finally, as noted earlier, the integration of energy access with other aspects of rural development is essential if development benefits are to be realised in villages. Productive enterprises which are vital for income generation and employment are likely to emerge if energy access is coupled with broader measures to improve local infrastructure, access to credit and markets for local entrepreneurs.

Lessons for Pakistan

SVI has generated important lessons for development actors interested in improving energy access in Pakistan. While the country remains in the throes of a protracted energy crisis, estimates suggest that there are 56 million people without access to any form of electricity (IEA, 2012). For cooking, the IEA estimates that more than a 100 million people in Pakistan utilize traditional biomass and do not have access to improved cooking technologies. The Smart Villages vision has particular salience for development actors in the country.

This lack of access is heterogeneous across provinces, and results of the 2008 village census indicate that in Punjab around 19% of villages have no/limited access to electricity, however in the other three provinces the average is 58% of villages (GOP, 2009). Not surprisingly, poverty in Pakistan also remains primarily a rural phenomenon and is exacerbated in areas without access to electricity. This seems to be the case in Balochistan where more than 74% of villages have either no or limited electricity and half of the rural population is estimated to live below the poverty line. Many of the rural areas without electricity comprise of isolated communities located in the mountainous regions of Balochistan and Khyber Pakhtunkhwa (KPK) or in coastal regions of Sindh and Balochistan.

For many of these communities, development of off-grid solutions could provide the way to achieve a better future, however, many of the framework conditions necessary to improve rural energy access seem to be missing. There is a chronic lack of clarity in terms of the policy and regulatory frameworks governing off-grid energy projects. While the Alternative Energy Development Board was set-up as a one window operation for renewable energy based solutions by the federal government, the focus of the organisation has been on large-scale grid connected projects as opposed to supporting small-scale distributed energy initiatives. While provinces have established their own Energy Departments, they lack the physical and human capital to improve rural energy access.

The lack of policy clarity has also stifled the emergence of private sector interest in larger off-grid energy initiatives such as mini-grids which could provide energy to power productive enterprises. Most of the hydro-power based mini-grids operating in the country have been supported by funding from non-governmental organisations or multi-lateral development agencies and they have been developed as stand-alone projects with productive uses of energy incorporated as an after-thought which not only has limited development impact but also raises questions about the long-term sustainability of these mini-grids.

One of the most important lessons from the Smart Villages Initiative for policymakers and development actors in Pakistan is to ensure that improved energy access is part of a holistic rural development strategy which is coupled with other appropriately designed development initiatives. In the absence of such plans, energy access alone is unlikely to have a positive impact on local development and sustainable poverty alleviation.

A VILLAGE GROWTH ACCELERATOR PROGRAM FOR PAKISTAN

Amer Zafar Durrani | Thought Leader
Maham Faisal Khan | Program Coordination Lead
Durreshawar Mahmood | Environmental Specialist and Inclusive Development Lead

A rural power crisis in the face of rapid urbanization

In the last decade, Pakistan's average electrification rate has remained abysmally low, not exceeding 68%, with many "officially" electrified villages facing over 12 – 16 hours of consecutive blackouts. At least over 32,000 villages have not been electrified to date. Meanwhile, UN figures estimate a 3% increase per year in urban-rural migration - the fastest pace in South Asia. Nearly 1/3rd of the population currently lives in cities; and the United Nations Population Division estimates this will change to 50% by 2025, whilst the Planning Commission estimates the number may already have reached 50%.

Cities are a locus of employment opportunities: 85% of Pakistan's non-agricultural SMEs are urban-based,

Pakistan's few centers of academic excellence are based in cities; and graduates are funneled into high-growth, city-head-quartered industries. The job market is severely constrained by rapid urbanization, which is also causing neglect of the agricultural industry, the primary contributor to Pakistan's GDP since partition. Traffic congestion, noise pollution, and disease remains on the rise, whilst urbanization fuels and is fueled by violence. With this insecurity in urban congestion, and exacerbation of political violence traditional voter bases are also seeing Pakistan through to a paradigm demographic shift.

Expansion of the grid to Pakistan's distributed pockets of sparse population remains financially unviable. The lack of access to grid-quality electricity is inextricably linked to extreme poverty, depriving rural populations with basic amenities such as shelter, food, healthcare, education, and secure land tenure, as well as access to agricultural inputs, credit and information. Attempts to create smarter village models have been siloed and uncoordinated.

The village growth accelerator program

The Pakistan Poverty Alleviation Fund along with its consortium partners aims to launch an integrated approach to creating smart village "clusters" by tapping into its expansive network of implementing partners and digital hubs to holistically resolve community-based, rural development challenges and destress urban land. This "Village Growth Accelerator Program" aggregates good market acceleration practices with access to finance, viewing energy access at the core of its development ethos. Put simply,

VGAP = Fund + Accelerator

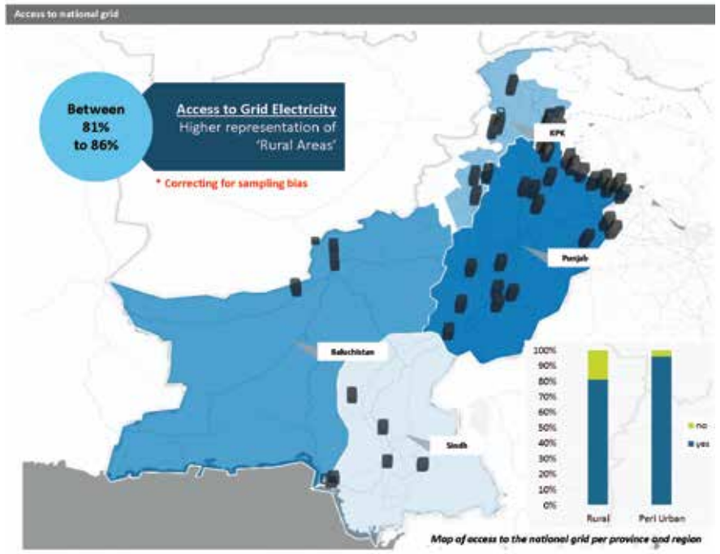
This is the notion that affordable, reliable and sustainable energy will pave the way for a wider range of developmental goals; particularly better education, healthcare, clean water and proper sanitation facilities. Through PPAF's networked support system of investors, enterprises, vendors, financial institutions, donor agencies, civil society organizations, policy makers and the primary beneficiaries (village community members) can come together to grow together.

Why the focus on energy? Hospitals cannot work without powering their machines, dairy and fishing products will go to waste without refrigeration, sanitation systems will not function, and schools will underperform. By funding and accelerating grid-quality access to electricity, VGAP will act as a catalyst of transformation, by empowering agri, WASH, health, education, and ICT markets; by attracting entrepreneurship of urban standards; and by accelerating the development of smart village "clusters" that function as "towns".

The VGAP "Fund" will act as an intermediary financial service provider, whilst the "Accelerator" will act as a network builder, connector, advisor , and ment or to bridge business intelligence gaps, and offer all stakeholders a platform to do business.

The vision

Ultimately, this approach to integrated, energy-centric rural development aims to both finance and accelerate livelihoods, encourage indigenous employment and enterprise development; support infrastructure, water and community physical infrastructure; and ultimately alleviate poverty. It will nurture and reimagine village clusters, enabling them eventually to become their own energy supply companies (ESCOs) and to become the bread-baskets of Pakistan.



Source: Electricity Access in Pakistan, March 2016, The World Bank

COMMUNITY MANAGED RENEWABLE ENERGY PROJECTS

Nafees Ahmed Kahn | General Manager, Renewable Energy,Pakistan Poverty Alleviation Fund

The energy crisis today is the greatest challenge to Pakistan's social and economic development. Despite having immense hydro, coal, gas, wind and solar potential, the country has been facing severe electricity shortages for the past 10 years. Load shedding is leading to a gradual economic meltdown, threatening the economic sovereignty of the country and has now become a back breaker for the government. As per the World Bank report, these shortages are retarding Pakistan's GDP growth by approximately 3%-4% per annum.

While the access to energy is one concern, adapting to climate change is another and both of these matters have to be addressed to achieve Sustainable Development Goals. Climate change is one of most serious environmental challenges faced by the world today. The effects of climate change and environmental degradation are becoming more severe, with Pakistan being one of the most vulnerable countries to climate change. Without targeted efforts for improving access to low carbon energy, climate change impacts cannot be reduced. PPAF

is reaching out to the poor in off- grid areas and supporting community based initiatives for meeting their energy needs as well as helping address climate change through clean energy solutions – thus displacing emissions from fossil fuels. In improving access to energy, PPAF envisions to play a leading role in promotion and development of renewable energy technologies and to focus on fast track implementation of innovative technological solutions coupled with innovative and flexible financing models for the full population spectrum - starting with community based interventions for socio-economic uplift of under developed areas and gradually taking it to industrial and commercial applications.

The objectives of the PPAF Renewable Energy (RE) Programme are in line with Sustainable Development Goals (SDGs) that include; Eradicate poverty (SDG-1) by

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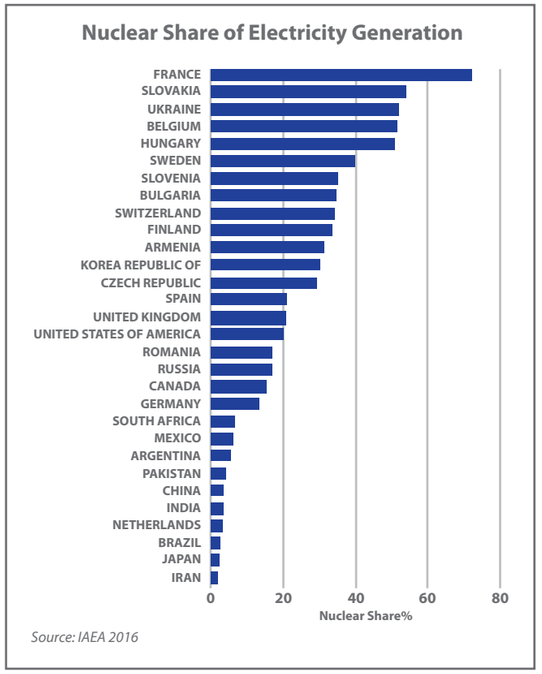
THE POWER OF FISSION:
AN ALTERNATIVE ENERGY SOURCE FOR PAKISTAN?

Uzma Nomani | Sr. Manager, Quality Assurance, Research and Design, Pakistan Poverty Alleviation Fund

Nuclear fuel offers unrivaled efficiency! One small uranium pellet produces the same amount of energy as 474 liters of oil or one ton of coal – that's enough energy to power one household for up to two months with almost no carbon emissions. The British Petroleum Statistical Review of World Energy 2016 reveals that growth in global primary energy consumption remained low in 2015 (increased by just 1.0% and well below its 10-year average of 1.9%); and the fuel mix shifted away from coal towards lower-carbon fuels. It further states that in 2015, global nuclear output grew by 1.3%, with China (+28.9%) accounting for virtually all of the increase.

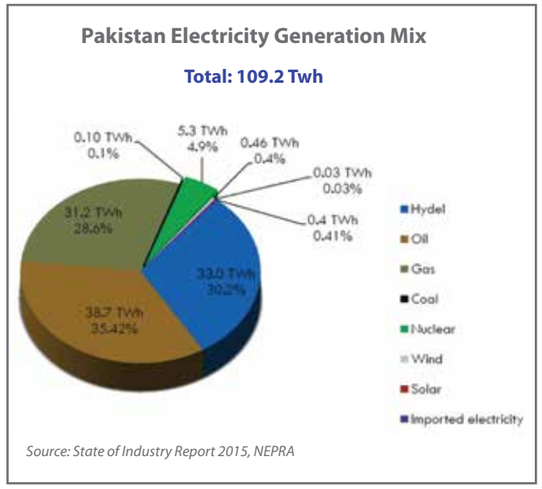
Nuclear energy around the world: The Nuclear Energy Institute (NEI) informs that in 2016, 13 countries relied on nuclear energy to supply at least one-quarter of their total electricity with France producing 72.3% and Czech Republic producing 29.4%. As compared to these, the nuclear share of electricity generated in Pakistan was only 4.4% (4.9% in 2015; NEPRA).

The World Nuclear Association (WNA) 2017 statistics show that there are 447 commercial nuclear power reactors operable in 30 countries, with over 392,080 MWe of total capacity. Together they provide 11.5% of the world's electricity as continuous, reliable base-load power, without carbon dioxide emissions. Now 19 more countries around across continents are seeing long-term role for nuclear power in national energy policies. At present 60 new nuclear plants are under construction in 15 countries.



Source: IAEA 2016

As the global trend shows a move toward clean energy, we see that despite the UAE being in the top ten countries with the biggest proven oil reserves (97.8 billion barrels as of 2015), it has an ambitious nuclear power programme. Four units with total 5.6 GWe capacity are now under construction and one of them is expected to be online in 2017. France also offers some learning as it derives over 70% electricity need from nuclear energy while using 17% of the fuel from recycled nuclear fuel. France being exporter of energy, earns €3 billion per year.



Source: State of Industry Report 2015, NEPRA

Handling the nuclear debris and safety of reactors:

Nuclear energy produced so far employs fission process-splitting the uranium atom, creating energy as well as a large amount of nuclear waste - which remains

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COMMUNITY MANAGED RENEWABLE ENERGY PROJECTS

increasing access to affordable, reliable, sustainable and modern energy (SDG-7) and to combat climate change and its impacts (SDG-13), thus reducing use of fuel wood, kerosene and diesel based power generation.

To date, PPAF has used a two-prong approach to develop programmes around the Productive Use of Renewable Energy (PURE), small community grants and micro finance. Substantial investment is required in both grants and microfinance interventions for the development of renewable energy technologies to reduce the country's reliance on import of expensive crude oil and to assist rural communities in accessing improved livelihoods. Based on PPAFs vast capacities and international reference models, there is huge potential to tap into the market of scaling up off-grid solar electrification in rural Pakistan.

PPAF has successfully developed and promoted the concept of community managed renewable energy projects. This is now an established renewable energy delivery model where communities are involved in initiating, developing, operating and gaining from renewable energy development. The size and shape of these projects may vary from community to community, growing from the diverse needs and available resources of the local community. Projects can get as diverse as a solar PV on the roof of community center, to a small wind farm in windy area, to a small hydro power project owned by two neighboring villages in northern Pakistan, where tremendous hydro power potential exists.

PPAF has so far supported over 1,000 such diverse projects of various capacities (summing up to 13 MW) which have benefited over 250,000 peop le in about 38 districts of Pakistan. These projects have been supported by various PPAF development partners including the World Bank (WB), KfW Development Bank, The International Fund for Agricultural Development (IFAD), and the United States Department of Agriculture (USDA).

These projects are benefiting local communities and business as well as stimulating local economies, and creating job opportunities for professionals and entrepreneurs. Besides, socio-economic benefits, these projects have significant environmental benefits as over 9,000 tons of carbon emissions (CO_2) are saved annually. These directly benefit over 38,000 households in far flung and off-grid areas from northern areas to southern parts of the country. After completion of the ongoing off-grid solar and hydro power projects, an additional 850 tons of carbon emission is expected to be reduced by end of 2017.

Expected outcomes will be gauged from observing how people are utilizing energy and to what extent this is beneficial for general livelihood as well as economic and societal wellbeing. Additionally, the programme is gender-sensitive and expects that by completion, it will aid women in reducing time spent on household chores and engaging in economic activities.

PPAF's efforts to improve access to clean energy have also been rewarded. Pakistan Poverty Alleviation Fund received global recognition from the Energy Institute (EI), UK for its Community Managed Hydropower Plants. PPAF's 55 micro hydro plants projects were selected for the EI Awards Community Initiative category for 2016. The plants provide clean energy for lighting and productive purposes to around 12,000 households.

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THE POWER OF FISSION: AN ALTERNATIVE ENERGY SOURCE FOR PAKISTAN?

raidoactive for thousands to tens of millions of years. A 1,000 MW reactor produces 30 tons of waste after one year. Most nations store waste above ground, in temporary storage facilities. However, there is a general concensus that permanent deep geologic storage is the best solution. In 2015, Finland became the first country to approve construction of a deep underground repository. This €3 billion facility will start storing waste in a deep underground repository from about 2023. The disposal of debris is a further cost to be added in the energy access equation.

While nuclear power plants are designed to be safe in their operation , no industrial activity is entirely risk-free. We see several thousand people die in coal mines every year too. For world nuclear safety, the International Atomic Energy Agency acts as an auditor and prescribes safety procedures and the reporting of even minor incidents. In the 50-year history of civil nuclear power generation in 32 countries, there have been only three major accidents - Three Mile Island (USA 1979), Chernobyl (Ukraine 1986), and Fukushima Japan 2011. Apart from Chernobyl, no nuclear workers or anyone from the public have ever died as a result of exposure to radiation; Fukushima accident resulted in radiation doses to the public. Nearly 200,000 people living within 30 kms of the Fukushima reactors were evacuated and those in no-go areas were never allowed to return. The total estimated cost for decommissioning the Fukushima No. 1 plant was ¥21.5 trillion ($ 3 trillion). An analysis undertaken in 2011 by the science magazine Nature and Columbia University, New York showed that the KANUPP plant in Karachi has the largest population living within a 30km radius as compared to any other reactor site globally - reactor site in the world – 8.2 million

Some nuclear energy thoughts for Pakistan:

In the current global context, Pakistan's nuclear energy share is a mere 0.2% (2015 figures) whereas the US led with 32.6%, followed by France (17%). Pakistan has a small nuclear power programme, with 1040 MWe capacity generated by 4 nuclear power plant units. The current demand and supply figures, as of April 2017, indicate Pakistan is short of 5000 MW; demand stands at 14,700 MW whereas 9400 MW is being supplied. Can we explore a nuclear option to fill this gap and reduce carbon emissions as well?

The future of nuclear energy is not unclear if there is a culture of safety and security. The critical factors to reduce the known risks are: constructing reactors of well-established design, ability of the city administration to cope with a real nuclear disaster, population density around the reactor, quality of maintenance and training, competence of the operator and the workforce, and the rigour of regulatory oversight. If Pakistan can ensure this then why not nuclear energy for electricity?

Satellite view of Karachi

JUST LIGHT IS NOT ENOUGH: PILOTING FOUR MINI GRIDS IN DISTRICT THATTA

Shahid Khan | CEO-Indus Earth Trust

"Just providing light in off-grid villages would not be sufficient to bring energy sustainability and improve life standards in the remote areas of Pakistan," concluded the project team members from Pakistan Poverty Alleviation Fund (PPAF) and Indus Earth Trust (IET). The team met in September 2016 to discuss the contours of a renewable energy project to be piloted in District Thatta. It was felt that the project should allow entrepreneurship development in communities and setting small scale businesses such as, beverages and vegetables and tailor shop, etc. For domestic purposes, a potential diurnal advantage of energy could be using household appliances, such as washing machine - instead of women spending hours doing this by hand. This will free them up to perform entrepreneurial work and hence earn profit.

A detailed survey with a complete Poverty Score Card analysis was administered on 1,500 households in 20 villages in Union Council Gharo and Dahbeji in District Thatta District, Sindh. The IET visited these households in order to clarify that this is not simply a situation where the PPAF is providing light for houses, and that it must be understood in the larger context. With the prevailing climatic and environmental parameters, the need for self-sustaining communities that use their own initiatives to earn income and support their families was stressed upon.

After completion of this stage, four villages, namely Hamzo Samo, Bachoo Koli, Jaffar Jokio, Isaque Jokio were selected by the IET team with the support and involvement of PPAF. These chosen villages were diverse in ethnicity and had varied poverty ranking. Locations were chosen from a scale of being on main grid access to those that were totally remote. To further aid in this venture, an Australian consultant with extensive experience in Mini Grid applications for off grid applications was brought in. Additionally, 'Nizam Energy' was selected as the project vendor and work began in February 2017, with complete project installation achieved in April 2017.

To access the results of this intervention it should be understood that these villages, which are about 300 years old, previously only had access to candle and kerosene

lanterns for night time use. After this intervention, not just houses but their entire villages lit up - from 7pm till 1am uninterrupted light, 7 days a week. The resulting psychological effects of this are visible in women, men, children and especially the elderly. There are certain emerging benefits particularly for women; they can perform their chores at night, clearly see what they are cooking and walk through the village without fear of snakes and scorpions which they were otherwise not able to see in the dark. Those that have started their enterprises have increased their income by 70%. Subsequently people, who are observing others add value to their income due to availability of electricity, feel encouraged to initiate their own enterprises. This increase in electric output is being analyzed by IET.

It is important to provide a "nurturing" programme to evaluate this intervention for 12 months. People who have never had electric power need to understand the extent and overall effect this can have on their lives. It is not enough to think that all you have to do is put on a switch. It will take time for communities to comprehend and value this asset.

Sustainability will be apparent when communities pay for power supply. A tariff system is in place and the earnings from this income are deposited in a village bank. This fund is for the sole purpose of replacing or maintaining equipment outside of the guarantee period. Eventually the best sustainability will happen when communities pay for the whole system themselves. At the moment each household pays a minimum of Rs. 1200/ month on kerosene and candles. A tariff just below this amount can provide a leasing possibility that pays back equipment cost over 5-6 years. The Indus Earth Trust is formulating such a proposal for PPAF's considerations.

THE IMPACT AND DOWNSTREAM ECONOMIC EFFECTS Of OFF-GRID RENEWABLE ELECTRICITY PROJECTS:

RECENT EVIDENCE AND FUTURE DIRECTIONS

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Households in Pakistan usually face one of two problems with electricity supply. Either they are connected to the grid but face load-shedding due to the overall gap between supply and demand, or they live in disconnected, off-grid areas. In order to address the shortages faced by connected households, large scale projects are planned or under construction in both renewables (such as the Tarbela Dam extensions) and fossil fuels (such as the under-construction Port Qasim plants). However, these projects are aimed at the existing energy supply deficit. Considering Pakistan's growing economy and population, these projects are unlikely to provoke extensions of the grid to previously unconnected households. Increasingly, renewables have been viewed as the solution to energy problems in unconnected areas. However, there is limited rigorous evidence about the direct impacts and downstream economic effects of distributed off-grid renewable energy projects.

Before advocating for these projects on a large scale, we should be able to answer two questions. First, what is the potential of decentralized solutions to the lack of electricity in off-grid areas? Second, how does rural electrification encourage economic and social development? Recent economics research in this field indicates that these off-grid electricity projects can be financially self-supporting and do supplant traditional fossil fuels like kerosene. However, there is mixed evidence regarding whether these projects improve household savings or encourage economic activity.

Recent evidence

In a paper published in Science Advances, a group of researchers report a randomized controlled trial (RCT) conducted in Northern India that randomly assigned 81 villages with the possibility of signing up for a solar powered microgrid.[1] These microgrids required monthly payments of about 1.7 USD from at least 10 households to be installed; only 21 of the 81 accepted the grids. Nonetheless, they find that households that were given the option to sign up for a solar microgrid spent less on kerosene and had more electricity available in their homes. However, households did not totally replace their kerosene usage and as a result the savings to the household were minimal; the two were not perfect substitutes. Furthermore, one year after the microgrids came online there were no discernable effects on "savings, household expenditures, household business creation, time spent in productive work by women, use of lighting for study, or other indicators of socio-economic development, including female empowerment.[2] "

Another RCT by World Bank researchers in Rwanda provided tiny solar systems (i.e. for lighting and phone charging only) to individual homes.[3] In addition to the positive impacts on the availability of electricity and negative impacts on money spent on kerosene, they also found increased educational activity in the household at night and decreased expenditures on mobile phone charging. However, as with the study in India, no clear effects were found on economic activity and household savings. Therefore, while there is promising evidence from different contexts that these projects shift consumption towards renewables and do not have a negative effect on economic welfare, they do not seem to be springboards for future development.

Some argue that these results can be explained by the capture of rural electrification by the rural middle class who use electricity increase to connectivity via television and cell phones but not for economic activity.[4] On the other hand, there exist case studies from Kenya[5] and Pakistan[6] arguing that electricity can lower operating costs for certain businesses, increasing household earnings, savings, and the economic welfare of households. While these studies focus on small samples and do not rely on the quality of evidence that is generated by an RCT, they do provide grounds for further work on when and why rural electrification via renewables drives further socioeconomic growth.

Future directions

In terms of economic feasibility and immediate adoption, we should study how to alleviate credit constraints that poor households face in obtaining electricity solutions.

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[6] See the effect on business described here: https://www.thethirdpole.net/2015/02/18/pakistans-first-community-power-company-lights-up-hunza-valley/

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THE IMPACT AND DOWNSTREAM ECONOMIC EFFECTS OF OFF-GRID RENEWABLE ELECTRICITY PROJECTS: RECENT EVIDENCE AND FUTURE DIRECTIONS

While microfinance has proved to be successful for many companies and organizations working in that space, evaluations of payment schemes and how this credit is made available could provide a better picture of what works best to target those who will benefit most greatly from these products.[7]

Second, for products like microgrids, how can we design institutions at the community level that ensure that payments are made and maintenance of the infrastructure lead to high reliability and stable provision of electricity. Past work in rural Pakistan demonstrates that having more choice over the type of project and encouraging strong leadership and ownership of development projects is key to the success of those projects.[8] RCTs should establish the importance of central actors and community characteristics on the success of these projects to better design interventions that focus on stability and independent operation of energy. For example, does pairing these distributed systems with social development interventions that foster community ownership and management of these projects increase their effectiveness and longevity?

Third, how does trading off reliability for breadth of service influence economic outcomes? A central complaint about electricity both on and off the grid is reliability [9], more should be done to understand whether a system that provides very reliable electricity to a few households will do more to jumpstart economic development than a system that provides a modicum of electricity to many households.

Lastly, perhaps electricity is not sufficient for the creation of businesses or cost-savings in existing businesses. Perhaps the necessary human or physical capital to start new businesses is not present in these communities and thus there is no opportunity to capitalize upon newly available electricity. One possibility is to test the effectiveness of off-grid electricity generation with and without complementary skills training. Another would be to test the difference in effectiveness in communities with high

levels of education versus communities with low levels of education.

While some of the largest hurdles facing rural electrification through renewables are technical (i.e. battery storage, maintenance for complicated systems) further understanding of the feasibility of these projects and their downstream economic impacts is needed. This information would allow the design of smart interventions that not only provide electricity, but also amplify the economic effects of this new power.

[7] Some work is ongoing in this field, funded by the International Growth Center, see: http://www.theigc.org/project/access-to-solar-electricty-in-rural-pakistan-impacts-and-sustainability/ and http://www.theigc.org/project/decentralised-electric-power-delivery-model-for-rural-electrification-in-pakistan/
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