Feasibility Study

Empowered lives.
Resilient nations.

Feasibility Report for the project "Afghanistan rural energy market transformation initiative – Strengthening resilience of livelihoods through sustainable energy access"

Abbreviations and Acronyms

ABA	Afghanistan Bank Association
ADB	Asian Development Bank
AFN	Afghani Afghan
AMA	Afghanistan Micro Finance Association
ANDMA	Afghanistan National Disaster Management Agency
ANDS	Afghanistan National Development Strategy
AREDP	Afghanistan Rural Enterprise Development Program
AREU	Afghanistan Renewable Energy Union
BHC	Basic Health Centers
BORDA	Bremen Overseas Research & Development Association
BTS	Base Transceiver Stations
CAR	Catchment Area Ratio
CBO	Community Based Organisation
CCSAP	Climate Change Strategy and Action Plan for Afghanistan
CDC	Community Development Council
CHC	Community Health Centers
CHW	Community Health Workers
DABS	Da Afghanistan Breshna Sherkat
DDA	District Development Assemblies
DDP	District Development Planning
DFID	Department for International Development
DNI	Direct Normal Irradiance
DOWA	Department of Women Affairs
DPR	Detailed Project Report
DRE	Distributed Renewable Energy
EPAA	Export Promotion Agency of Afghanistan
EPC	Engineering, Procurement and Construction
ERDA	Energy for Rural Development in Afghanistan
ESRA	Energy Supply for Rural Areas
FAO	Food and Agriculture Organization
FDC	Flow Duration Curve
FGD	Focus Group Discussion
GCF	Green Climate Fund
GDI	Gender Development Index
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHI	Global Horizontal Irradiance
GII	Gender Inequality Index
GoIRA	Government of Islamic Republic of Afghanistan
HDI	Human Development Index
HOMER	Hybrid Optimization of Multiple Energy Resources

HP	Health Posts
IDB	Islamic Development Bank
IMF	International Monetary Fund
INC	Initial National Communication
INDC	Intended Nationally Determined Contributions
JICA	Japan International Cooperation Agency
LDC	Least Developed Country
MAIL	Ministry of Agriculture, Irrigation and Livestock
MDG	Millenium Development Goals
MEW	Ministry of Energy and Water
MHP	Micro Hydropower Plant
MOWA	Ministry of Women Affairs
MRRD	Ministry of Rural Rehabilitation and Development
NABDP	National Area Based Development Program
NAMA	Nationally Appropriate Mitigation Actions
NAP	National Adaptation Plan
NAPA	National Adaptation Program of Action
NBSAP	National Biodiversity Strategy and Action Plan
NCSA	National Capacity Needs Self-Assessment
NEAP	National Environmental Action Plan
NEPA	National Environment Protection Agency
NESP	National Energy Supply Programme
NGO	Non Governmental Organisation
NPP	National Priority Program
NRVA	National Risk and Vulnerability Assessment
NSP	National Solidarity Program
NZAID	The New Zealand Agency for International Development
O&M	Operation and Management
PAYG	Pay-As-You-Go
PFR	Pre Feasibility Report
PMO	Project Management Organisation
PSMP	Power Sector Master Plan
PV	Photovoltaic
PwC	PricewaterhouseCoopers
RAGA	Rapid Assessment Gap Analysis
RE	Renewable Energy
RED	Renewable Energy Department
RENP	Renewable Energy Policy
RER2032	RE Roadmap for Afghanistan
RESCO	Renewable Energy Service Companies
RET	Renewable Energy Technology
REU	Rural Electrification Utility
Ru-WatSIP	Rural Water Supply, Sanitation and Irrigation Programme

SE4All	Sustainable Energy for All
SHG	Self Help Group
SHP	Small Hydropower Plant
SHS	Solar Home Systems
SME	Small and Medium sized Enterprises
SNAP	Strategic National Action Plan
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNOPS	United Nations Office for Project Services
USAID	United States Agency for International Development
USD	US Dollar
WB	World Bank
WEF	Water-Energy-Food Nexus
WHO	World Health Organisation
WTP	Willingness to Pay

Executive Summary

1. This Feasibility study provides the basis for the GCF proposal 'Afghanistan rural energy market transformation initiative - Strengthening resilience of livelihoods through sustainable energy access'. The proposed project builds on an understanding that self-sustained rural renewable energy markets will lead the country to a low-emission development pathway while simultaneously making rural Afghan population more resilient towards climate change impacts by giving them access to clean energy for their livelihood and agriculture related activities. The project recommends the use of Renewable Energy (RE) systems to mitigate the GHG emissions which are expected to rise on account of growing energy demand and lack of other alternatives such as grid extension.

2. The Feasibility study has based its assessment of climate vulnerabilities of Afghan rural population on the knowledge created and documented in the National Risk and Vulnerability Assessment 2012, National Adaptation Plan 2015, Nationally Appropriate Mitigation Actions 2015, Climate Change Strategy and Action Plan 2015, (Intended) Nationally Determined Contribution 2015 and Rapid Assessment Gap Analysis 2015, among others. Accordingly, the effects of climate change are expected to be significant; droughts are likely to be the norm by 2030 leading to associated dynamics of desertification and land degradation; decreasing snow cover leading to depletion of water resources; dryer conditions and rising temperatures adversely affecting agricultural pattern and yields; aggravating the damage of forests and rangelands already caused by overgrazing of cattle and fuel wood needs. The impacts of climate change on key vulnerable sectors- livelihoods and agriculture, socio-economic development of societies, water resources and energy are discussed in the context of water-energy-food security nexus highlighting the impact of energy access on agriculture and livelihoods. Chapter 1 of this Feasibility study deals with the above.

3. The Feasibility study has analysed the rural energy poverty in the country on the basis of the grid extension plan and availability and use of renewable energy (RE) resources. Main findings point towards acute energy poverty; total generation capacity consisting of 60% imports, 30% electrification rate, 141 kWh per capita annual energy usage, 85% of primary use from traditional biomass, and 95% of rural population using solid fuel. Chapter 2 of this Feasibility report includes the mapping of areas where the national grid is available (courtesy DABS) and an assessment of available RE resources in Afghanistan (courtesy Ministry of Energy and Water) that can be harnessed through various RE technologies either already available in Afghanistan, or having potential to be used. An important component of this section is understanding the past experiences of using RE in Afghanistan and lessons that can be drawn for recommending specific interventions and approaches in this project. Some of the key lessons have come from National

Area Based Development programme, the National Energy Supply Programmes, The Afghanistan Sustainable Energy for Rural Development (ASERD) programme, and other donor programmes.

4. Subsequently, Chapter 3 of this report frames the analyses of barriers to the uptake of RE systems in Afghanistan for improving energy access towards increasing the resilience of rural livelihoods to climate risks and bringing transformational changes to rural renewable energy markets. Some of the key barriers point at policy gaps towards mini-grid developments and lack of technical standards; limited institutional coordination for on-grid and off-grid energy planning; lack of mainstreaming of innovative approaches such as rural energy service company (RESCO); limited experience in designing viable delivery models for mini-grids; no inclusion of gender specific requirements in designing RE systems and high costs of installing and maintaining RE systems, aggravated by the lack of funds and finances.

5. Chapter 4 of the Feasibility study develops a strategy and recommendations based on addressing the barriers as described in Chapter 3 by a combination of derisking strategies. In order that the project's design takes a systematic approach, the project utilizes the taxonomy of mini-grid investment risks developed under UNDP's DREI (Derisking Renewable Energy Investment) framework[11]. The project targets *Energy Market Risk, Social Acceptance Risk, Labour Risk* and *Developer Risk* through a range of activities leading to three project outputs.

6. The project is comprised of three **Outputs** which will occur in parallel. The **first Output**, addressing Energy Market Risk, focuses on strengthening the enabling institutional and regulatory framework for mainstreaming rural renewable energy markets by undertaking a set of 4 activities. These are i) Regulations for mini-grids and tariff mechanisms and structure developed and approved ii) Technical standards and guidelines developed for design and operation of mini-grids iii) Policy on fostering institutional reform and coordination mechanism among responsible institutions for mini grid development developed and iv) A framework for financial de-risking and financial incentives for RE mini-grids designed. The **second Output**, addressing Social Acceptance Risk and Labor Risk, comprises of capacity building of all relevant stakeholders. Specific activities include i) Capacity strengthening activities designed and delivered for government entities on technical, managerial, administrative and financing aspects of RE mini-grids ii) Community commitment and local business interest activities designed and delivered for beneficiaries of 3 solar mini-grid systems and iii) Capacity strengthening activities designed and delivered for private sector/RESCOs on designing, operating and maintaining mini-grids. The **third Output,** addressing Developer Risk, will implement 3 solar mini-grids and will develop accompanying green procurement and safeguards standards as well as a knowledge platform. Activities are i) Investment in 3 greenfield solar mini-grids ii) Set up of a knowledge platform, including developing a pipeline for future mini-

grid development iii) Green procurement policy for mini-grids developed and mainstreamed and iv) Social and environmental safeguards policy for mini-grids developed and mainstreamed.

7. One of the prerequisites in rural renewable energy development is the need for policies and regulatory direction from the government. Specific policies for mini-grid development are a vital condition that will signal the government's intent to encourage rural renewable energy development. Technical standards and guidelines for designing and operating mini-grids are essential to guarantee sufficient impact of mini-grid development. Coordination among ministries with mandates for energy development and rural development are needed as well as collaboration with other Ministries. Institutional reform can contribute to dedicated responsibilities for rural energy development and potential to manage and organize fund for future implementation of mini-grids. Given the finance constraints and high costs of RE mini-grids, a financial de-risking strategy is an important aspect of the rural renewable energy market transformation.

8. The Feasibility study has identified lack of technical capacities, awareness among beneficiaries and knowledge on mini-grids as crucial challenges to mini-grid development in Afghanistan. The Rural Energy Service Company (RESCO) model was recommended as the service delivery model for operations and maintenance of mini-grids and other devices. The Feasibility study has recommended collecting a fee-for-service from the users of these energy services towards meeting the O&M requirements. This is essential for sustaining the RESCO business model as recommended in this study. Capacity building is needed for government entities, for beneficiaries and for private sector energy companies/RESCOs. Institutionalizing RE training in universities and vocational training centres is essential to guarantee long term sustainability of project results.

9. Proof of concept of actual implemented solar mini-grids is crucial for creating market confidence in nascent markets and the implementation of 3 solar mini-grids is therefore foreseen to create the evidence base for customer ability and willingness to pay as well as further contribute to data on load growth over time and cost data. To prepare for future government procurement or (in case of a financial de-risking strategy in place) tendering procedures for mini-grid implementation, a knowledge platform will be set up containing all the information of the 3 solar mini-grids as well as detailed investment design reports for 5 RE mini-grid, in line with green procurement guidelines and social and environmental safeguards standards.

10. The project will foster the full potential of RE in Afghanistan for improving energy access towards increasing the resilience of rural livelihoods to climate risks by creating the necessary conditions to de-risking of renewable rural mini-grid development in Afghanistan (addressing Market Risk,

Social Acceptance Risk, Labour Risk and Developer Risk) thereby setting the foundation for rural renewable energy market transformation. The Feasibility Study has thereby identified 3 solar mini-grids for implementation on the basis of available detailed technical designs and cost estimates which will benefit 49,000 beneficiaries (of which over 23,500 are women). The Feasibility Study also pre-identified 5 areas that have potential for either solar or hydro mini-grid development.

11. This Feasibility study has utilized the baseline survey conducted at 56 sites spread over 32 provinces (out of a total 34 provinces in Afghanistan), and has identified 25 sites in 11 provinces to be offering opportunities for mini-grid development. The selection process included three stages and covered an assessment of baseline survey results, security situation, climate vulnerabilities, availability of the national grid, energy consumption and expenditure patterns, possibility of load creation and presence of public institutions such as schools, health centers, mosques and police stations that would be benefitted with RE systems. An optimisation software HOMER has been used to size and optimize the solar mini-grid at a representative site. As a result of the Afghanistan Sustainable Energy for Rural Development (ASERD) project, 3 sites are foreseen from detailed technical designs of solar mini-grids with capacities varying from 600 kW to 1000 kW, in the provinces Kandahar, Khost and Parwan. This project proposes to procure, implement and operate these 3 solar mini-grids. As part of preparations for future government procurement or (in case of a financial de-risking strategy in place) tendering procedures for mini-grid implementation and complete detailed investment design reports for 3 solar mini-grids & 2 mini hydro mini-grids with a total size of 3.8 MW are proposed to be prepared under the project.

12. The Feasibility study has estimated a mitigation potential of 173,082 tCO_{2eq} of savings after implementation of 3 solar mini-grids over their useful lifetimes (25 years). In addition, co-benefits are expected to come from access to better educational facilities, health facilities, public facilities (police stations), livelihoods for SMEs and agricultural activities.

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1 Situational analysis- Climate risk profile of Afghanistan

1.1 Development context and challenges

Afghanistan is situated in South-Central Asia and is a land-locked country occupying around 652,000 square kilometres. It borders Pakistan (East and South); Iran (West); Turkmenistan, Uzbekistan, and Tajikistan (West, North) and China (Northeast). It is endowed with abundant natural wealth in terms of water resources, forest cover and mineral wealth, including hydrocarbons. The population of Afghanistan is estimated to be 34.66 million in 2016[1] (though another source estimates it as 29.2 million in 2016-17)[2] and the Gross Domestic Product (GDP) is US$19.47 billion (2016).[3] The country is divided into 7 regions and 34 administrative provinces, with 73% of total population living in rural areas.

Although Afghanistan has made measurable progress in human development over the past few years, it still remains one of the poorest countries in the world. The 2015 Human Development Index (HDI) value of Afghanistan is 0. 479 positioning the country at 169 out of 188 countries and is below the average of 0.497 for countries in the Low Human Development group.[4] Since the advent of democracy in 2002 the country has been making efforts to rebuild the economy; however, there are still wide gaps left to be fulfilled as far as balanced growth in Afghanistan is concerned. GDP growth rates are fueled largely by external support and very little revenue generation takes place by way of taxes, and the indigenous economy is still very agrarian and highly localized.

The share of Afghans living below the poverty line is 36.5%, with incidence of poverty in rural area higher than urban (37.7% and 28.9% respectively). Further, 70% of the poor population belongs to households headed by illiterate or uneducated individuals. The adult literacy rate for men is 45.4% and for women is 17%.[5] Overall labour force participation in Afghanistan is 49.8% with employment to population ratio being 45.7. The most common sector of employment is agriculture and livestock where 45% of Afghans are employed, followed by skilled workers and artisans at 10% and sales and business at 9%.[6] About 67% of households' own livestock and over 38% of the households are engaged in farming. However, the productivity in the agriculture sector is low with agriculture contributing just over 25% of the GDP. Of the total land area, 46% is under permanent pastures, 39% is mountainous and only 12% arable with the remaining 3% under forests.

Afghanistan produces exceptionally high-quality fruits; notably grapes, pomegranates, apricots, berries and plums. According to the Export Promotion Agency of Afghanistan (EPAA), the fresh and dried fruits make the biggest part of the country's export and there is a great potential to increase this export in near future. In 2014, Afghanistan produced 4000kg of Saffron (World's best Saffron in 2015 as per The International Taste & Quality Institute– iTQi Brussels)[7] which is seen as a major source of income to Afghan farmers and an alternative to poppy cultivation. However, a

[1] The World Bank
http://data.worldbank.org/country/afghanistan
[2] Central Statistics Organisation, Afghanistan
http://cso.gov.af/Content/files/%D8%B3%D8%A7%D9%84%D9%86%D8%A7%D9%85%D9%87%20%D8%A7%D8%AD%D8%B5%D8%A7%D8%A6%DB%8C%D9%88%DB%8C%20%D8%B3%D8%A7%D9%84%201395/Abstract.pdf
[3] The World Bank
http://data.worldbank.org/country/afghanistan
[4] UNDP, Human Development Report 2016
http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/AFG.pdf
[5] National Risk and Vulnerability Assessment 2011-2012, NRVA
http://www.af.undp.org/content/dam/afghanistan/docs/MDGs/NRVA%20REPORT-rev-5%202013.pdf
[6] The Asia Foundation, Afghanistan in 2013: A Survey of the Afghan People
https://asiafoundation.org/resources/pdfs/2013AfghanSurvey.pdf
[7] Afghan Exports Increases- an article in In-flight Magazine Safi Airways, issue no, 25 May 2016

major obstacle for the increase in fruit exports is the lack of industrial facilities to process and package these products according to international standards.

Though a Least Developed Country (LDC)[8] with one of the lowest levels of greenhouse gas (GHG) emissions[9] in the world (World Bank data indicates per capita emissions to be 0.3 tonnes CO_2 per capita for the year 2014), the country is on a growth path and will require energy to fuel this growth. The current development priorities in Afghanistan after three decades of unrest and insecurity are focused on basic aspects of income and livelihood security. While agriculture and rural development have contributed to the recent economic progress in Afghanistan, the biggest challenge to poverty reduction continues to be the agricultural sector's low productivity and extreme volatility of its production.

The unfolding of climate change and the limited awareness of climate change risks and impacts threaten to undermine socio-economic progress and constrain agricultural and livestock production, the backbone of the Afghan economy, potentially affecting the livelihoods of millions of Afghans.

1.2 National gender context

The formal analysis of the gender dimensions of the impacts of climate change in Afghanistan has been relatively thin, even though it is important, given the precarious situation of women in the country. While equal rights for women are enshrined in the Constitution and some steps have been taken over the past decade to increase the opportunities available to them, in general women in Afghanistan have limited access to financial resources and other assets, education and employment opportunities, freedom of movement, and a voice in shaping decisions. The Gender Development Index (GDI) defined as the ratio of female to the male HDI and measures gender inequalities in terms of three basic dimensions of human development, health, education and command over economic resources, has a value of 0.609 for Afghanistan; in comparison to 0.925 for Nepal and 0.742 for Pakistan. Likewise, the Gender Inequality Index (GII) ranks Afghanistan at 154 out of 159 countries in the 2015 index.[10] In addition, Afghanistan's National Gender Strategy[11] acknowledges that women have lacked the opportunities provided to men and as a result they fall behind men in all fields of self-advancement.

Women in Afghanistan partake in household as well as income generating activities in a manner that is common across South Asia. However, the income generating possibilities of rural women are highly constrained by traditional customs, and few have ownership of resources such as land and livestock. As a result of lack of ownership of resources, women in rural areas are engaged more in activities such as carpet weaving, embroidery and tailoring.

The labour market in Afghanistan shows a large gender disparity. Out of the total labour force of 7.2 million, only 1.3 are women.[12] The share of women employed in rural areas is 19% compared to 13% in urban areas, however 45% of women workers in rural areas are unpaid workers working within their families and the informal sector without much recognition for their contribution to household, community or society. Further, female work is much more concentrated in a few sectors, particularly livestock tending and food processing.

As women typically do not have direct control of financial resources, they are forced to ask family members for money, depriving them of financial independence. This is often exacerbated by customary restrictions on freedom of

[8] http://unohrlls.org/about-ldcs/
[9] The World Bank https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?year_high_desc=false
[10] UNDP, Human Development Report 2016: Human Development for Everyone
http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf
[11] National Gender Strategy 2012-2016, Islamic Republic of Afghanistan, Ministry of Public Health - Gender Department
http://moph.gov.af/Content/Media/Documents/MoPH_National_Gender_Strategy_Final_English_20121642012129342465533325325.pdf
[12] National Risk and Vulnerability Assessment (NRVA), 2011- 2012

movement, education opportunities and access to health care. These restrictions on independent actions have rendered rural women especially vulnerable to the impacts of climate change on livelihoods and human health, such as those caused by draughts, floods and pests.

Climate change will affect the socially constructed gender roles between men and women and may undercut efforts to build more equitable access to development. One of the key proposals in the National Adaptation Programme of Action (NAPA)[13] is to commission research into the ways that climate impacts, both already existing and anticipated, are likely to affect women in Afghanistan. This would include research and analysis at the national level, along with research initiatives that could apply to specific provinces on account of different local contexts. There is a significant correlation between gender and livelihood issue in the country, which is likely to be exacerbated by climate change.

On the other side, Afghanistan has a strong experience of agricultural cooperatives, women self-help groups and other community development organisations, which are now exceedingly playing important role in benefiting farmers and rural communities both economically and socially.

1.3 Climate change risks and vulnerabilities

1.3.1 Overview of climate and disaster risk profile

The climate in Afghanistan is characterized by semi-arid to arid continental type with hot dry summers and cold winters. Most of the precipitation received is in the form of snowfall during the winter. Climate change scenarios for Afghanistan suggest temperature increases of 1.4-4.0^{o}C by the 2060s, and 2.0-6.2^{o}C by the 2090s (from 1970-1999 averages), and a corresponding decrease in rainfall. The biophysical effects of climate change are expected to be significant; droughts are likely to be the norm by 2030 leading to associated dynamics of desertification and land degradation; decreasing snow cover leading to depletion of water resources; drier conditions and rising temperatures adversely affecting agricultural pattern and yields; aggravating the damage of forests and rangelands already caused by overgrazing of cattle and fuel wood needs.[14]

Agriculture, which is the mainstay of rural economy, is primarily dependent on precipitation (rain and snow), as the climate is generally arid, and 40% of the rural households relying on agriculture do not receive any income during winter months. The Afghanistan Initial National Communications (INC) to the United Nations Framework Convention on Climate Change (UNFCCC) identifies extreme hunger and poverty as key problems for Afghanistan, and mentions that climate change impacts could further deepen this by reducing livelihood opportunities, agricultural production, and the availability of energy, water and other natural resources. On health, vector borne diseases are likely to become more pronounced.

In recent decades, agriculture has been adversely affected by unpredictable and slightly decreasing precipitation levels, as well as overgrazing, leading to exposure of the top soil and increasing run off, with resulting loss of soil cover

[13] National Adaptation Plan (NAP), 2015
[14] NRVA, 2012

Figure 1 Flash Floods in northern districts of Balkh Province, Afghanistan (April 2013), courtesy CCSAP

(Figure 1). Over time, vast tracts of the country's agricultural lands have been moderately or severely degraded.[15] Added to this is the lack of access to roads, water for irrigation, and electricity which reduces options that are available to farmer to sustain livelihoods in the event of partial or complete crop failures. Finally, the need for fuelwood (firewood) is a significant pressure on the green cover and another contributor towards land degradation.

1.3.2 Impacts on climate change on livelihoods and agricultural sectors

Although adequate data and analytical reports on climate change and its impact in Afghanistan is unavailable, multiple symptoms of climate change is quite prominently visible in the forms of frequent and prolonged drought, erratic precipitation (such as snowfall and rainfall), and inconsistent temperature regime, as indicated in earlier sections. This is affecting the life and livelihood of Afghan people and poorer segments of the society have become more vulnerable to the effects of climate change. The impacts of climate change on four major affected sectors are described below:

Agriculture: Evidences are already visible that the vulnerability of the agriculture sector to increased temperatures and changes in rainfall/snowfall patterns and snow melt is high. Increased soil evaporation (resulting moisture stress), reduced river flow and less frequent rain during peak cultivation seasons are already affecting agricultural productivity and crop choice options. Crop failure level due to water shortages is increasing (Figure 2). Furthermore, an amount of potentially productive land will be left uncultivated because of water shortage. More water intensive staple crops will become less remunerative to farmers, with a likely increase in the attractiveness of those that are more drought hardy, including opium poppy. If proper adaptation measures and water management interventions are not pursued, the agriculture sector will suffer immensely and it is the poor agriculture dependent population that will be the worst victim in terms of their food security, livelihood strategy and overall economic conditions. The existing irrigation systems in Afghanistan are operating at a low efficiency level of about 25%, which indicates that there is considerable scope for reducing wastage of water.

Figure 2 Wheat crop failure due to lack of rains (courtesy CCSAP)

Socio-economic development of rural poor: The poor are the most vulnerable to the effects of climate change in Afghanistan. Climate change is likely to compound existing chronic and acute food security issues. As mentioned above, effects of this will be more on the people who depend on agriculture for their livelihood and economic

[15] Afghanistan: Level of Soil Degradation with Cultivated Areas- 2011 (UNEP/ FAO/ WRI)

activities. More specifically, impact will be acute on women and children, and on those involved in subsistence agriculture or pastoralism. A large proportion of the Afghan population live just above the poverty line, climatic shocks have the potential to throw down a large percentage of population into poverty. Impacts on human health, such as increased prevalence of disease affect the amount of labour productivity and availability for agriculture and other non-farm rural economic activities.

Water Resources: Water availability has already been drastically reduced both in terms of surface and ground water. Change in the precipitation pattern along with unsustainable use of water and wetlands is posing a serious threat to ecosystems productivity, food production, and all different utilizations aspects including domestic use. Poor water management interventions reduce adaptive capacity and increase vulnerability and disasters. The cumulative effects of more frequent and intense droughts on reservoirs and groundwater could threaten the water supply to entire communities specifically in the arid regions of Afghanistan, leading to a range of humanitarian crises, including disease, population displacement and conflict. Rises in winter and spring temperatures will lead to more rapid and earlier snow melt, creating risk of flash flooding. The impact of increasingly frequent flash floods is exacerbated by subsequent droughts. The lack of water availability will increase pressure on Afghanistan and surrounding countries to claim the greatest possible share of regional water sources in the longer term. Water disputes have plagued the central Asian region for years and will likely continue if climate change increases water scarcity in the region. Efforts by Afghanistan to increase its share of water use in the region may have regional implications.

Energy: From a mitigation perspective, greenhouse gas emissions in absolute and per capita terms are low in Afghanistan. Climatic impacts are most likely to be felt in hydro-electricity production, although large thermal power plant and transmission infrastructure are also susceptible to flash flooding and heat stress. Changes in precipitation, ice pack and snow melt patterns, combined with climate change-related land use change (devegetation and deforestation) will impact the variability and availability of water flow. Small hydropower plants (SHP) are particularly vulnerable. Monthly discharge at many lowland hydro plants is already declining, partly due to increased competition for water use from upstream irrigation. It has a direct linkage with potential ‘intra’ and ‘inter’ community conflicts on water use issues. Expected impacts of climate change are likely to result in heavier flow peaks in winter (due to higher precipitation and earlier snow melt/deglaciation), and less flow in summer. Figure 3 maps the energy impacts on vulnerable sectors.

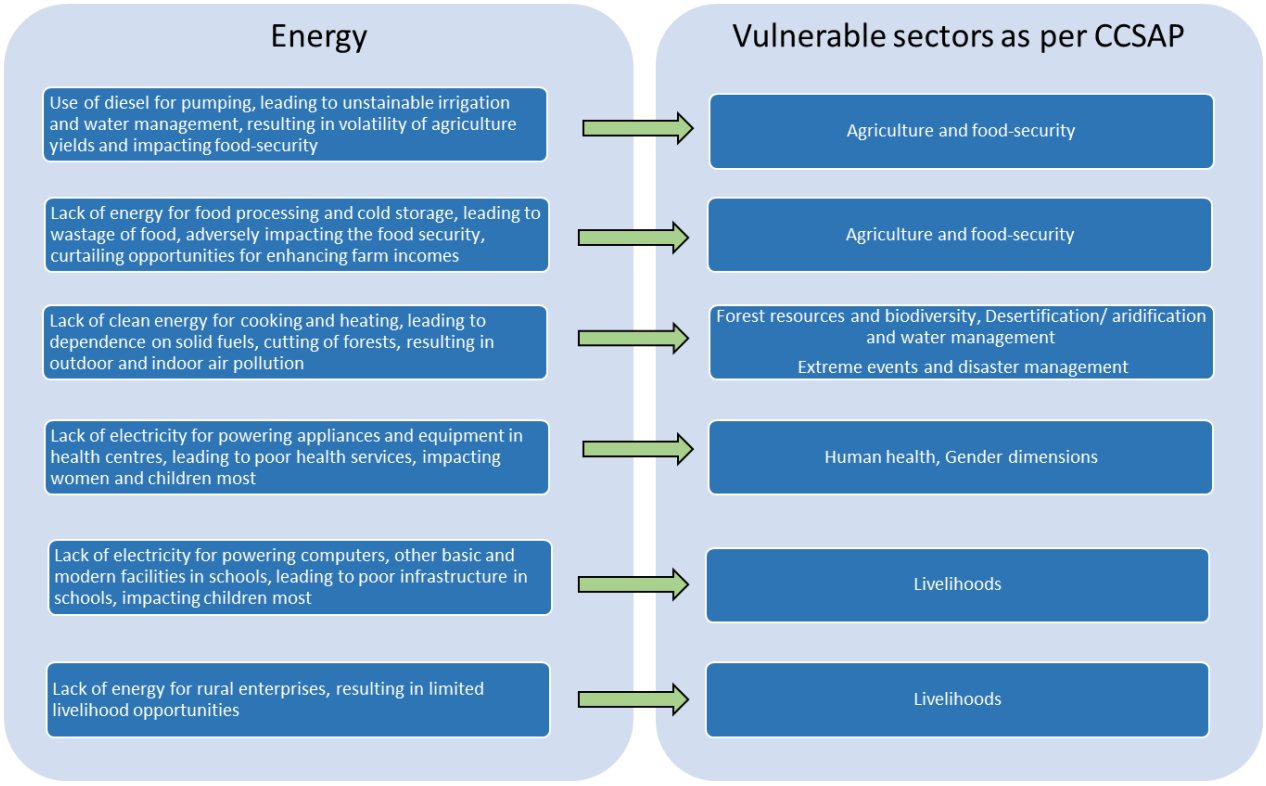


Figure 3 Energy and its impact on vulnerable sectors

1.4 Institutional and policy landscape for climate change

Climate change patterns in the country in the forms of variations in seasons, uncertainties in precipitation levels and the extreme events observed in the past 50 years have necessitated action on climate change for a variety of ecological, developmental and human development reasons. National level planning process, centered on the Afghanistan National Development Strategy (ANDS) with strategic directions provided by the National Priority Programs (NPPs), address many climate change adaptation issues through the agricultural and rural development, infrastructure and human resources development clusters. The clusters dealing with agricultural and rural development focus on rural energy access, water and natural resources management, agriculture, and local institutional strengthening in ways that would enhance resilience of the agriculture sector and rural communities to shocks from extreme events such as flood and droughts. Electricity supply is a key focus of the infrastructure cluster, while human health is a priority in the human development cluster. Table 1 below summarizes the landscape covering the strategic frameworks to address climate change, directly or indirectly:

Table 1 Landscape of strategic frameworks to address climate change in Afghanistan

Category	Legislation, Policies and Plans, Reports and Documents pertaining to climate change adaptation and mitigation
Biodiversity	National Biodiversity Strategy and Action Plan (NBSAP, 2013)
	National Adaptation Programme of Action (NAPA, 2015)

Climate Change (Mitigation and Adaptation)	Climate Change Country Profile: Afghanistan (UNDP)
	Framework Document for Comprehensive Climate Change Strategy for Afghanistan
	National Capacity Needs Self-Assessment (NCSA, 2009)
	Climate Change Strategy and Action Plan (CCSAP, 2015)
	Nationally Appropriate Mitigation Actions for Afghanistan (NAMA, 2015)
Disaster Risk Management	Afghanistan Disaster Management Law
	Afghanistan Disaster Management Plan
	Disaster Management Strategy and Mitigation Policy
	National Disaster Management Commission
	Strategic National Action Plan (SNAP) for Disaster Risk Reduction
	Afghanistan National Disaster Management Authority (ANDMA)
Environment	The Environment Law, 2007
	National Environmental Protection Agency (NEPA, 2005)
	National Environmental Action Plan (NEAP, 2009)
Food Security	Food Security Act (under development)
	NPPs in the Food Security and Agriculture Cluster
Human Health	NPP: Health for All Afghans
Land Degradation	NPP: Natural Resource Management and Development
Overarching	Afghanistan National Development Strategy (ANDS)
	National Risk and Vulnerability Analysis (NRVA, 2012)
Poverty and Development	Poverty Environment Nexus Report
Water Security and Safety	The Water Law, 2009
	National Water and Natural Resource Management Priority Programme

Source: NAP 2015 & INDC 2015

1.4.1 Climate Change Strategy and Action Plan for Afghanistan (CCSAP, 2015)

The Environmental Law (2007, English version), discusses at length several regulatory processes and guidelines necessary for environmental protection, thereby providing the foundation for future policy making in this sector. The Afghanistan Climate Change Strategy and Action Plan (CCSAP, 2015)[16] supports the Environmental Law and strengthens the legal and institutional framework for taking action on climate change in Afghanistan by adopting a judicious mix of adaptation and mitigation measures.

The CCSAP acknowledges that Afghanistan has negligible carbon emissions per capita as well as gross emissions; it is still committed to stabilizing greenhouse gas concentrations in the atmosphere and adopt a developmental path that is climate friendly, without compromising on human rapid economic growth and human development. Hence, the short and medium term goals of CCSAP are to strengthen the core sectors of agriculture and rural development to protect them from adverse impacts of climate change. The CCSAP has four targets- protect its population from climate-change related extremes; improve rural livelihood security; prevent land degradation; and increase the share

[16] Climate Change Strategy and Action Plan (CCSAP), 2015

of renewable energy in the overall energy mix. It has identified the most vulnerable spots in the country from climate change perspective as under:

Table 2 Most vulnerable provinces with respect to climate change

Climate Change Impact	Vulnerable Provinces
Desertification	Kandahar, Farah (aridification)
Forest & Biodiversity Loss	Especially in Kunar, Nuristan
Extreme Events	Northern Afghanistan Provinces, especially Jowzjan, Sar-e-Pul, Balkh, Samangan, Kunduz, Takhar and Badakhshan, have a high incidence of earthquakes and floods. Nuristan (Avalanches)
Human Health	Epidemics in Baghlan, Badakhshan, Takhar and Samangan
Food Insecurity	Food insecurity has increased across Afghanistan. However, Central Highland Regions are particularly vulnerable.
Water Scarcity	Southern and Western Provinces of Afghanistan

Courtesy: CCSAP 2015

1.4.2 National Adaptation Plan (NAP, 2015)

The National Adaptation Plan for Afghanistan (NAP 2015)[17] has identified most vulnerable sectors in Afghanistan as- sustainable irrigation and water management; agriculture and food production; livelihoods; human health; and forests and biodiversity. Further, it has categorized affected regions and susceptible sectors as under:

Table 3 Climate affected regions and susceptible sectors

Climate Change Impacts	Intensity	Affected Regions	Susceptible Sectors
Diminishing surface water level	Low to medium	All Provinces	Agriculture, water availability
Floods	High	All, but especially South, West and North	Life and livelihoods, human health
Land degradation / Soil loss	High	Northeast, Central Highlands and Southern Provinces	Agriculture, livelihoods
Droughts	High	West, North and Southeastern Provinces	Agriculture, livelihoods
Decreasing agricultural productivity	High	All Provinces	Agriculture, livelihoods
Landslides	Medium to high	North & Northeastern Provinces	Agriculture, human health
Desertification / Aridification	Medium to high	Southern Provinces	Agriculture, livelihoods, water availability
Deglaciation	Medium		Agriculture, water availability
Human health	Medium	All Provinces	

Courtesy: NAP 2015

[17] NAP, 2015

1.4.3 Nationally Appropriate Mitigation Actions (NAMA, 2015)

The Nationally Appropriate Mitigation Actions (NAMA 2015)[18] for Afghanistan has identified renewable energy, energy efficiency, efficient transportation, and waste management as priority areas for low emissions development. Promotion of Decentralized Renewable Energy (DRE) systems for enhancing energy access in rural areas with an objective of enterprise development is one of the focus areas for NAMA.

1.4.4 Intended Nationally Determined Contribution (INDC, 2015)

Afghanistan submitted its INDC in September 2015 which covers energy, natural resources management, agriculture, waste management and mining as focus areas.[19] The INDC targets 13.6% reduction on GHG emissions by 2030 scenario; energy production using hydropower, solar systems, wind and biomass, clean cooking-cum-heating devices and fuels feature as prominent mitigation contributors. The adaptation actions focus on development of a system to monitor and assess vulnerability and adaptation to climate change; development of water resources through rehabilitation and reconstruction of small, medium and large-scale infrastructure; planning for proper watershed management; increasing irrigated agricultural land and regeneration of degraded forests, among others.

1.4.5 National Adaptation Programme of Actions (NAPA, 2009)

The main climatic hazards identified in the NAPA are periodic droughts, floods due to untimely and heavy rainfall, flooding due to the melting of snow and ice, and increasing temperatures. There is a discernible trend that these events are occurring more regularly and are more intense in nature. There have been severe flood or drought events in 8 out of the past 11 years. In fact, the period 1998-2006 marked the longest and most severe drought in Afghanistan's known climatic history. At the same time, flood risk is also increasing as rainfall patterns have become more erratic. Areas that traditionally receive 250mm of rain over a period of six months are now receiving that amount of rainfall during the course of only one or two months, with a devastating effect on agriculture and livelihoods. Unless action is taken to strengthen the resilience of Afghan communities and reduce disaster risk, climate change impacts will jeopardize development gains and could push an even greater number of Afghans into poverty.

1.4.6 Institutions and their role in the climate change agenda

The institutional landscape related to climate change adaptation and mitigation aspects spans across seven key ministries / departments. These are:

1. National Environment Protection Agency (NEPA)- NEPA serves as Afghanistan's environmental policy-making and regulatory institution. Its role is to regulate, coordinate, monitor and enforce environmental laws. The agency is expected to play a major role in environmental protection, as well as to be the central point in dealing with the management of Afghanistan's environment so that it benefits all the citizens of Afghanistan. NEPA is responsible for the implementation of the NAP.
2. Afghanistan National Disaster Management Agency (ANDMA)- ANDMA is mandated to coordinate all aspects related to disaster mitigation, preparedness and response at the central and provincial levels.
3. Ministry of Agriculture, Irrigation and Livestock (MAIL)- MAIL facilitates the development of agricultural cooperatives and supports farmers in enhancing their agricultural productivity.

[18] NAMA, 2015
[19] INDC 2015 http://www4.unfccc.int/submissions/INDC/Published%20Documents/Afghanistan/1/INDC_AFG_Paper_En_20150927_.docx%20FINAL.pdf

4. Ministry of Women Affairs (MOWA)- The ministry takes special steps to reduce vulnerability of women in disaster prone areas. Department of Women Affairs (DOWA) at the provincial level supports outreach to women in the communities.

1.5 Climate vulnerability drivers and recommendations on areas of intervention

Afghanistan is a high-risk profile country according to the National Risk and Vulnerability Assessment (NRVA 2012).[20] The Global Adaptation Index ranks it as the most vulnerable in 2012 country in the world, taking into account the country's exposure, sensitivity and ability to cope with climate related hazards, worsened by the socio-political conflicts and security. Coping with the impacts of climate change is a major challenge for development in Afghanistan given that its negative effects are likely to be most severely felt by the poor and marginalized due to their high dependence on subsistence agriculture and limited capacity to cope with the impacts of climate variability and extremes.

Climate change impacts are likely to negatively affect a number of different socio-economic sectors in Afghanistan. The most significant impacts are likely to be on the vital agricultural sector, upon which the majority of the Afghan population (80% or 19 million people)[21] depends for its livelihood. More recent data confirm that 80% of the population lives in rural areas, but it now represents around 26 million people. Decreased mean annual rainfall and the increased incidence of drought will lead to reduced viability of rain-fed and dry land farming in many areas. Small-scale traditional irrigation will also be impacted as rivers dry up. The predicted temperature rise will increase soil evaporation and reduce soil water availability, which will further exacerbate the severity of droughts when they occur.

The water sector too will be heavily impacted by climate change. The likelihood of changes in rainfall intensity and increased drought frequency and intensity will lead to reduced river flow, forcing Afghans to seek costly and less accessible alternative water sources. Increased demand on stressed and over-exploited underground water sources will lead to the drying up of essential wells and springs, further negatively impacting human health and livelihoods. The drying of wells has already been observed around Kabul city, where the current rates of water extraction in the Kabul basin has already led to a severe shortage of water.

The next chapter of this Feasibility study deep dives into the energy access challenges, options, past experiences and lessons. It further analyses the barriers towards improving the energy access situation in order to recommend areas of intervention.

[20] NRVA, 2012
[21] State of the Environment, Afghanistan, 2008, NEPA

2 An assessment of the energy sector in Afghanistan

2.1 Current status and challenge in energy development

Afghanistan is rich in energy resources, both fossil fuel based and renewables. However, it still depends heavily on imported electricity and fuels and has one of the lowest per capita consumption of electricity in the world. Lack of domestic generation remains the key challenge for energy security and energy access in Afghanistan. Its 30% electrification rate ranks it in the lowest 5% in per capita energy consumption globally. Total installed generation capacity (domestic and imports) available to Afghanistan is approximately 1504.6 MW, of which 60% consists of imports (604.6 and 900 MW domestic and imports respectively). Domestic operating capacity stands at approximately 83.5% of installed capacity. It does not include off-grid installed renewable capacity of close to 55 MW (52.9 MW micro hydro power plants– MHPs and 2.1 MW of solar and others).[22]

Out of the total 604.6 MW installed capacity, 56% is thermal (diesel and furnace oil) with a generation cost of US$ 0.25-0.35 per kWh, which is four times that of imported electricity. The remaining 44% (254 MW) is from hydropower, which is seasonal and has a capacity factor of less than 40%.

Only around a third of the Afghan population has access to modern and clean energy while in the rural areas most communities are not connected to the electricity grid. Households therefore are often dependent on scare production of electricity using diesel generators, which is a costly and environmentally damaging practice. Using diesel generators is not only pollutive and expensive but also unreliable and means that the availability of electricity is exposed to regular price fluctuations, unscrupulous suppliers and transport disruptions. In the baseline scenario, the first option for meeting increased energy demand in rural areas, as income levels grow, is likely to be diesel generated power in the absence of clean alternatives.

Communities in rural areas are dependent on traditional biomass for cooking and heating. Presently up to 85% of primary energy use is from traditional biomass (such as wood and dung), which contributes to deforestation. Over 97% of the rural population is estimated to use solid fuels (i.e. firewood, dung cakes, crop residues) often combusted in inefficient devices to meet space heating and cooking needs, leading to high cost of fuels and severe and adverse effects on health particular for women and children. As a result, Afghanistan is among the top 10 countries worst affected by indoor air pollution[23] and is the biggest cause of premature deaths in Afghanistan estimated at 54,000 per year according to World Health Organization.[24] United Nations Environment Programme (UNEP) estimates that at the current rate of wood consumption and deforestation, Afghanistan's forests will disappear within 30 years.[25]

Lack of access to affordable energy is limiting economic, social and educational opportunities, particularly for the rural poor population. Poor availability of energy, especially for agriculture and enterprise development has considerably reduced rural livelihood options at the community level in Afghanistan, leaving communities more vulnerable to climate related impacts. The Afghanistan Rural Enterprise Development Program (AREDP) which supports rural enterprises, has identified specific instances where productivity and viability of rural industries such as agro-processing, food-processing and apiculture have been constrained due to lack of energy supply.

[22] http://red-mew.gov.af/red/index.php/login assessed August 2016 & Energy Sector Status Summary Report Q2 2016- MoEC/ICE
[23] World Bank Data http://data.worldbank.org/indicator/NY.GDP.PCAP.CD
[24] WHO, 2009, country profile of environmental burden of disease in Afghanistan
[25] World Bank Fact Sheet – Accessed at
http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/0,,contentMDK:21935594~pagePK:146736~piPK:146830 ~theSitePK:258644,00.html

2.2 Energy access options

Energy access is a high development priority for Afghanistan. Since 2001, major efforts have been on reconstruction and expansion of the national electricity grid. Despite these efforts, it is accepted that there are swathes of the country that the national grid will not serve by 2030. It is therefore important to focus on decentralized forms of generation and distribution of electricity and other forms of energy using renewable energy sources.

Afghanistan has good domestic energy resources.[26] The renewable energy resources in Afghanistan are plentiful- the hydro power potential in the country is estimated at 25,000 MW of which the near-term potential of micro-hydro and mini-hydro is estimated to be 800 MW. Afghanistan has good wind energy resources with measured annual average wind speeds of 4.3 to 5.6 m/s at 10 m heights. Solar energy resources are also good with over 300 sunny days in a year with annual average insolation levels of 4.7 - 5.47 kWh/m2. The country also generates significant amounts of biomass resources which could be converted for thermal or electrical energy purposes. The biomass resources include 6.8 million tonnes/year of crop residues, 34 million tonnes/year of animal manure and 0.6 million tonnes/year of municipal solid waste.

The CCSAP targets 100% electricity coverage by 2100 as mandated within the NPPs. It further targets at least 40% share of renewable energy in the Afghanistan national grid by 2100, with an increased presence of decentralised renewable energy based systems to cater to off-grid areas. The Renewable Energy Policy (RENP, 2015) has further raised the targets to 95% of the total energy mix to come from renewables by 2032. In terms of absolute figures, it translates to around 5000 MW of RE based generation capacity.

Renewable energy sector development is one of the priority areas for the government for immediate purpose of providing access to modern energy to remote and rural population and for medium to long term purpose of providing energy security to the country.[27] The 20-year Power Sector Master Plan (PSMP, 2013) recognizes that decentralized renewable sources of energy are likely to be the best option for energy access for many areas of the country in the medium term. Many multilateral and bilateral donors have supported isolated Renewable Energy (RE) projects so far and have contributed to the development of RE sector in Afghanistan.

According to the Ministry of Energy and Water (MEW), about 5100 RE Projects have been jointly implemented/under implementation by MEW/MRRD/DABS and other developers, the installed capacity of the mentioned projects is 55 MW. MEW has recently invited private sector to invest in 30 on-grid RE projects totaling up to 100 MW and comprising biogas, solar, wind, hydro and hybrid technology options. (Table 4)

Table 4 Status of RE projects in Afghanistan

Projects		Total
Total No. of Renewable Energy Projects Completed		4,602
Total No. of Renewable Energy Projects Planned		99
Total No. of Renewable Energy Projects Under Construction		493
Total Capacity of Renewable Energy Projects (No.)		5,194
Total Capacity of Renewable Energy Projects Completed and (kW)		55,011
RE type	**Total number**	**Capacity (kW)**
Biomass	44	0
MHP	2,678	52,913
Solar	2,450	1,868

[26] Afghanistan Renewable Energy Policy (RENP), 2015
[27] Afghanistan National Development Strategy (ANDS) and National Energy Supply Programme (NESP)

Wind	22	230
Total	**5,194**	**55,011**

Courtesy: MEW[28]

2.3 Institutional and Policy landscape for rural and renewable energy

The current policy regime in the country emphasizes upon major investments in renewable energy to provide energy security as well as enhancing energy access to its population. This is broadly in sync with the Sustainable Energy for All (SE4All) target for energy access for all by 2030, which is developed as a country level plan of action to ensure access to energy for all. Development of renewable energy is also one of the priority areas for low emission development for Afghanistan (NAMA, 2015) particularly in the context of energy access to rural communities to think and act beyond lighting energy.

The foundation of the RE development is based upon the Afghanistan National Development Strategy (ANDS, 2008) which provides the overall vision and goals of the energy sector; PSMP, 2013 that provides the overall status and priorities of power sector network planning and expansion, including identification of regions where network expansion in not economically viable; and the National Energy Supply Program, (NESP, 2013) which has set the short-term (by 2015) and long-term (up to 2022) targets for electricity supply; energy efficiency and renewable energy sector; energy institutions and private sector participation; and capacity and regulatory framework development. The Renewable Energy Policy approved in 2015 (RENP, 2015), as an overarching policy instrument, has set ambitious targets for RE development in the country. The strategy for implementation of the RENP and the RE Roadmap for Afghanistan (RER2032) further provide directions to meet the targets enshrined in the RENP. The Afghanistan Integrated Energy Policy (under development) is proposing to put the RE sector development as one of its strategic intents. Table 5 gives a RE policy landscape in Afghanistan.

Table 5 Renewable energy policy landscape in Afghanistan

Name of the Document	Dated and Version	Key highlights
Citizens' Charter	2016	National Priority Program of National Unity Government contributing to a number of priority areas: Ensuring Citizens' Development Rights; Building Better Governance; Reforming Development Planning & Management and Developing Partnerships.
EOI for 100 MW[29]	2016, Final Version	First batch of projects launched, considered as a curtain raiser to increased activity in the RET sector.
Feed-in-Tariff Policy	2015, Final Dari Version	Provides critical comfort levels to the private sector in terms of revenue assurances. Major enabling factor in fast-tracking projects in the RET sector.

[28] http://red-mew.gov.af/red/index.php/login, accessed on September 2017
[29] http://mew.gov.af/Content/Post/Attachment/REN%20100%20MW%20Package%20EOI10fb3a23-194f-41e8-949a-4e123ecd311f.pdf

Investment Policy	2015, Final Dari Version	Significant in terms of facilitating and attracting investment in the Afghan economy – strong links for private participation in the RET sector.
Power Services Regulation Act	2015, Final English Version	De-licenses and deregulates small scale power production through renewables of upto 100 kW generation plants
Power Sector Master Plan (PSMP)	2013, Final	Precursor to all policies: provided a national perspective on medium to long term energy planning for Afghanistan
RAGA	2015, Draft	Targets sustainable energy access for all by 2030, syncs well with PSMP's 2032 target profile, also demands higher intensity of renewable energy and energy efficiency projects
RE Roadmap for Afghanistan (RER2032)	2017, Final	Provides technology specific achievable targets based on RE potential, prioritization of technologies and projects, costs for achieving the RE generation targets, appropriate business models for implementation, enablers for market development, institutional arrangement and capacity building requirements
Renewable Energy Policy (RENP)	2015, Final	Comprehensive and overarching policy document that promises to give fillip to the RE sector in the country

2.3.1 Institutions and their role in rural and renewable energy

MEW and MRRD are the apex institutions of GoIRA to promote rural and renewable energy sector development. Many donors and international organisations are supporting these two Ministries in these sectors. The Asian Development Bank (ADB), GIZ, DFID, Islamic Development Bank (IDB), the World Bank (WB) are among a few. Table 6 maps the RE initiatives supported by the local ministries, donors and NGOs.

1. Ministry of Rural Rehabilitation and Development (MRRD)- MRRD is the key Ministry that has been designing and implementing all rural infrastructure projects, including rural energy projects. Mini-grids up to 1 MW capacity can be implemented by the MRRD as per the RENP.
2. Ministry of Energy and Water (MEW)- The Ministry is responsible for overall energy sector development, including renewable energy, in Afghanistan. MEW through its Renewable Energy Department (RED) provides guidance and oversight for RE resource assessment, technology selection, technical designs and implementation aspects.
3. De Afghanistan Breshna Sherkat (DABS)- As the flagship national electricity utility, DABS manages the entire transmission network. In addition, it has commissioned or planning to install several micro and mini hydropower and solar projects.

Table 6 Renewable Energy Initiatives in Afghanistan

S. No.	Organisation and Profile	Involvement in RE Sector
1	Asian Development Bank (ADB)	Provided technical assistance to MEW for RE sector development, supported the development of RE Roadmap and a few projects for investments and has conducted feasibility/Feasibility studies of three projects. Also, developing and rehabilitating energy facilities as well as build the institutional capacity of DABS.
2	Bremen Overseas Research & Development Association (BORDA)	Implementation of demonstration projects in different parts of the country. Conducting numerous capacity building workshops on biomass and biogas technologies. Established the Afghanistan Biogas Consortium with the support of Renewable Energy Department.
3	Department for International Development (DFID)	Installed projects in Helmand Province. Pursuing climate change mitigation and adaptation projects that include energy sector
4	Groupe Energies Renouvelables, Environnement Et Solidarités (GERES)	Implementation of energy efficiency projects in buildings in urban and rural areas of the country.
5	GIZ	Have been a long-standing partner in the energy space in Afghanistan. Institutional Development for Energy in Afghanistan project (2009 – 2017), focused on energy sector development in Northern Provinces.
6	Islamic Development Bank (IDB)	Conducted Feasibility study of Naghlu solar hydro hybrid project.
7	KFW	Have supported construction of Faizabad hydropower plant (7.2 MW) and extension of city grid; R&M of the Pol-i-Khumri HPP, Baghlan
8	Mercy Corps AF (NGO)	Several SPV projects in 1 – 60 kWp range installed in Lashkargah (LKG), Helmand
9	New Zealand Ministry of Foreign Affairs and Trade	A 1 MW solar PV–diesel power plant with T&D network supplying power to 2,490 users in Bamyan
10	South Korean Government	Seeking to support RET projects through other donors (UNDP-ASERD) and their own programmes

11	The World Bank	Afghanistan Energy Study– A 3-year initiative seeking more facts on the RE sector
12	United Nations Development Programme (UNDP)	45 MW of grid connected micro and small hydropower stations installed under NABDP programme with MRRD. Other RETs supported through the Small Grants Programme
13	United Nations Environment Programme (UNEP)	Thermal, motive and electrical energy solutions for communities and households in selected provinces
14	UNOPS and JICA	Support for 2 MW solar / wind hybrid project in Herat
15	USAID	Supporting 10 MWp solar project at Kandahar. In collaboration with Afghan Government, the USAID has launched the Afghan Energy Capacity Building Program.

2.4 Business, industrial and financial environment

The renewable energy industry in Afghanistan is in it's infancy. The Afghanistan Renewable Energy Union (AREU) is a newly formed body with about 45 members and consist of equipment manufacturers and system integrators. They have limited capacity of designing and installing RE systems, particularly using state-of-the-art technologies and concepts. Post installation maintenance support, especially of community level infrastructure, is negligible or absent, leading to a lack of sustainability of projects.

The tariff regime is largely dominated by Da Afghanistan Breshna Sherkat (DABS), the national utility. DABS operates on a cost-plus pricing basis. As a result, tariff rates can be high, and they often are. The weighted average tariff in 2014 was Afs 7.3 (0.11 US$) per kWh. Commercial customers of DABS almost everywhere pay around 8-10 Afs (0.15 US$) per kWh. Further, DABS finances are affected by foreign exchange movements; since imported power is purchased in USD while local revenues are in AFN. Increasing the proportion of supply from domestic sources is one lever to manage this risk.

Afghanistan's financial sector continues to be critical, especially since 2002 when the formal financial sector was almost non-functioning and the legal framework was practically ineffective. Internationally, the risk profile of Afghanistan precludes the long-term project financing of assets, and, as a result, direct foreign investment has been limited to grant funding and deeply concessional loans from multilateral institutions, including in power generation sector. The local capital markets and domestic banking sector is under-developed and there is little to no experience in project finance. Loans are typically offered with limited tenors, only extending to two years. Interest rates are high, resulting in a cost of capital of roughly 15%.

According to the International Monetary Fund (IMF) Country Report, the country continues to depend on donor support; the banking sector is characterized by a weak credit culture and credit collection, lack of collateral, and insufficient bank capacity for proper credit assessment and risk management.[30] Public external debt is at high risk of distress according to the IMF-World Bank framework. Afghanistan's borrowing capacity, specifically in the energy

[30] Multi-Country Report: Building Fiscal Capacity in Fragile States-Case Studies-Press Release; Staff Report. IMF Country Report No. 17/153, June, 2017.

sector, is severely restricted and it would continue to depend on foreign grants in the medium term as mentioned in a recent study conducted by the PwC.[31]

The business environment is characterized by grant based delivery models. Private sector engagement in the RE market is still weak and unsystematic. The status of financial sector remains a constraint for private sector development and limited access to credit is limiting the growth and involvement of local RE industry in rural and renewable energy sector.

2.5 Rural and renewable energy programs and key outcomes

The rural and renewable energy landscape in Afghanistan is dominated by hydropower and solar PV technologies for historical and economic reasons. Hydropower resources were the first ones to be exploited in the country for power generation and irrigation purposes remain the mainstay of domestic power supply in Afghanistan. Post 2002, there has been greater focus on mini and micro hydropower projects, largely due to lack of financial prowess.

National Solidarity Program (NSP) / NABDP and Energy for Rural Development in Afghanistan (ERDA) within NABDP, have been the flagship programs of MRRD for rural energization. Though the coverage and accomplishments of these programs is substantive, however, there are also good lessons that have a bearing on the design of the proposed project (Box 1).

A recent project on rural renewable energy development is the Afghanistan Sustainable Energy for Rural Development ASERD project. The ASERD project is a four-year project that commenced on January 2016. The ASERD has completed the Detailed Project Reports (DPRs) for 5 renewable energy mini-grids including 2 hydropower and 3 solar photovoltaics in Dara-e-Noor district in Nangahar province, Gurbuz in Khost, Pul-e-Hesar in Baghlan province, Bagram in Parwan province and Paniwayee in Kandahar province and initiated the procurement processes for the construction of 1 renewable energy mini-grid. The project also distributed cook stoves to 3,696 households in 36 villages in Pashton Zarghon district in Herat, Sholgar District in Balkh, Dar-e-Noor district in Nangarhar and Bagram district in Parwan provinces. Furthermore, ASERD completed the installations of Solar Hot Water Systems (SHWS) to 17 public health clinics in Herat, Nangarhar and Parwan provinces aiming at improving the energy services related to these public services.

Most of the projects have provided basic electricity for households. Very little support was available for enterprise development. Further, the selection process for the villages and projects was prone to political interference and most of the projects were skewed in terms of technology towards micro-hydro-electricity using cross-flow turbines. The ownership and operational responsibility of the village energy services were passed to Community Development Councils (CDCs). A significant share of the CDCs has struggled to manage the technical, financial and business management of the village energy utilities resulting in several village power plants being defunct before their useful lifetime. The rural electrification efforts have mostly been driven by fairly autonomous programmes under the aegis of MRRD and have not engaged the financial sector at all and have only had a limited engagement with the private sector.

In addition to MRRD, DABS also carries out grid extensions to rural areas under the NESP of MEW. Apart from the MRRD and MEW programmes, there are efforts by FAO, NZAID and ESRA at a smaller scale which are also supporting village electrification. There are also small-scale efforts by NGOs such as COAM and GERES targeting thermal energy issues. However, the thermal energy needs are not being addressed in any significant scale by existing programmes and there has not been much penetration of energy efficient devices. Dependence on fuel wood and other non-

[31] CAREC: Study for Power Sector Financing Roadmap, Mobilizing Financing for Priority Projects, Afghanistan, PwC Report. September, 2016

renewable biomass is very high and indoor air pollution and resultant lower respiratory illnesses is the biggest cause of pre-mature deaths in Afghanistan.

Along with hydropower, solar home systems (SHS) have also proliferated across the country. The main reasons behind solar PV's popularity are its affordability and portability, due to its highly scalable and modular structure. However, as on date the renewable energy landscape is dominated by smaller systems, catering mostly to lighting and household level demand. There are also national programmes run by government agencies and donors that have provided household and community level solar PV units.

Some experience has been generated recently on the use of solar PV pumps both for drinking water and for irrigation by the MRRD's National Rural Water Supply, Sanitation and Irrigation Programme (Ru-WatSIP), and also on large scale (between 500 kWp to 1 MWp) of solar PV based mini-grids.

Box 1

Energy for Rural Development in Afghanistan (ERDA)

ERDA was initiated to contribute to meet strategic benchmarks set at the Afghanistan National Development Strategy (ANDS) and was launched to address the major challenges associated with the rural energy promotion in the country. The program was built on the UNDP global experience in promoting community based rural energy systems across the globe.

ERDA was embedded in the overall programme framework of wider National Area Based Development Programme (NABDP) and was designed to demonstrate how energy projects can contribute to the sustainable development of the country and assist Afghanistan to reach the country's MDGs. It was intended to support the communities in rural areas to implement and manage energy projects sustainably. ERDA's institutional structure was designed to respond to District Development Assemblies (DDAs) that have prioritized energy projects in their District Development Planning (DDP) wherein ERDA was committed to provide capacity building support to DDAs and MRRD to plan and monitor rural energy projects. It was also designed to support MRRD in consolidating rural energy development activities under one programme/department in order to provide inputs to support government's goals to prepare a strategy for development and use of renewable energies.

Operation Modality

Main focus of ERDA was to support the rural energy schemes, mainly micro hydro, solar and biomass based technologies with involvement of the community and district for implementation and monitoring of the energy systems. The projects were being implemented with having a tripartite contracting with CDC, DDA, and the ministry, where the roles were clearly defined. The community was responsible for implementation of the project, DDA for monitoring and technical supervision and MRRD would provide necessary technical backstopping for implementation of the project.

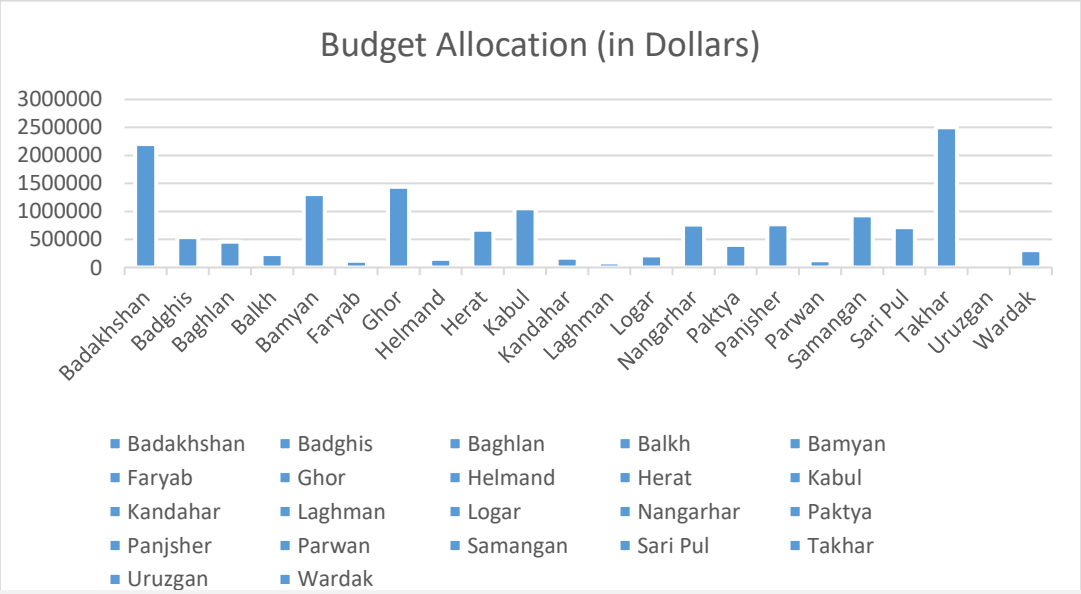
The private sector companies were responsible for supply and delivery of equipment for these energy technologies to be installed in the community. ERDA was also providing capacity building for the community for successful operation of the plant. The modality of ERDA was to mobilize the community through a community mobilization process in which the community is involved in the decision making and for implementation especially in carrying out the construction works, mobilizing local resources and selecting companies for delivery and installation of equipment.

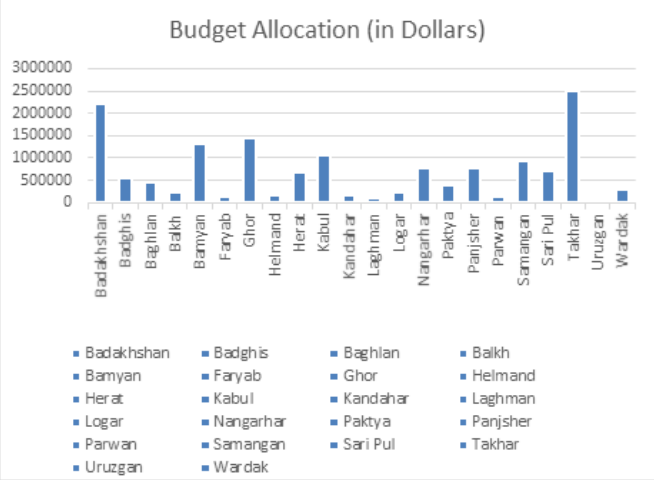
Major Accomplishments

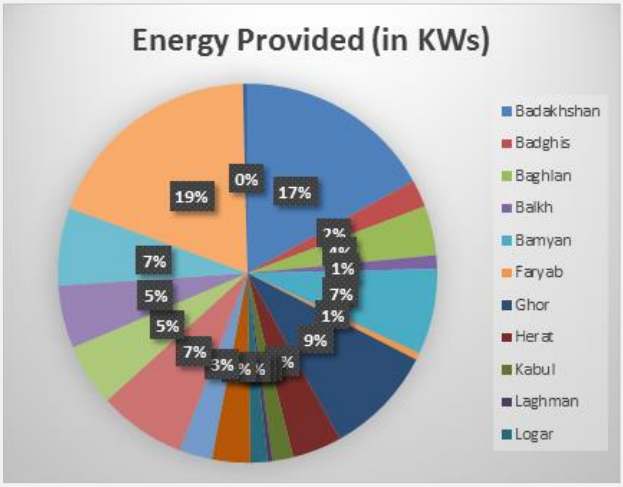
ERDA has been supporting implementation of MHP, solar and biogas project in 22 provinces.

- Solar Home System (60W) in Kandahar for 70 families
- Solar Lantern (20W) for Kochi community in Kabul, for 223 families
- Solar home system (60W) for returnees in Aliceghan township in Kabul for 328 families
- Around 300 biogas plants in Ningarhar and Kandahar designed for every household.

The following charts the coverage details of the ERDA component of NABDP.







Lessons Learned

Low capacity of private companies: The low capacity of private companies posed a serious threat to the implementation of infrastructure projects. Many private companies have little operating experience in remote rural areas. Insecurity, lack of basic services and conflicts with local communities proved to be highly challenging.

Cost-benefit effectiveness: NABDP mostly identified projects based on community requests. Although requests were assessed through feasibility studies to ensure minimum cost-benefit effectiveness, this predominantly bottom-up planning approach has its weaknesses.

Sustainability: The lack of maintenance of infrastructure projects threatens their sustainability. The best sustainability practice among all NABDP projects can be found in the energy section. For every community, NABDP trained one person to operate and maintain the energy facility. Every household paid a monthly tariff to cover the operator's salary and future repairs.

Outcome monitoring: While most infrastructure projects aimed to increase agricultural productivity, NABDP lacked a monitoring system to track this indicator.

2.6 Key lessons from past experiences and identification of energy vulnerability drivers

Over 10 years of rural electrification efforts supported by the international community has led to key learning including:

- There is a need to go beyond household electrification for lighting by addressing household thermal energy needs and engaging anchor customers for productive use in the commercial sector and public service opportunities in rural government institutions. Monthly expenditure on solid fuels during winter months is considered to be 10 times higher than they spend on kerosene for lighting.[32]
- Existing gaps in government policy, regulation, standard setting and incentive frameworks should be addressed.
- Decentralized electricity schemes should be included in the overall policy, regulatory, planning, implementation, operation and management framework for a universal energy access programme.[33]
- Instead of building micro hydroelectric plant for each village community, larger mini-grids that serve a number of villages serving productive need in the community should be developed.
- The mini-grid systems are real infrastructure projects and hence require standard approaches of engineering services, project planning and operational management. All the projects should be planned and implemented in a coherent manner using standard guidelines and practices. In this regard, internationally accepted forms of contract, contract management and engineering supervision should be used.
- Planning and engineering teams must track technology innovation and integrate the new technology within the overall framework of electricity service provision. Further, system planning and optimisation tools for maximising the benefits of hybrid configurations for generation from renewable energy and distributed generation topologies must be used.
- A common and accepted understanding of the roles and responsibilities in the ownership, operation and management (O&M), maintenance, payment for services, regulation, funding and financing, etc. are critical and should be achieved.
- Financing model of almost all the cost of the installation and maintenance with donor funding is not sustainable, collecting fee-for-services from the consumers is important for O&M of the plant.
- It will be important to create rural energy service delivery models that engage the private sector and financial institutions and leverage donor and government sources to create scalable and replicable models.
- There is a need to include gender perspective in the planning and implementation of rural energy projects and gender mainstreaming should be an integral component of any policy and planning framework.
- There is a need for integrated planning for energy projects along with infrastructure projects that will get direct benefits from reliable energy and vice-versa. For instance, planning for agriculture based livelihoods projects (i.e. cold-storages) should include a component of energy provision and planning for energy projects (i.e. MHP) should identify and support enterprises and public institutions that will use the electricity thus generated.

The next chapter of this Feasibility report deep dives into the assessment of needs and barriers towards improving energy access using baseline survey and stakeholder consultations.

[32] COAM, 2012, Shan Foladi village survey
[33] High-level learnings for the implementation of decentralized electricity (mini-grid) schemes in Afghanistan- November 2014. Personal communication with GiZ-IDEA team, Kabul

3 An assessment of needs and barriers to RE based rural energy markets

3.1 Barrier Analysis

As discussed earlier, access to energy could play a critical role in helping Afghan rural poor in their ability to cope with the adverse impacts of climate on their livelihoods, including rain-fed agriculture which is the back bone of rural economy while simultaneously introducing the low-carbon growth trajectory for Afghanistan. However, only a third of Afghan population has access to modern energy and about 95% rural population still rely on solid fuels for cooking and space heating. The electricity distribution utility DABS is limited in its reach to the vast rural population and is unable to service the domestic and agricultural demands due to technical and commercial reasons. Further, the social inequalities and lack of gender perspective has left women and children, particularly in rural Afghanistan, most vulnerable groups to climate change. Renewable energy systems can provide clean energy access to rural poor, but so far, their use has been limited to providing domestic lighting and there are gaps in policy and regulatory framework to utilize RE's full potential for productive applications. Inherent political and security risks have restrained the introduction of state-of-the-art technologies and concepts in RE, particularly through RE mini-grids and efficient thermal devices which are used extensively across the world in developing countries for providing clean and reliable energy to communities. Based on primary and secondary data, the Feasibility report has identified the barriers in realizing the full potential of RE in Afghanistan for improving energy access towards increasing the resilience of rural livelihoods to climate risks and bringing transformational changes to rural renewable energy markets. Barriers have been discussed below:

i. Lack of incentives and guidelines for private sector to participate in rural electrification projects

The RE sector has not been able to attract private sector investment in mini-grid development on account of risk perceptions as well as limited experience among local entrepreneurs to set up and operate such projects profitably.

The project team conducted a consultation meeting with AREU members to solicit their views, perceptions and experience on mini-grids market in Afghanistan.[34] Private companies are involved in design and construction of energy projects of different scales as contractors, but O&M of these projects have been the responsibility of either DABS (large projects) or the community (mini/micro-grids). The rural energy market is perceived to be risky not only due to inability of the rural population to pay for the energy services, but also because of local socio-cultural-political and security issues prevalent in Afghanistan that do not provide private investors and project developers confidence on the return of the investments.

ii. Lack of awareness, exposure and experience on use and benefits of RE mini-grids

Though RE systems have been in use for many years in Afghanistan, lack of technical skills and information, perceived technology performance uncertainty and risk, higher cost of capital due to lack of experience in mini-grids acts as market entry barrier for RE mini-grids. This often results in technical and financial failure of RE mini-grids system, which can be avoided with a standardized and programmatic approach to RE intervention by providing training on organization, system design and operation of RE mini-grids, which has been missing thus far in the country.

iii. Lack of regulatory framework for mini-grids and uncertainty on future grid connection

[34] Minutes of Stakeholder Consultation Meeting with AREU Members

There is no regulatory framework for mini-grids that covers safety, quality of service, tariff regulation and provisions for what happens to the mini-grid when the main grid arrives (e.g. the grid owner abandons the system with compensation, or the owner continues distribution and/or generation). Such a framework would partly address the uncertainties developers and investors face about their investments.

iv. Low technical quality of installation and poor operation and maintenance of mini-grid and stand-alone PV options will hamper its more widespread diffusion

Mini-grid systems installed in the past vary in quality and do not always meet today's design criteria and today's international standards or face operation and maintenance problems. Where RE technologies are making inroads into the market, some of these are using low-quality products and this may result in low consumer and policy-makers' confidence and may stunt future rural RE market growth. User disappointment can adversely affect the consumers' impressions of the technology and diminish their willingness-to-pay to acquire or replace faulty systems.

v. Limited government funds, reluctance of banks and private sector to finance RE projects

Even though the Government is committed to promote RE sector in Afghanistan and has announced up to 25% subsidy support for the first 100 MW portfolio of projects[35], there is no dedicated budget for supporting RE projects in Afghanistan. The heavily indebted local government, Islamic prohibitions on taking loan etc., are some of the other barriers that come in the way to secure any long-term funding for this sector. Further, there is no evidence of local private sector financing for renewable energy. Though the members of Afghanistan Banks Association (ABA) and Afghanistan Micro-Finance Association (AMA) are beginning to look at this sector as a potential sector for lending, the market route has not taken off in Afghanistan primarily due to the lack of an enabling environment for the same.

vi. Limited resources, capacities and priority for national utility DABS towards rural electrification

DABS, the state-owned provider of electricity in Afghanistan, though committed to rural electrification, has not given the top priority for rural electrification through renewable energy based rural electrification projects. Diesel based mini-grids continue to be the first option for towns and villages which have good electricity demand, but are beyond the reach of the national grid. Further, they also lack appropriate level of technical qualification to operate and maintain RE based projects.

vii. Limited capacities to design, engineer, procure, construct, operate and maintain RE mini-grids

Though RE systems have been in use for many years in Afghanistan, the local capacities have not been enhanced to design, engineer, procure, construct and maintain RE mini-grids because most of the RE projects have been donor driven with each project having its own guidelines, processes and procedures. The standardized and programmatic approach to RE intervention that should naturally lead to systemic and human capacity building, has been missing so far.

The ability to design, customize and integrate some of the other livelihood oriented techniques with RE technologies has also been limited. For instance, the experience and exposure to several innovative institutional models to build, own, and operate RE projects, particularly the mini-grids, is limited in Afghanistan. Most of these projects have been built by donors and handed over to the communities for managing, operating and maintaining them after giving them necessary trainings. While this model has worked in some cases, the new thinking and approaches on service delivery that have been effective in the other countries have not been introduced so far.

[35] http://mew.gov.af/Content/Post/Attachment/REN%20100%20MW%20Package%20EOI10fb3a23-194f-41e8-949a-4e123ecd311f.pdf

viii. Weak business case to install, maintain and operate RE systems due to high costs and security factors

The cost of procurement, installation, operation and maintenance of RE projects continue to be high in Afghanistan even as compared to its regional neighbors on account of several reasons- lack of capacities, minimal local production, thin market volumes, unfavorable and difficult logistics, unavailability of spare parts, poor paying capacities etc. Box 2 provides further insights on RE costs in Afghanistan as taken from RER2032.

3.2 Conclusion on overall barrier analysis and strategy to address the barriers

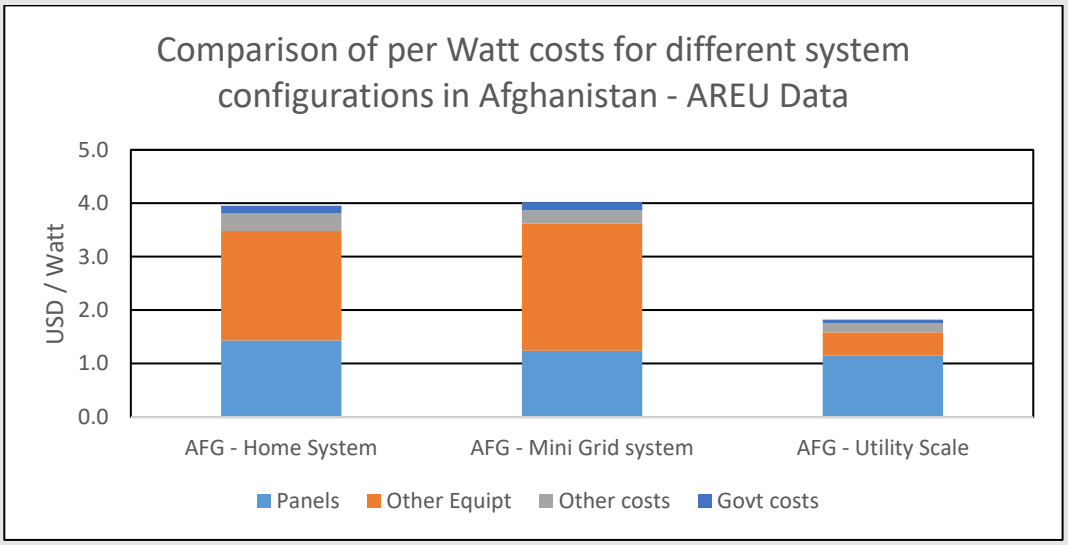
The barriers to realizing the full potential of RE for rural energy markets in Afghanistan can be described under two broad but interrelated categories- lack of financing and institutional mechanisms to involve private sector to expand RE in rural areas both in the short term and long term; and inadequate technical and market knowledge to design and implement viable RE projects.

The strategy to address these barriers should encompass technical, policy, finance and institutional aspects based on innovative approaches that are customized and contextualized for Afghanistan. These should include:

- Use of modern tools and techniques for providing energy that not only caters to domestic and community demand of electricity and heat, thereby impacting women and children most; but should also target improving the efficiency and thus productivity of agricultural and other local enterprises.
- Improving the policy and regulatory landscape that integrates energy with livelihoods and facilitates inter-departmental/ inter-ministerial coordination for maximizing the impacts of RE projects
- Transitioning from a completely donor-driven RE eco-system to a public-private-partnership and ultimately to a private-sector driven and financed commercially viable RE/RE sector
- Building new, and strengthening existing institutions that can design, monitor, and improve projects and programs that cut across climate change and energy access agenda

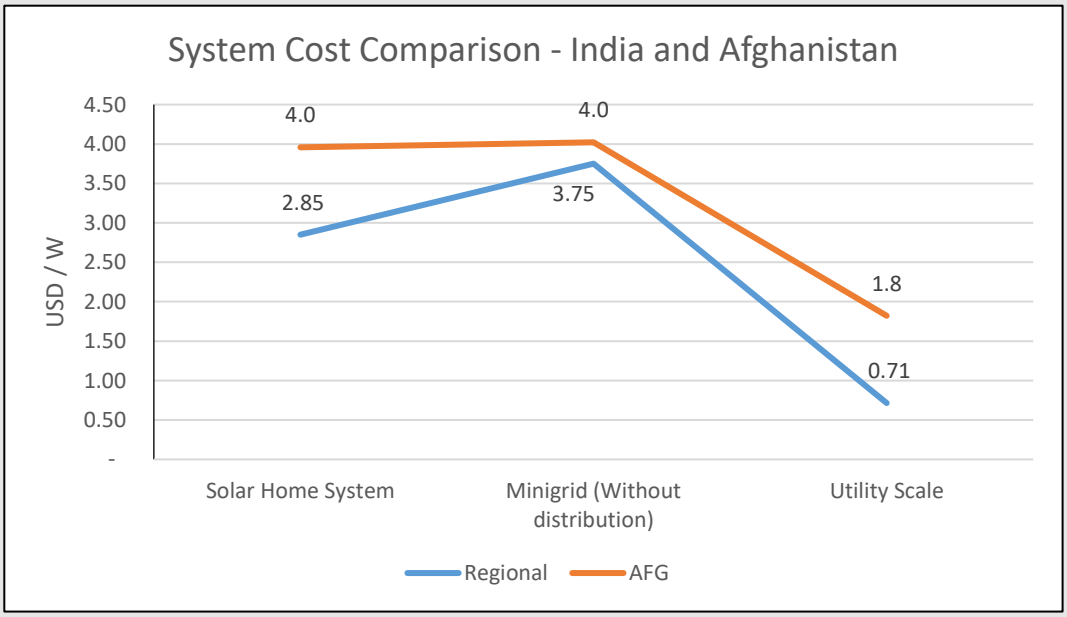
In the business-as-usual scenario, if the barriers are not addressed, the baseline energy poverty situation will continue and worsen as the demand for energy grows. Diesel, kerosene and firewood will continue to be the fuel for providing energy to rural population.

Box 2



Solar panel costs were broken out separately, while other costs were grouped within the categories of other equipment, other costs, and government costs for sake of comparison as shown below. It should also be noted that land costs and security costs are not included as these are highly variable and site specific.

Other equipment: Inverters, batteries, PV panel stands, battery racks, grounding, cabling, safety ropes, nuts, and bolts and other miscellaneous minor equipment required for plant construction
Other costs: Equipment transport to site, management and administration charges, site labor charges, site design and civil works and other miscellaneous design and site preparation costs
Government costs: Taxes and permitting fees



Source: RE Roadmap development for Afghanistan (MEW/ADB)

4 Proposed strategy and recommendation for transforming rural renewable markets

4.1 Overall approach to meet the challenge- Theory of Change

The previous Chapter discussed the needs and barrier analysis to RE based rural energy markets in Afghanistan and the development challenge linked to the core problem of underdeveloped rural (renewable) energy infrastructure and services, a situation which is caused by the persistence of a number of main and underlying barriers and challenges. Realising this change requires a number of interventions under the project's theory of change, as explained in this Chapter.

Responding to the identified core problem, **the objective of the project is** to prepare the ground-work for rural renewable energy market transformation in Afghanistan through a combination of targeted de-risking activities to address key mini-grid investment risks. These activities include: (1) policy and regulatory design, setting the basis for public and private sector financing, (2) capacity building and awareness raising of both the public, private sector and end-users, and (3) implementation of 3 greenfield solar minigrids and setting up a knowledge platform, including the development of 5 investment design reports.

This approach will create the basis for mainstreaming renewable energy mini-grid solutions and continued reduced GHG emission as compared to the alternative, diesel generated power. The project seeks to achieve this by means of a multi-pronged barrier removal approach, focusing on solutions for policy and regulatory de-risking, capacity building and awareness raising and derisking developer risk by empowering government for green procurement and safeguards applied to detailed investment design reports for RE mini-grids.

The interactions of barriers and proposed interventions is illustrated in the Theory of Change (Figure 4).

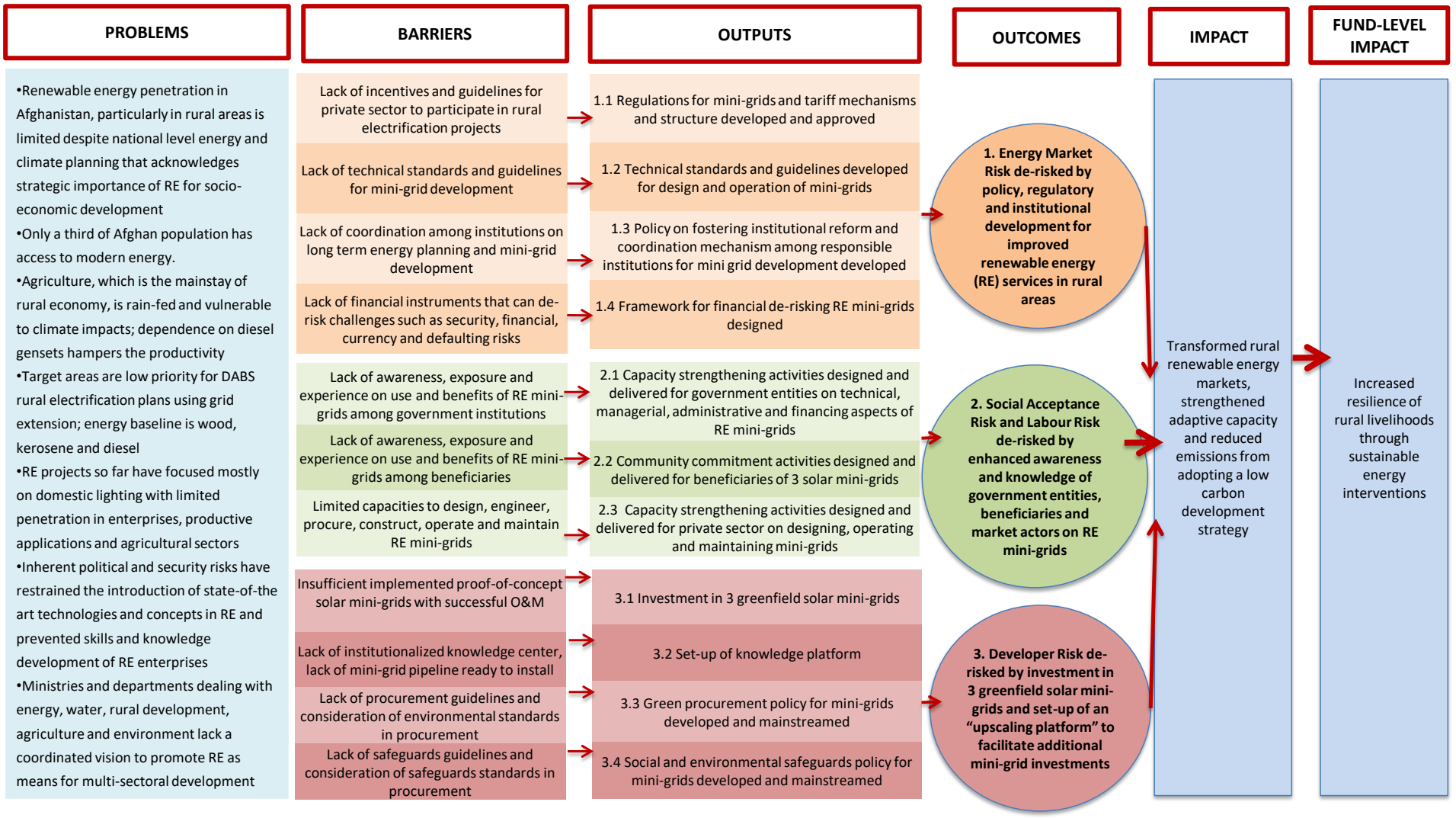


Figure 4 Theory of Change

4.2 Recommended project design and interventions

The objective of the project is to prepare the ground-work for rural renewable energy market transformation in Afghanistan through a combination of targeted de-risking activities to address key mini-grid investment risks. The project will create the necessary conditions via policy and regulatory strengthening, as well as institution and capacity building of government, beneficiaries and the nascent domestic private sector RE mini-grid developers. The project will also implement of 3 greenfield solar minigrids in the provinces Khost, Kandahar and Parwan, representing a total installed capacity of 2.6 MW. Ultimately, the project aims to contribute, in a phased approach, to scaled-up deployment of mini-grids in Afghanistan, with the eventual, end-goal of large volumes of investment by the private sector on commercial terms.

Derisking is the central mechanism by which this project will act. Public derisking measures can improve the risk-return profile of investment opportunities in three ways: policy de-risking instruments (that *reduce* risk), financial de-risking instruments (that *transfer* risk) and direct financial incentives (that *compensate* for risk). Typically a combination of all three instrument types is needed[36]. Policy de-risking measures, which address the underlying barriers that create investment risks, can be a cost-effective first step in creating an enabled investment environment. These instruments utilize policy and programmatic interventions to mitigate risks related to e.g. permits and approvals, generation licences, land rights and address overlapping institutional responsibilities, lack of staff capacities and knowledge. Given the nascent and early-stage of mini-grids in Afghanistan, the project will therefore primarily focus on a policy derisking approach, but will also prepare a framework for follow-up financial derisking and financial incentives, and pave the way for forthcoming investment.

In order that the project's design takes a systematic approach, the project utilizes the taxonomy of mini-grid investment risks developed under UNDP's DREI (Derisking Renewable Energy Investment) framework[37]. The project targets in particular the following investment risk categories, defined as follows:

- *Energy Market Risk*: Risk arising from limitations and uncertainty in the energy market regarding market outlook, access (regulations), price (tariffs) and competition.
- *Social Acceptance Risk*: Risks arising from lack of awareness and resistance to renewable energy and minigrids in end-users and communities
- *Labour Risk*: Risks arising from the lack of skilled and qualified potential employees at mini-grid operators (including, engineering, customer acquisition, operations/maintenance)
- *Developer Risk*: Risks arising from limitations in the mini-grid operator's management capability (system sizing and design, business model selection), and its creditworthiness and cash flow

The project is comprised of three **Outputs** which will occur in parallel. The **first Output**, addressing Energy Market Risk, focuses on strengthening the enabling institutional and regulatory framework for mainstreaming rural renewable energy markets by undertaking a set of 4 activities. These are i) Regulations for mini-grids and tariff mechanisms and structure developed and approved ii) Technical standards and guidelines developed for design and operation of mini-grids iii) Policy on fostering institutional reform and coordination mechanism among responsible

[36] UNDP & ETH Zurich (2018). Derisking Renewable Energy Investment: Off-Grid Electrification. United Nations Development Programme, New York, NY and ETH Zurich, Energy Politics Group, Zurich, Switzerland

[37] UNDP & ETH Zurich (2018). Derisking Renewable Energy Investment: Off-Grid Electrification. United Nations Development Programme, New York, NY and ETH Zurich, Energy Politics Group, Zurich, Switzerland

institutions for mini grid development developed and iv) A framework for financial de-risking and financial incentives for RE mini-grids designed. The **second Output**, addressing Social Acceptance Risk and Labor Risk, comprises of capacity building of all relevant stakeholders. Specific activities include i) Capacity strengthening activities designed and delivered for government entities on technical, managerial, administrative and financing aspects of RE mini-grids ii) Community commitment and local business interest activities designed and delivered for beneficiaries of 3 solar mini-grid systems and iii) Capacity strengthening activities designed and delivered for private sector/RESCOs on designing, operating and maintaining mini-grids. The **third Output,** addressing Developer Risk, will implement 3 solar mini-grids and will develop accompanying green procurement and safeguards standards as well as a knowledge platform. Activities are i) Investment in 3 greenfield solar mini-grids ii) Set up of a knowledge platform, including developing a pipeline for future mini-grid development iii) Green procurement policy for mini-grids developed and mainstreamed and iv) Social and environmental safeguards policy for mini-grids developed and mainstreamed.

The components and activities are listed and discussed in detail in the Funding Proposal Section B.3.

4.3 Project Map and description of 3 solar mini-grid sites and 5 sites for mini-grid investment design reports

The project is designed to be Pan-Afghan, with an approach that overcomes the limitations of isolated and one-off efforts thus far. Target communities have been selected after a Pan-Afghan survey of 56 sites across 32 of the country's 34 provinces based upon which 3 sites have been selected for implementation of a solar mini-grid and another 5 sites were selected for development of Investment Design Reports. These 8 sites are spread of 8 provinces, see the map in figure 5. Site selection was based on analysis of demand and supply patterns, potential loads, ability to pay for energy services, the national grid extension plan from DABS[38] and a security assessment on the basis of UN Security Map[39]. The selected 3 sites for implementation of solar minigrids and 5 sites for developing mini-grid investment design reports will provide an optimum contribution to the intended paradigm shift of the project as they will be able to give sufficient substance to provide an evidence base (with implementation of 3 solar minigrids) as well as lead to a project pipeline for future implementation (with 5 investment design reports available, ready to be implemented). Moreover, the sites were selected on the basis of their potential for productive use and willingness to pay, thereby favouring successful deployment of RESCO services. Feasibility studies conducted for all sites described the demographic and socio-cultural aspects as well as energy baseline scenarios of these communities. Accordingly, the population of the3 solar minigrid sites is estimated to be 49,000 (around 7,800 households), while the 5 sites for development of investment design reports represent a population of 63,700 (around 11,900 households). Of the total, 47% is female population. All selected sites have good presence of enterprises (tailoring shops, vegetable oil extraction units) and agricultural applications. Each site has a primary health centre, school and mosques. Most sites have police stations present at their locations. The project will benefit all of these enterprises and institutions. Figure 5 details the selected locations.

[38] Da Afghanistan Breshna Sherkat (DABS) is the national power utility in Afghanistan
[39] A detailed description of the site selection process is presented in Chapter 7

Figure 5 Proposed 3 solar minigrids for implementation and Investment Design Reports for 5 mini-grids RE project province

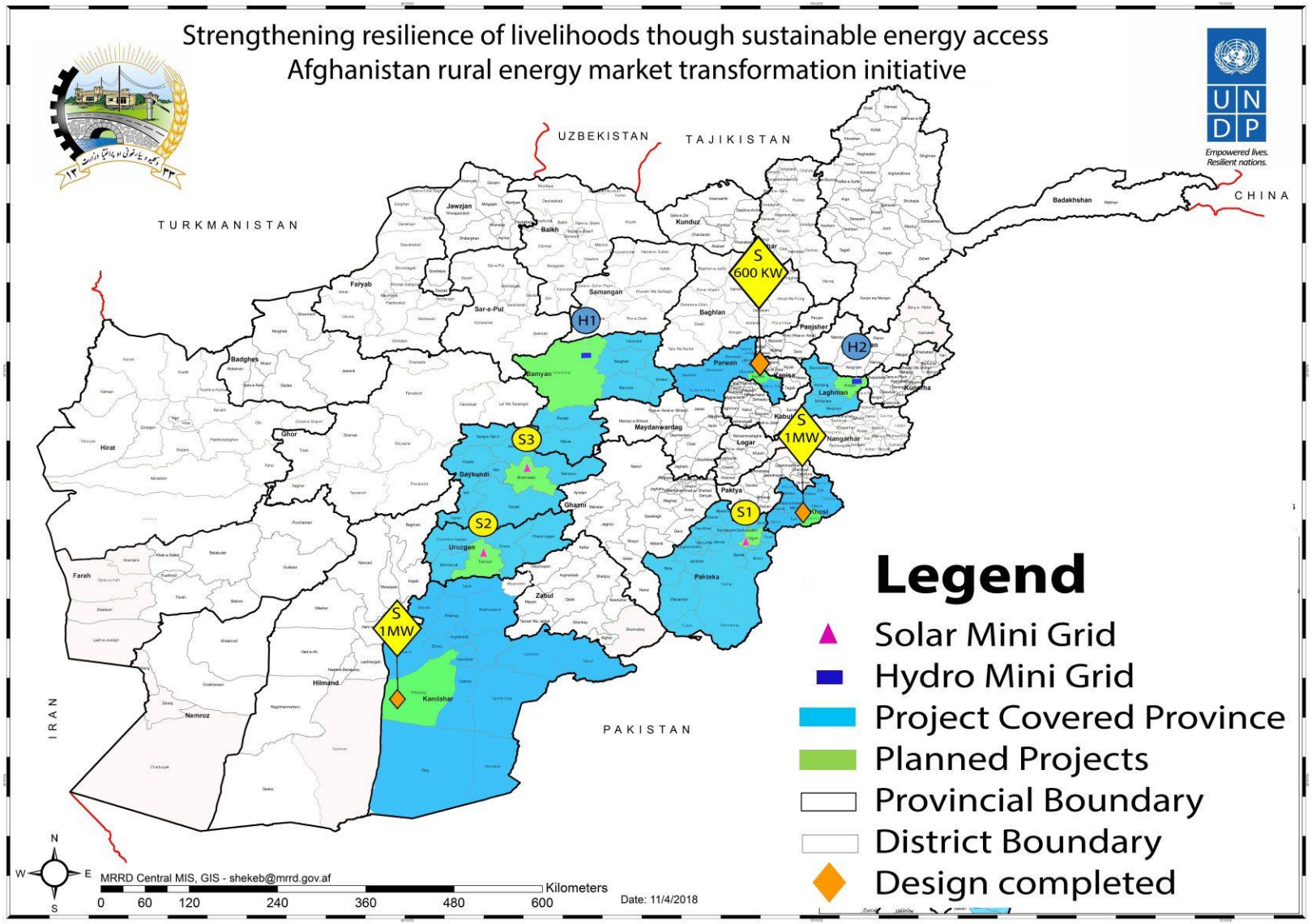


Table 7 Selected Locations for implementation of 3 greenfield solar mini-grids and main characteristics of RE mini-grids and areas served with electricity

Province	Solar Mini Grid	Population	Households (HH)	Institutions (Numbers)			Enterprises (Numbers)			Number of Existing Water Pumps	Plant capacity (kW)	Annual Energy Generation (kWh)
				Schools	Health centers	Public Centers	Tailory	Oil Extraction	Other (telephone towers & indicate)			
Kandahar	1	14,500	2,081	3	1	94	86	1	3	300	1000	1,752,000
Khost	1	22,500	3,725	7	1	122	10	-	5	590	1000	1,752,000
Parwan	1	12,000	2,000	2	1	14	16	-	-	6	600	1,051,200
Total	**3**	**49,000**	**7806**	**12**	**3**	**230**	**112**	**1**	**8**	**896**	**2600**	**4,555,200**

Table 8 Selected Locations for development of 5 RE mini-grids Investment Design Report and main characteristics of RE mini-grids and areas served with electricity

Running number	Province	Solar or Hydro Mini Grid	Latitude/Longitude of electricity generating facility (Lat./Long)	House Holds	Population	Schools	Health centers	Mosques	Public Centers	Retail shops	Technical potential capacity (kW_p) according to Pre-Feasibility Studies	Annual energy generation (kWh)
H1	Bamian	Hydro	34.980203 66.579163	1,600	10,050	2	1	12	0	67	400	1,401,600
H2	Laghman	Hydro	34.790762 70.102027	2,700	15,700	4	1	10	3	79	900	3,153,600
S1	Paktika	Solar	33.22199 68.77170	2,272	9,890	4	2	35	4	148	750	1,314,000
S2	Urozgan	Solar	32.656752 65.912076	3,800	23,300	3	0	29	1	63	1,000	1,752,000
S3	Daikundi	Solar	33.7844 66.71814	1,530	4,780	6	8	2	0	77	750	1,314,000
				11,902	**63,720**	**19**	**12**	**88**	**8**	**434**	Hydro: 1300 kW Solar: 2500 kW **3800 kW**	8,935,200

5 Project alternatives and baseline survey and assessment of target communities for the project

5.1 Do nothing alternative

Without this project people, social facilities and businesses in the targeted rural areas will not have access to electricity from renewable sources and no clean cooking-cum-heating devices would be made available to them.

In the rural areas, selected for the development of the RE mini-grids for any foreseeable future connection to the central electricity grid is not likely because of too large distances to the nearest grid, low ratio of potential customers to costs of central grid extension and generally insufficient capacity of the national grid. In the absence of RE mini-grids or central grid local people, social facilities and businesses would not have access to electricity, install self-made unreliable devices of low capacity or rely on diesel generators for generating electricity leading to high GHG emissions. Lack of reliable electricity supply negatively affects social and economic development in the rural areas of Afghanistan.

5.2 Alternative Locations

Target communities have been selected after a Pan-Afghan survey of 56 sites across 32 of the country's 34 provinces. The proposed activities could be undertaken in a number of different locations. However, the proposed locations, particularly RE mini-grid locations have been identified in the frame of the Pre-feasibility Study by the GoIRA, especially by MRRD, as those sites that provide the greatest economic, environmental, and social benefit and replication potential. The process of site selection is presented in the Feasibility Study, section 5.3.

When considering alternative sites during the development of this project, the Pre-feasibility Studies and the Feasibility Study also considered the likelihood of connection to the central grid, potential of larger interventions by the Ministry of Energy and Water (MEW) and the potential for the specifically proposed RE mini-grid technologies.

Furthermore, the selection of sites is based on consultations with sub-national government bodies, Community Development Councils (CDCs) and community representatives. The Community Development Councils (CDCs) were first established under the National Solidarity Programme (NSP). They are tasked with planning, negotiating, and managing development investments. The Councils are trained in financial management and bookkeeping, and in basic principles of transparency, participation, and accountability. Under the Citizens Charter National Priority Programme the existing Shuras, such as health, education, and agriculture committees are to be integrated as subcommittees to the CDCs. They will carry out technical functions and coordinate with line ministries, while providing CDCs with their full financial and planning information, allowing rural and urban communities to manage and implement a single and transparent budget and development plan.

The project held six consultation workshops in the regions during October 2015 till April 2016. In these meetings participated members of the District Development Assemblies, locally active NGOs, of the regional technical teams of the Ministry of Energy and Water (MoEW), Ministry of Agriculture, Irrigation and Livestock (MAIL) and Ministry of Rehabilitation and Rural Development (MRRD) as well as of the Afghanistan Renewable Energy Union (AREU). During these meetings the objectives of the project and the approaches to achieve these objectives were discussed – electricity from renewable sources and clean cooking and heating options, also reducing indoor air pollution.

During three Technical Working Group meetings in the premises of the MRRD the technical scope and geographic focus (1st meeting), site selection and feasibility study preparation (2nd meeting) and proposed outputs and activities were discussed and revised by participants from the MRRD; MAIL, National Environmental Protection Agency (NEPA),

MoEW, Inter-Ministerial Committee on Energy, UNDP, international organizations and representatives of civil society and private sector.

Alternative locations would be possible and indicate the replication potential of the applied approach, but at any alternative location the ratio of environmental and social risks and impact and of benefits would be similar to the situation in the selected areas.

5.3 Site Selection Process

As mentioned in the previous chapter, the project has identified 3 sites for solar mini-grid development (see Chapter 6) and 5 sites for developing investment design reports. The sites consist of main and other small villages in a cluster, where the proposed RE projects will be implemented. These 8 sites are spread over 8 provinces.

The below Figure 6 illustrates the processes involved in site selection and development of Investment Design Reports:

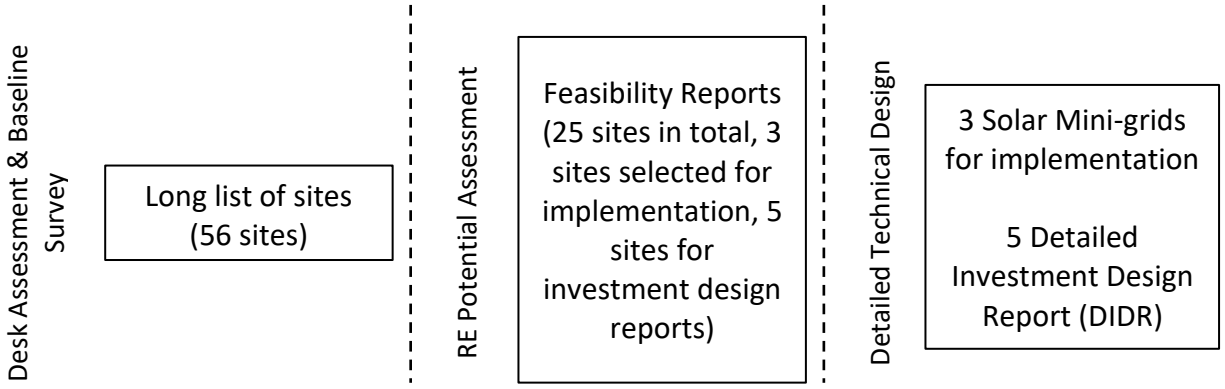


Figure 6 Project development phases

The stages of project development (Figure 6) have been described below:

Stage 1: At this stage, a Pan-Afghan desk assessment was conducted to prepare a long list of sites from among all the possible options, based on experience of previous energy access projects such as National Area Based Development Programme (NABDP) and National Solidarity Programme (NSP). The desk assessment identified 56 sites spread over 32 Provinces (out of the total 34 provinces in Afghanistan), which could be considered for implementation of RE projects.

Subsequently baseline survey was conducted at all 56 sites and it focused on identifying energy consumption patterns, energy supply options, economic and public service opportunities, potential loads and ability to pay for the energy services, possibilities of operational model and other institutional arrangements, including a macro level risk analysis of possible RE interventions. Details regarding number of households, public institutions (schools, hospitals/ health centres/ mosques/ police stations/ government offices), shops and small-medium enterprises were collected and data was segregated accordingly.

Stage 2: This stage mapped the provinces, and short-listed districts in each province and screened them based on security assessment on the basis of UN Security Map and categorized as 'high' and 'low'. Accordingly, sites with 'high' security risk profile were not considered for further assessment. A region-wise assessment and mapping of vulnerability to climate change was subsequently used to profile districts with high vulnerabilities and categorized according to potential impacts of climate change on susceptible sectors.

The national grid extension plan from DABS was studied next to identify provinces having 'at least or below' a 35 kV sub-station that would indicate the availability of grid distribution network in the province for domestic and other uses. Provinces having 35 kV sub-station and above were not considered for further evaluation. Though the presence of grid and 35 kV sub-station does not imply the access to electricity by rural population, considering that vast regions of Afghanistan are unserved by the national grid, it was felt prudent to consider only those provinces which do not have even a 35 kV sub-station.

RE potential of sites were assessed using the MEW data and sites were characterized according to the potential for RE resources namely solar and hydro. Following this, the technical potential for each site was determined and a daily load curve was generated for the site. In every hydro site the head was measured using Total Station and water flow was measured using simple methods.

Subsequently, a Pre-Feasibility Report was developed for the 25 target sites. It contained details of the site including connectivity, socio-economic profile of villages to be energized and a summary of economic activities (including micro-enterprises both existing and proposed). These details provide the basis for estimation of energy demand, as well as determination of the most feasible option for energy supply. Accordingly, 14 sites were selected for hydro based and 11 sites for solar based mini-grids. Preference was given to mini-hydro over solar on account of the lower overall costs for MHP as compared to that of solar. The overarching approach was to – i) identify sites in a cluster, which would facilitate the implementation of a larger-scale project with bigger impact, ii) design interventions that maximize benefits for women and children, and iii) concentrate the number of RE projects to maximize the collective impact on all susceptible sectors. Out of these 25 sites, 5 sites were included in the ASERD project for development of investment design reports, 1 mini-grid out of these 5 is implemented. and 4 sites were pulled out after further analysis of hydropower resources. Out of the remaining 4 sites with investment design reports from the ASERD project, 3 solar mini-grids were selected for implementation in this project (see Chapter 6). Furthermore, 5 minigrids out of the original 25 pre-feasibility studies are selected for development of investment design reports in this project.

Stage 3: For the 3 selected sites for solar minigrid implementation in Khost, Parwan and Kandahar, Detailed Investment Design Reports (DIDR) are available and provided in Annex II-A, II-B and II-C (see also Chapter 6). These DIDRs formed the basis for detailed cost assessments and will be used for procurement in order to construct the mini-grids.

For the 5 selected sites for development of Investment Design Reports, the final stage is the preparation of the Detailed Investment Design Report, (DIDR) containing the detailed Technical Designs. At the DIDR stage, further examinations are conducted to develop the detailed technical design of the project (comprising power generation and distribution architecture). A system design and optimization exercise will be needed using HOMER[40] software to estimate size of the mini-grid. The validation of RE potential at each site will be finalized with the technical design of mini-grids.

This stage builds further on the Feasibility studies, and has three distinct, although overlapping, outputs:

- Micro-siting of the project, development of plant and equipment design parameters, power evacuation / distribution details and others, which are essential for the subsequent stages of construction of plant;
- Detailed analysis of loads, both existing and planned (ramp-up), is carried out at this stage; and
- Enterprise, willingness to pay (WTP) and gender surveys at the community level and in partnership with local CDC members. Willingness to pay provided basis for tariff determination and revenue collection. An assessment of

[40] Hybrid Optimisation Model for Electric Renewables- a software by NREL, USA

gender dynamics in the sites, and how the project might affect them, is also useful in determining social contribution of the project

For solar mini-grids, to confirm the renewable energy potential at the site, the global and diffuse solar irradiation data from Meteonorm 7.1 and 3TIER data sources for geographical location (latitude, longitude) of the sites are used. The variability of the solar radiations leads to the uncertainty in the electricity generation expected at a given site. Therefore, the results obtained from both data sources are compared to provide the most reliable figure of electricity generation.

For MHP mini-grids, where the site specific discharge data was available[41], discharge data was validated through spot measurements and a detailed discussion with the villagers about the river flow variations as observed by them. Based on this, a Flow Duration Curve (FDC) is developed which decides the design flow. When site specific discharge data is not available, discharge data of nearby rivers with similar characteristics is referred to and data for the site is generated using Catchment Area Ratio (CAR) Method and Regional Specific Discharge Method. Then the validation of data is done following the similar process.

5.4 Sites Selected

This project is implementing 3 solar minigrids in Khost, Parwan and Kandahar, for which Detailed Investment Design Reports (DIDR) are available and provided in Annex II-A, II-B and II-C (see also Chapter 6).
The project is developing Detailed Investment Design Reports for mini-grids in 5 sites, applying government green procurement and safeguards principles, to come to facilitate government procurement or possible future tendering processes. The total combined population of these 5 sites is estimated to be 63,720 (around 11,902 households). Of the total, 47% is female population. See Table 8 for detailed characteristics of each of the 5 sites. All selected sites have good presence of enterprises (tailoring shops, oil extraction units) and agricultural pumps. Each site has a primary health centre, school and mosques. Most sites have police stations present at their locations. The project will benefit all these enterprises and institutions.

[41] Streamflow Characteristics at Streamgages in Northern Afghanistan and Selected Locations, USGS

6 Solar mini-grid implementation in Khost, Kandahar and Parwan

6.1 Solar Resource in Afghanistan

Afghanistan is considered to be a "sunbelt" country[42]. The annual average Global Horizontal Irradiance (GHI) in Afghanistan is 1,935 kWh m2/day and the national average seasonal maximum and minimum are 7.84 and 2.38 kWh/m2/day, respectively[43]. In some provinces in the west and south, GHI summer peaks reach about 9.0 kWh/m2/day. Preliminary estimates by the U.S. National Renewable Energy Laboratory (NREL) suggest roughly 220,000 MW of solar potential in the country[44] [45], using Multicriteria Decision Analysis (MCDA) and Geographical Information System (GIS), calculated the total annual generation potential at 146,982 GWh, including 140,982 GWh from photovoltaic (PV) and 6,000 GWh from concentrating solar power (CSP) technologies. Figure 7 shows installation capacity values.

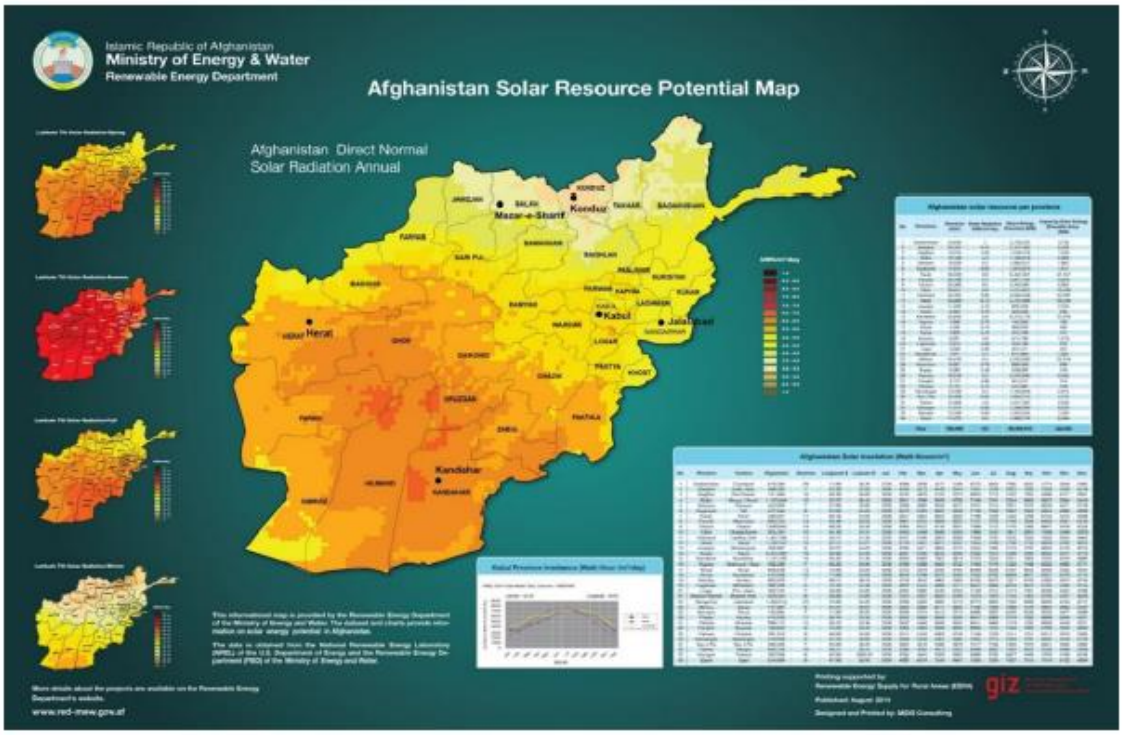


Figure 7 Afghanistan Solar Resource Map

This shows that Afghanistan has excellent climatic conditions for the development of PV. The country has high irradiation, ranging from 4.5 - 7 kWh/m²/day and approx. 300 days of sun annually. The provinces with the highest potential and with a solar radiation of > 6 kWh/ m²/day are Badghis, Bamian, Daikondi, Farah, Ghazni, Ghor, Herat, Hilmand, Kandahar, Nimruz, Paktika, Sar-I Pol, Uruzgan, Wardak and Zabul.

[42] Burns, R. K. (2011). Afghanistan: solar assets, electricity production, and rural energy factors. Renewable and Sustainable Energy Reviews, 15(4), 2144–2148.
[43] Ershad, A. M. (2016). Institutional and policy assessment of renewable energy sector in Afghanistan. Kabul, Afghanistan: Kabul University.
[44] Asian Development Bank. 2014. Technical Assistance Report: Islamic Republic of Afghanistan: Renewable Energy Development, Project Number 47266-001. Manila, Philippines: Asian Development Bank
[45] Anwarzai, M. A., & Nagasaka, K. (2016). Utility-scale implementable potential of wind and solar energies for Afghanistan using GIS multi-criteria decision analysis.

6.2 Solar mini-grid general technical design

Solar mini-grids have their own generation source (solar PV) and a local distribution grid. These are an ideal alternative to grid electricity in areas (such as remote villages) that do not have grid connectivity and where loads are concentrated with a small geographical area. Mini-grids provide reliable electricity, as any power cuts or interruptions to electricity supply can be quickly identified and corrected. Additionally, having the site of power generation closer to the load also reduces T&D losses. As compared to solar home systems which are more popular worldwide, mini-grids have the ability to service a variety of loads consisting of domestic, commercial and public, both for basic electricity requirements such as lighting, as well as for productive applications such as motors, machines, refrigerators etc.

Main components of solar mini-grid are a solar PV power generating plant, a battery bank to store the electricity, power conditioning unit (PCU) consisting of junction boxes, charge controllers, inverters, distribution boards and necessary wiring/cabling, etc., all located within an appropriately constructed building, and a power distribution network (PDN) to carry power to individual houses and other entities.

In most cases solar mini-grids are either hybridized with other RE sources (i.e. wind) or with diesel and are backed up with batteries to increase the reliability and supply of electricity, particularly in case where electricity is required for after sun-shine hours. Typical sizes of mini-grids are from 10 kilowatts (kW) to 1 megawatt (MW). Figure 8 shows a typical solar system.

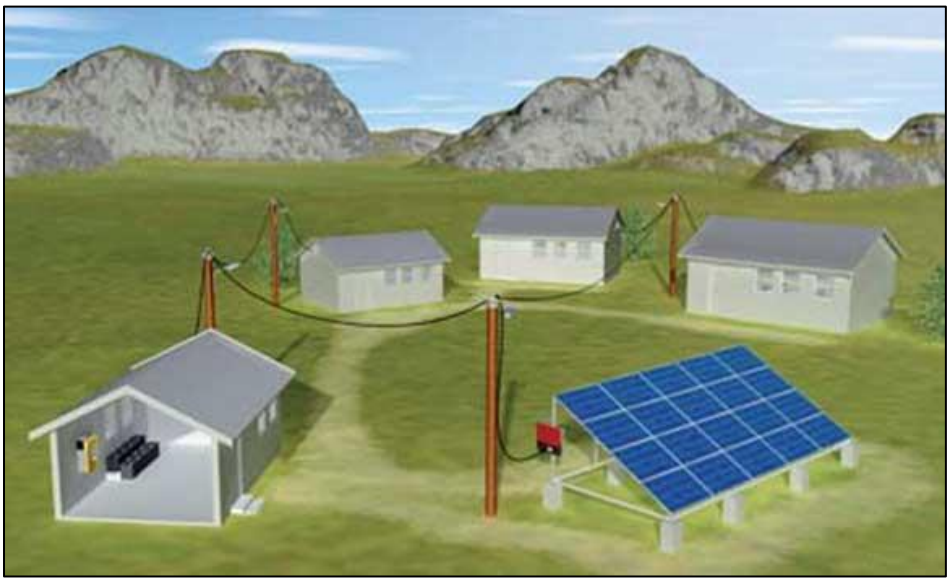


Figure 8 Abstract picture of a typical solar system

In general, a solar mini-grid will basically consist of:

1. the photovoltaic panels, the total size of their modules is determined by the capacity and the insolation intensity, with about 7-10 m^2/kW_p (Note: DC to AC conversion causes losses of about 20% of capacity);
2. support structures, which place the panels in the optimum ankle towards the sunlight; and
3. solar charge controllers, backup batteries, DC/AC converters and substation.

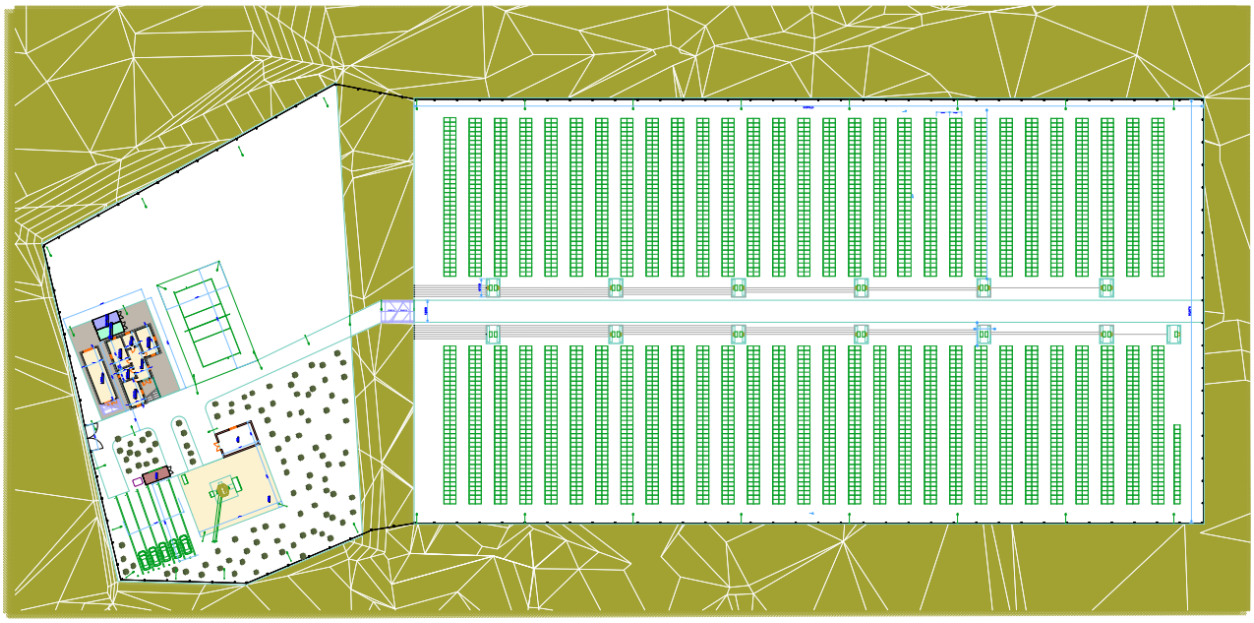


Figure 9 Overview of solar system with backup batteries (Source: Detailed Project Report: Solar Mini-Grid in Khost; Part 1 – Power Plant and Remote Monitoring Design, January 18, 2018)

The area of the PV system will be fenced with chain-link fence to avoid unauthorized persons and livestock from entering the site and potentially causing damage or experiencing accidents. The totally fenced area depends on the number and size of modules and their placement. A 1,000 kW_p system will need 7,000-10,000 m² solar panel size; the panels are on supporting structures and will require a total size of the fenced area of about twice the panel size, i.e. about 1.5 to 2 ha/MW_p. The fenced area can be used for haymaking if the vegetation cover is suitable.

The PV systems will be guarded and served 24/7. For the service of the PV system, including control of the electrical systems and regular cleaning of panels from dust, a single-story service building of up to 50 m² has to be erected at each site, which contains at least one technical room, one or more rooms for service personnel and guards, facilities for cooking and eating and a simple outhouse (dry toilette).

The proposed design for Khost[46] includes some auxiliary elements (in the left part of fig. 2): parking lot (252 m²), generator room (13 m²), substation (300 m²), well house (50 m²), warehouse (47 m²), service building (110 m²) with hall, control room, bath room, personnel room, kitchen and equipment room, two 40 ft-containers (each 13-4 m²) for bidirectional inverter system and battery storage and a volleyball field (360 m²). The system includes 4,050 polycrystalline PV modules of 250 W designed in 225 strings of 18 modules connected in series with an intercepting surface of 7,249.5 m² (tilt angle 34°), inter-row spacing between modules of 2.67 m, and spacing of 4.33 m between module centres. The total project site of the PV system with all auxiliary elements is about 12,000 m².

[46] Detailed Project Report: Solar Mini-Grid in Khost; Part 1 – Power Plant and Remote Monitoring Design, January 18, 2018

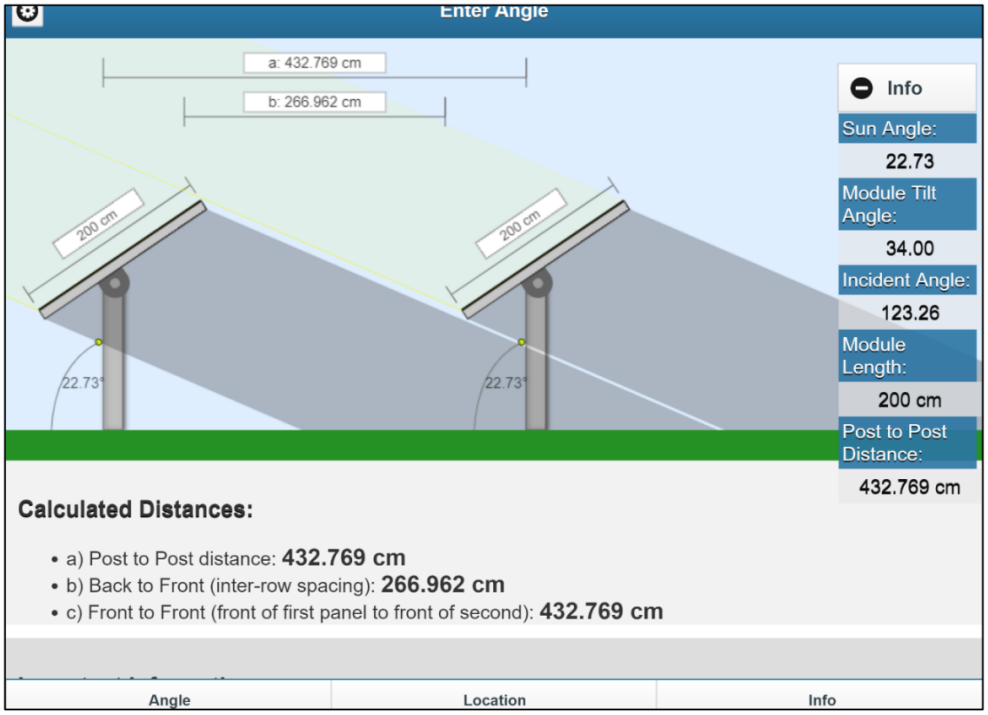


Figure 10 Solar modules and inter-row spacing (Source: Detailed Project Report: Solar Mini-Grid in Khost; Part 1 – Power Plant and Remote Monitoring Design, January 18, 2018)

The proposed design for Khost suggests a hybrid system configuration of 1 MW solar PV, 330 kW diesel generator and 4,032 kWh battery backup (total capacity of battery storage is 5,040 kWh, but maximum 80% depth of discharge).

Batteries should best be kept at stable ambient temperature, avoiding heat or freezing. The draft design for Khost suggests storing the 6,300 pieces of 2V/400Ah batteries in a 40 ft. container with cooling and ventilation.

6.3 Three solar minigrids for implementation in Khost, Kandahar and Parwan provinces

6.3.1 Solar minigrid 1000 kW in Khost province

The project site for a solar power minigrid in Khost has been identified in Mangal Borikhel village of Gurbuz district, 1.8 km (0.4 km asphalt road plus 1.4 km dirt road) away from the Khost district center. The site is easily accessible by vehicle and trucks so there is no barrier in transporting equipment and material to this site. The geographical coordinates of the site are 33.277^{o}N, 69.931^{o}E and elevation is 1,206 m above MSL. Available land area at the project site is more than 15,000 m2. The location is on private land currently being used for agricultural purposes where a land area of 12,000 m2 has been granted for the project and the agreement has been signed in presence of the MRRD representative and the district governor.

A survey has identified twenty-eight (28) villages based on the list provided by the official representative of MRRD to the survey team. The load centers of the villages which will be served by this project have been identified during the survey while the area has shown presence of 5 government buildings, 2 police stations, 7 schools, 3 health clinics, 82 mosques, 284 commercial shops and 8 enterprises. The project site falls in secure area, due to the presence of Afghan government official forces and Afghan local police. The local people also help to maintain the security of the area. Police check points are dispersed along the main road.

The average annual solar resource at the project site in Gurbuz is very good with an annual global irradiation of about 1,950 kWh/m2/year according to 3TIER data and 1,943 kWh/m2/year according to Meteonorm data. There is a suitable environment with minimum dust and no proximate shading to the solar power plant in the project site.

The hybrid system consists of solar PV plant having nominal power of 1,000 kW supported by a diesel generator unit of 330 kW operational capacity and 5,040 kWh of battery backup system. All three sources will be controlled by a central control and monitoring system consisting of EMS and BMS. The mini-grid has been designed using IEC International standards. The mini-grid will have a 20 kV medium and a 400 Volt low voltage distribution lines connecting the 25 beneficiaries communities to the powerplant. The powerplant will have a computer interface control system and the overall system can also be monitored remotely. Pre-paid meters will be used for electricity distribution.

The project will provide electricity to 28 villages and all households, public institutions and enterprises inside these villages. During operation, the system will supply power to the load and charge the batteries if there are excess energy, when there is sufficient solar energy available. The priority is given to supply the loads at all times. When sufficient solar energy is not available, the system will supply the loads from the battery backup until minimum state of charge is reached. After this point, diesel generator will start up and supply the loads and charge the batteries if there are excess energy. The system monitors all parameters and can be set to operate automatically or manually.

The ability of tariff revenues to sustain operation and maintenance (O&M) expenses at the plant level is the key to long term and effective operations of the project. As such, for the proposed project, tariff revenues have been determined by a combination of top-down and bottom-up considerations. The former involves achieving sustainability by structuring tariff levels to make the project operationally viable. The latter is determined by an estimate of the willingness to pay (WTP) for energy services at the community level.

The “pay-as-you-go” (PAYG) model is a techno-financial construct, which involves a process of making small, convenient payments by the user as one ‘goes on’ consuming a product or service. For the solar mini-grid project in Gurbuz district of Khost, the PAYG model has been recommended to be a hybrid design, which requires a mix of smartphone and basic mobile phone users. The smart meter, metering device for the consumers, can be enabled with Radio Frequency (RF) of GSM capabilities which can unlock the connection once the payment confirmation reaches the server as well as lock the connection in case of non-payment.

The objective of the monitoring and evaluation (M&E) plan for solar mini-grid in Khost is two folds – first to monitor the system (power plant and distribution network) performance and second to monitor the social impact generated by the project. For the Khost minigrid, a monitoring framework has been developed to provide a guide on monitoring the system performance and the socio-economic impact generated by the project. Monitoring of system performance focuses on the management and supervision of technical parameters, seeking to improve efficiency and overall effectiveness of solar mini-grid. As part of the monitoring plan, meteorological data, energy generated and energy consumed, performance of power plant and the transmission & distribution network performance of solar mini-grid will be monitored continuously with the help of identified indicators. Social indicators will be monitored as a part of the M&E plan for assessing the overall impact of the project. Indicators of social impact are both quantitative and qualitative.

Socio-economic survey indicates that the beneficiaries are very supportive towards the project. Beneficiaries understand that the electricity tariff will be applied for the use of electricity. They have willingness and ability to pay. The mini-grid will be constructed using grant money and support from the users in terms of local material and resources. Electricity tariff will be set to cover the operation, maintenance and fees and depreciation of the mini-

grid. Environmental studies have been conducted and it indicates that the mini-grid do not cause any environmental damages that cannot be mitigated

The Ministry of Rural Rehabilitation and Development (MRRD) will have the full ownership of the project after completion of construction. MRRD will select a Rural (Renewable) Energy Service Company (RESCO) for the operation, maintenance and tariff collection of the mini-grid in a Public-Private Partnership (PPP) model.

The Detailed Project Report of the 1000 kW solar minigrid in Khost Province, explaining load identification, system sizing and design, battery storage system design, civil designs, tariff collection and operation and maintenance plan is provided in Annex II-A.

6.3.2 Solar minigrid 600 kW in Parwan province

Parwan province lies to the north of Kabul city and can be reached through the Kabul-Mazar highway. Its capital city, Charikar, is a bustling city, fairly peaceful and economically active. The cluster of six villages around Qalandar Khil is located about 7 km from the Bagram district center is located along the asphalted Parwan-Kapisa road. The cluster consists of villages of Qalandar Khil, Beg Muhammad Khil, Jafar Khil, Ghulam Shah, Turkman and Qala e Beland.

The population is mostly engaged in agriculture and horticulture but some commercial activities such as tailoring, flour milling, bicycle and motorcycle repair, shop keeping and other are also found. The cluster of villages has about 91 shops, one hospital (10 bed), three schools, three police posts and 44 mosques. About 80% of the households have a single solar panel plus a battery backup to meet their basic need for lighting and phone charging. The cluster of villages is not connected to the grid power, even though a 20 KV power line passes about 3,500 meters from the site of the planned solar plant in Qalandar Khil. It is not expected that the cluster of villages will be connected to the grid power in the foreseeable future.

The households in the target area are classified under tier 0 and tier 1 of the World Bank's Multi-Tier Framework. About 20% of households are classified under tier 0 and have no access to energy and are forced to solely depend on fossil fuels such as firewood, Kerosene, propane gas, etc. the like to meet their energy needs. About 80% of the households are classified under tier 1 and have access to a solar panel (less than 100 Watts) and a battery unit, which provides lighting for about four hours during the night. The energy demand is, therefore, fairly significant and the desire to benefit from other aspects of electrified dwelling is highly desired.

The overall system size installed in Parwan is expected to be 600 kW solar, with 2.4 MWh of Battery Energy Storage System (BESS) and two diesel generators sets of 300 kW and 75 kW. The 300kW diesel generator will cater to peak demand, while the 75 kW diesel generator will ensure continuous power late at night when the BESS has reached its discharge limit and there is no solar radiation to provide power to the customers. The mini-grid has been designed using IEC International standards. The mini-grid will have a 20-kV medium and a 400 Volt low voltage distribution lines connecting the 25 beneficiaries' communities to the powerplant. The powerplant will have a computer interface control system and the overall system can also be monitored remotely. Pre-paid meters will be used for electricity distribution.

While the residential customers demanded about 3.1 kW power on a 24-hour basis, the project is able to provide only 200 Watts per household from 5 pm until 9 am. All commercial customers, with the exception of irrigation pumps and flour mills, who receive no solar power from the utility, receive power as per their need but from 9 am to 5 pm only. Institutional customers receive power as needed on a 24-hour basis.

The solar power plant produces 400 Volt power, which is stepped up with a 500 kW transformer to 20kV, which is then transmitted via overhead lines to the cluster of six villages.

Altogether 8 transformers will then step down the power and provide electricity to the villagers and commercial and institutional customer through about 280 meter boxes, which equipped with 6 to 9 meters. Prepaid metering system with associated components are installed.

Socio-economic survey indicates that the beneficiaries are very supportive towards the project. Beneficiaries understand that the electricity tariff will be applied for the use of electricity. They have willingness and ability to pay. The mini-grid will be constructed using grant money and support from the users in terms of local material and resources. Electricity tariff will be set to cover the operation, maintenance and fees and depreciation of the mini-grid. Environmental studies have been conducted and it indicates that the mini-grid do not cause any environmental damages that cannot be mitigated

The Ministry of Rural Rehabilitation and Development (MRRD) will have the full ownership of the project after completion of construction. MRRD will select a Rural (Renewable) Energy Service Company (RESCO) for the operation, maintenance and tariff collection of the mini-grid in a Public-Private Partnership (PPP) model.

The Detailed Project Report of the 600 kW solar minigrid in Parwan Province, explaining load identification, system sizing and design, battery storage system design, civil designs, tariff collection and operation and maintenance plan is provided in Annex II-B.

6.3.3 Solar minigrid 1000 kW in Kandahar

Kandahar province lies about 500 km to the south-west of Kabul and is connected through the Kabul-Herat highway running through Maidan-Wardak, Ghazni and Zabul provinces. Kandahar City is the capital of the province. The project is located in Panjwayee district of Kandahar, which is located about 40 km to the west of Kandahar city. The project site is located at the district center of Panjwayee, which is a small township with neighborhoods and suburbs. The 25 villages/neighborhoods that are part of the project scope are in reality mostly neighborhoods of the city plus some suburban communities. The 25 target communities had previously been organized in 15 Shuras or community development councils. However, these Shuras had been canceled and replacement Shuras had not been established at the time of this assessment. As a result, the assessment team had to put together an ad-hoc team of village elders and insiders to collect the data needed to design this project.

Even though household data has been collected for the 25 communities, commercial and institutional data could not be separated based on villages/neighborhoods as nearly 95% of the commercial institutions are located within one cluster of the commercial district that stretches across multiple neighborhoods. Small mosques are located in almost every community and they have been listed as such.

The population is mostly engaged in agriculture and horticulture but significant commercial activities such as tailoring, flour milling, bicycle and motorcycle repair shops, machine shops, mechanical shops, cosmetic shops, grocery shops and other commercial activities also engage the population. Altogether 516 commercial entities are in operation and their numbers are growing. The target area has two hospitals, two schools, one main police station and 10 police posts, and one main mosque and 67 community mosques, in addition to a district office and a municipal building. About 96% of the households have a single solar panel plus a battery backup to meet their basic need for lighting and phone charging. The average size of a household is about twelve persons, even though some households have as many as 18 members, which signals that multiple households possibly reside within one Qala (housing compound). The target area is not connected to the grid power, even though a 20 KV power line passes about 4 kilometers north of the site of the planned solar power plant and a 110kV grid, which is part of the South Electric Power Systems (SEPS) is expected to pass within two kilometers of the site.

The households in the target area are classified under tier 0 and tier 1 of the World Bank's Multi-Tier Framework. About 5% of the households are classified under tier 0 and have no access to reliable energy and are forced to solely depend on fossil fuels such as firewood, kerosene, propane gas and the like to meet their energy needs. About 95% of the households are classified under tier 1 and have access to a solar panel (less than 100 Watts) and a battery unit, which provides lighting for about four hours during the night time. The energy demand is, therefore, fairly significant and the desire to benefit from other aspects of an electrified dwelling is highly desired.

The overall system size installed in Kandahar is expected to be 1,000 kW solar, with 3.5 MWh of Battery Energy Storage System (BESS) and two diesel generators sets of 450kW and 75kW. The mini-grid has been designed using IEC International standards. It will have a 20 kV medium and a 400 Volt low voltage distribution lines connecting the 25 beneficiaries communities to the powerplant. The powerplant will have a computer interface control system and the overall system can also be monitored remotely. Pre-paid meters will be used for electricity distribution

While the residential customers demanded about 1.1 kW power on a 24-hour basis, the project is able to provide only 195 Watts per household from 5 pm until 9 am. All commercial customers, with the exception of irrigation pumps, flour mills and other users with greater than 5kW consumption, who receive no solar power from the utility, receive power as per their need but from 9 am to 5 pm only. Institutional customers receive power as needed on a 24-hour basis.

The solar power plant produces 400 Volt power, which is stepped up with a 750kVA transformer to 20kV, which is then transmitted via overhead lines to the target communities. Altogether 8 transformers will then step down the power and provide electricity to the villagers as well as commercial and institutional customer through about 300 meter boxes, which equipped with 6 to 9 meters. Prepaid metering system with associated components are installed.

Socio-economic survey indicates that the beneficiaries are very supportive towards the project. Beneficiaries understand that the electricity tariff will be applied for the use of electricity. They have willingness and ability to pay. The mini-grid will be constructed using grant money and support from the users in terms of local material and resources. Electricity tariff will be set to cover the operation, maintenance and fees and depreciation of the mini-grid. Environmental studies have been conducted and it indicates that the mini-grid do not cause any environmental damages that cannot be mitigated

The Ministry of Rural Rehabilitation and Development (MRRD) will have the full ownership of the project after completion of construction. MRRD will select a Rural (Renewable) Energy Service Company (RESCO) for the operation, maintenance and tariff collection of the mini-grid in a Public-Private Partnership (PPP) model.

The Detailed Project Report of the 1000 kW solar minigrid in Kandahar Province, explaining load identification, system sizing and design, battery storage system design, civil designs, tariff collection and operation and maintenance plan is provided in Annex II-C.

7 Stakeholder Consultation and Stakeholder Engagement Plan

7.1 Stakeholder Consultation Process

A series of consultation sessions and meetings with the technical working groups with the relevant stakeholders took place during the project design. The attendees at the meeting were given a brief description as to the purpose of the consultations. The Green Climate Fund was also introduced with the highlight of climate change impacts in Afghanistan.

The following ministries/government authorities were represented at the sessions – Ministry of Rural Rehabilitation and Development (MRRD), Ministry of Energy and Water (MOEW), Ministry of Agriculture, Irrigation and livestock (MAIL), National Environmental Protection Agency (NEPA) relevant international agencies, NGOs, Private sector and Community Development Councils (CD) at the national level and sub-regional level of the country (North, South, East, West, Center, Northeast and Southeast). The following areas were highlighted as major areas of Afghanistan.

Agriculture

- The vulnerability of the agriculture sector in Afghanistan is due to increased temperatures and changes in rainfall/snowfall patterns and snow melt which is high. Increased soil evaporation, reduced river flow and less frequent rain during peak cultivation seasons are already affecting agricultural productivity and crop choice options
- The existing irrigation systems in Afghanistan are operating at a low efficiency level
- Community level awareness raising at all levels

Lack of Renewable Energy

- Enhance capacity of communities identified as amongst the most vulnerable in the world to the impacts of climate change,
- Reducing carbon emissions and steering the country of Afghanistan towards private sector- led growth
- Create food-energy-water nexus as important factor of climate change impacts in Afghanistan
- Presently up to 85% of primary energy use is from traditional biomass (such as wood and dung), which contributes to deforestation.
- Afghanistan is among the top 10 countries worst affected by indoor air pollution
- Poor availability of energy, especially for agriculture and enterprise development has considerably reduced rural livelihood options at the community level in Afghanistan
- Afghanistan has good domestic energy resources
- Third of the Afghan population has access to clean energy while in the rural areas most communities are not connected to the electricity grid
- The renewable energy industry in Afghanistan is in infancy

GCF Proposal

- Validation of data collected from sites
- The outputs and activities were proposed
- Technical Feasibility Report and draft Project Proposal reviewed
- Theory of Change of the proposed proposal reviewed and finalized

Summary at end of Discussions:

The proposed project is to be designed to empower the rural poor in fighting climate change impacts such as changing seasons, erratic precipitation and increased incidence of extreme events affecting lives, ecosystems and livelihoods in rural Afghanistan.

The emphasis during the consultations were that apart from building resilience against climate change impacts by enhanced livelihood and environmental security, the proposed project should also deliver direct benefits such as reduction in indoor air pollution. Clean cooking and heating options and will contribute to tangible reduction in the pre-mature deaths of women and children due to indoor air pollution.

List of the consultation workshops in different regions were as below:

Table 9 List of consultation workshops

No	Workshop Location	Team Leader	Date
1	Consultation Workshop in North Region	Ahmad Bahman	Feb 9, 2016
2	Consultation Workshop in South Region	Shafiq Sahel	Mar 27, 2016
3	Consultation Workshop in East Region	Shafiq Sahel	Apr 10, 2016
4	Consultation Workshop in West Region	Ahmad Shah	Oct 29, 2015
5	Consultation Workshop in Central South East Region	Qari Belal	Nov 12, 2015
6	Consultation Workshop in Southeast Region	Qari Belal	Jan 9, 2016

North

East Region

West Region

South and Central

Table 10 **List of the participants in consultation workshops:**
South Region

No	Name	Province	Position and organization
1	Haji M Omarjan	Kandahar	District Development Assembly (DDA) member
2	Haji Abdul Majid	Kandahar	District Development Assembly (DDA) member
3	Haji Juma Khan	Kandahar	District Development Assembly (DDA) Head
4	Haji Amanullah	Kandahar	District Development Assembly (DDA) Head
5	M Rasool	Kandahar	Deputy Director, MAIL
6	Haji Gulbidin	Kandahar	Director, MRRD
7	Madat Khan	Kandahar	Head of National Solidarity Programme
8	Ali Mohammad	Kandahar	Member of Afghanistan Renewable Energy Union
9	Dawood Shah	Kandahar	Member of Afghanistan Renewable Energy Union
10	Zarif Khan	Kandahar	Member of Afghanistan Renewable Energy Union
11	Rahmatullah	Kandahar	Member of Afghanistan Renewable Energy Union
12	Mirza Khan	Kandahar	MRRD regional technical team
13	Haji Fazel Ahmad	Kandahar	MRRD regional technical team
14	Mowlawi Khaleq Dad	Kandahar	MRRD regional technical team
15	Rahmatullah Agha	Kandahar	MRRD regional technical team
16	Haji M Nawab	Kandahar	MoEW regional technical team
17	Sharafuddin	Kandahar	MoEW regional technical team
18	Haji Ahmad Khan	Kandahar	MoEW regional technical team
19	Haji Nik Mohammad	Kandahar	MAIL regional technical team
20	Gul Dasta	Kandahar	MAIL regional technical team
21	Abdul Ghafar	Kandahar	MAIL regional technical team
22	Abdul Ghafor	Kandahar	NEPA regional technical team
23	Nazar Mohammad	Kandahar	NEPA regional technical team

East Region:
Ningarhar Province

No	Name	Province	Position and organization
1	Hj.M. Kareem	Nangarhar	Deputy chairperson District Development Assembly (DDA)
2	Ma.Akbar	Nangarhar	Chairperson, District Development Assembly (DDA)
3	Najeebulah	Nangahar	Deputy chairperson, District Development Assembly (DDA)
4	Esmatullah	Nangahar	Treasurer, District Development Assembly (DDA)
5	Darwesh	Nangahrhar	Chairperson, District Development Assembly (DDA)
6	Darya khan	Nangahrar	MoEW regional technical team
7	Zikrya khan	Nangrhar	MoEW regional technical team
8	Ashna	Nanghar	MAIL regional technical team
9	Noor Lal	Nangarhar	MAIL regional technical team
10	Gul .wali	Nanghara	NEPA regional technical team
11	Ab.Qader	Nangrhar	NEPA regional technical team
12	Hj.Redwanull ah	Nangrhar	MoEW regional technical team
13	Fazal mola	Nangrhar	MAIL regional technical team
14	Hj.Ab Jalal	Nangrhar	MRRD regional technical team
15	Momtaz	Nangrhar	MRRD regional technical team
16	Temor sha	Nangrhar	Afghanistan Renewable Energy Union (AREU)
17	Ala Nazar	Nangrhar	Afghanistan Renewable Energy Union (AREU)
18	Mer zaman	Nangrhar	Afghanistan Renewable Energy Union (AREU)
19	Bakhan	Nangrhar	Afghanistan Renewable Energy Union (AREU)
20	Yeshed khan	Nangrhar	AREA international NGO
21	M.Hashm	Nangrhar	AREA international NGO
22	M.Ghani	Nangrhar	GERES
23	Sonobar	Nangrhar	GERES

Kunar Province:

No	Name	Province	Position and Organization
1	Hizbullah	Kunar	Deputy chairperson, District Development Assembly (DDA)
2	Hj.Noorulalh	Kunar	Treasurer, District Development Assembly (DDA)
3	Adam khan	Kunar	Chairperson, District Development Assembly (DDA)
4	Khan zada	Kunar	MoEW regional technical team
5	Ismail	Kunar	MoEW regional technical team
6	Hj.Sharefullah	Kunar	MAIL regional technical team
7	Hj.khan zareen	Kunar	MAIL regional technical team
8	Hj.M. Alam	Kunar	NEPA regional technical team
9	Naiamatullah	Kunar	NEPA regional technical team
10	Rasool mohmmad	Kunar	MoEW regional technical team
11	Hj.Ab Rahman	Kunar	MAIL regional technical team
12	Sharefa	Kunar	MRRD regional technical team
13	Emal khan	Kunar	MRRD regional technical team
14	Bas golon	Kunar	Afghanistan Renewable Energy Union (AREU)
15	Najmodeen	Kunar	Afghanistan Renewable Energy Union (AREU)
22	Mo .Ahmad	Kunar	Chairperson
23	Akram khan	Kunar	Chairperson
24	Hj. Aslam	Kunar	Member of DDA
25	Hj.Sayed Jalal	Kunar	Member of DDA

Technical Working Group (TWG) Consultations

1st TWG

- The Ministry of Rural Rehabilitation and Development (MRRD) in collaboration with the Ministry of Agriculture, Irrigation and Livestock (MAIL), National Environmental and Protection Agency (NEPA), Ministry of Energy and Water (MoEW) with support from UNDP, is formulating a 5 years project on "Strengthening resilience of livelihoods through sustainable energy access- Afghanistan rural energy market transformation initiative" for submission to the Green Climate Fund (GCF).

- Accordingly, the 1st Technical Working Group (TWG) meeting was held, the main focus of this meeting was to narrow the scope and geographical focus.

- Mr. Abhijit Chaterjee the Technical Expert and Dr. Akanksha Chaury who will be supporting with data gathering and research for project formulation, were introduced.

- Three main stages were generally agreed upon, but there was consensus that the selected regions should implement an integrated approach that combines all three stages,

  Stage 1: A Pan-Afghan baseline survey was conducted covering 32 (out of the total 34 provinces in Afghanistan) provinces. The survey covered 56 sites and focused on identifying energy consumption patterns, energy supply options, economic and public service opportunities, potential loads and ability to pay for the energy services, possibilities of operational model and other institutional arrangements, including a macro level risk analysis of possible DRE interventions. Details regarding number of households, public institutions (schools, hospitals/ health centres/ mosques/ police stations/ government offices), shops and small-medium enterprises were collected and data was segregated accordingly.

  Stage 2: The provinces were mapped for their security assessment on the basis of UN Security Map and categorized as "high' and 'low'. Provinces with 'high' security risk profile were not considered for further assessment. Subsequently, the region-wise assessment and mapping of vulnerability to climate change from NA, was used to profile provinces with high vulnerabilities and categorized according to potential impacts of climate change on susceptible sectors.

  Stage 3: This stage focused at the sites and was completed below sub-stages.

  Sub-stage A- sites with high population density, large number of shops and enterprises, and public institutions were evaluated for their current energy consumption patterns and willing to pay for modern energy services and were considered for DRE based mini-grids.

  Sub-stage B- in continuation to the above, the sites were selected either for SHP based or solar based mini-grids depending upon the RE technical potential. Preference was given to SHP over solar on account of the lower overall costs for SHP as compared to that of solar.

  Sub-stage C- hospitals/ health centre/ mosques and police stations at all selected sites were considered for providing with energy access, and households with improved cookstoves.

  In the final selection of sites, the overarching approach had been to – i) adopt for clusters, ii) maximize the benefits for women and children, and iii) concentrate the number of DRE projects to maximize the collective impact on all susceptible sectors.

The Provinces suggested for the integrated approach are listed in Table 11 below.

Table 11 Targeted provinces and beneficiaries

Province	District	Village (installation Site)	Total Population	Population Covered
Baghlan	Pul-e Hesar	Toop Khana	28,201	16,050
Balkh	Sholgara	Tajik Alitayn	116,438	43,125
Bamian	Yakowlang	Sookhtegi	62,162	12,000
	Center	Toop Chi	58,281	22,500

Daikundi	Meramoor	Jawoz, Charkh, Siadara, Wona, Sangerkesh, Shinya & Nalech	63,962	35,798
	Shahristan	Chaprasak, Ghaf, Zardnai, Ghochan	67,923	11,475
	kiti	Kesaw& Royan	34,202	29,010
Faryab	Balcheragh	Sar Awleya	53,282	20,528
	Gurziwan	Turk ha Dara-e-Shakh	77,404	16,613
Ghor	Feroz Koh	Nahoor Shoyeej	138,511	7,875
	Dawlat Yar	Samak	33,362	12,263
Herat	Pashton Zarghon	Takhche Bala	102,364	7,125
Kandahar	Panjwayee	Panjwayee	88,924	26,625
Khost	Gurbuz	Shaykhmir	36,486	33,750
Laghman	Alisheng	Qala Gul Mohammad	72,844	20,250
	Alingar	District center	98,764	18,750
Ningarhar	Dare Noo	Shimul	41,162	13,388
Paktika	Orgun	Qara Khell	56,402	17,040
Parwan	Bagram	Barik Ab	105,844	4,950
Parwan	Bagram	Turkman and Qalandar khel	105,844	13,500
Samangan	Royee Duab	Zard Khawal	46,542	12,900
Sar-e Pol	Balkhab	Dahana	51,362	12,150
Takhar	Dashte Qala	Dashte Qala	32,642	22,425
Urozgan	Tarinkoot center	Shahidano Kalacha	104,891	16,875
		Now Bahar	104,891	28,500
Grand Total			**1,782,690**	**475,463**

2nd TWG

The Ministry of Rural Rehabilitation and Development (MRRD) in collaboration with the Ministry of Agriculture, Irrigation and Livestock (MAIL), National Environmental and Protection Agency (NEPA), Ministry of Energy and Water (MoEW) with support from UNDP, is formulating a 6 years project on "Strengthening resilience of livelihoods through sustainable energy access- Afghanistan rural energy market transformation initiative" for submission to the Green Climate Fund (GCF).

Dr. Akanksha Chaury, the Technical Expert, who is responsible for drafting the Technical Feasibility Report, made a clearly structured presentation to explain the report he was currently working on.

The presentation focused on the following areas;

1. Feasibility report frames the problem statement and analyses barriers to the uptake of DRE systems in Afghanistan. Some of the key barriers point at high costs of installing and maintaining DRE systems, aggravated by the lack of funds and finances; limited experience in designing livelihood specific DRE programmes and viable delivery models such as mini-grids; policy gaps at mainstreaming of innovative approaches such as rural energy service company (RESCO); no inclusion of gender specific requirements in designing DRE systems etc. The transformational shift is articulated as '"*if access to rural energy services for productive and livelihood related applications are increased; policies and regulations cutting across rural energy, renewable energy, and environment are strengthened; innovative approaches for rural energy service delivery and business models are mainstreamed; and the capacities of selected institutions are*

enhanced, then transformation of rural Afghan societies moving to low-emission, more secure livelihood and climate resilient trajectories is successful'.

2. Feasibility develops a strategy and recommendations for facilitating the above 'change'. Accordingly, the strategy is built on three pillars:

   Enhance livelihood opportunities and agricultural productivity of rural communities by giving them access to clean and modern energy provided by decentralised renewable energy technologies

   Support the existing policy and regulatory framework cutting across climate change adaptation and mitigation, specifically dealing with environment, renewable energy, and rural development, to mainstream the above program for scaling up

3. This feasibility study has utilised the Feasibility studies conducted at 56 sites spread over 32 provinces (out of a total 34 provinces in Afghanistan), and has selected 25 sites in 17 provinces to be the target areas for this project. The selection process includes three stages and covers an assessment of baseline survey results, security situation, climate vulnerabilities, availability of grid, energy consumption and expenditure patterns, possibility of load creation and presence of public institutions such as schools, hospitals, mosques, police stations that would be benefitted with DRE systems. An optimisation software HOMER has been used to size and optimise the solar mini-grid at a representative site.

4. The Feasibility report justifies the GCF intervention by being a 'catalyst' to an uptake of DRE in Afghanistan through innovative approaches, capacity building and policy strengthening that are aligned to the INDC and RE Roadmap for Afghanistan. This would ensure the mainstreaming and scalability of DRE projects for livelihoods which would facilitate the development of climate resilient rural Afghanistan.

3rd TWG

The Ministry of Rural Rehabilitation and Development (MRRD) in collaboration with the Ministry of Agriculture, Irrigation and Livestock (MAIL), National Environmental and Protection Agency (NEPA), Ministry of Energy and Water (MoEW) with support from UNDP, is formulating a 6 years project on "Strengthening resilience of livelihoods through sustainable energy access- Afghanistan rural energy market transformation initiative" for submission to the Green Climate Fund (GCF).

Accordingly, the 3rd Technical Working Group meeting the Technical Expert, who is responsible for drafting the Technical Feasibility Report, listed out the draft outputs, activities and sub-activities for review of the participants;

The budget for major project interventions were up for discussion and certain amendments were made.

A comment was made at the involvement and engagement of the local community organizations will be the key in this aspect.

A concern was raised whether women led civil societies or agriculture cooperatives will be engaged in this process, it was reiterated that the registration of organizations will help in this regard and a fair balance of representatives will be used for service delivery

Sustainability of the project was highlighted as a key area of focus.

Table 12 List of Participants in TWG meetings

No	Name	Designation	Organization
1	Sultan Ali	Head of REED	MRRD
2	Naqeeb Karimi	Coordinator	GIZ-IDEA

3	Amy Jennings	Coordinator	BORDA
4	Ahmad Rasooly	Technical Specialist	ASERD
5	M. Belal	PA	ASERD
6	Haroon Rasheed	Advisor	MRRD/Deputy Minister
7	Akanksha Chaury	Technical Expert	UNDP
8	Abhijit Chatterjee	Climate Change Policy Specialist	UNDP
9	Haris Haidari	RE Coordinator	Inter-Ministerial Committee on Energy
10	Ahmad Murtaza Ershad	Lecturer	Kabul University
11	Nangyalay Zarmal	ASS.G.Manager	Afghanistan Renewable Energy Union
12	Rahimi	Climate change expert	MRRD
13	Laura Rio	Head of L&R Unit	UNDP
14	Nilofer Malik	Program Analyst	UNDP

Table 13 Summary of the TWG meetings

Meeting	**Venue**	**Objective**	**Participants**
1st Technical Working Group	Ministry of Rural Rehabilitation and Development (MRRD)	The main focus of this meeting was to narrow the scope and geographical focus	The Ministry of Rural Rehabilitation and Development (MRRD) in collaboration with the Ministry of Agriculture, Irrigation and Livestock (MAIL), National Environmental and Protection Agency (NEPA), Ministry of Energy and Water (MoEW),UNDP, civil society, private sector
2nd Technical Working Group	Ministry of Rural Rehabilitation and Development (MRRD)	The objective of this meeting was to view the progress of the Project Team in drafting the Technical Feasibility Report	
3rd Technical Working Group	Ministry of Rural Rehabilitation and Development	Proposed outputs and activities were revised	

7.2 Stakeholder Engagement Plan

Outputs	**Activity**	**Stakeholders**
		1) National Environment Protection Agency

Output 1- Energy Market Risk de-risked by policy, regulatory and institutional development for improved renewable energy (RE) services in rural areas **Implementing partner:** Ministry of Rural Rehabilitation and Development (MRRD) **Responsible Parties:** Ministry of Rural Rehabilitation and Development (MRRD)	Activity 1.1- Regulations for mini-grids and tariff mechanisms and structure developed	(NEPA) 2) Da Afghanistan Breshna Sherkat (DABS) 3) Ministry of Rural Rehabilitation Development (MRRD) 4) Private Sectors 5) Ministry of Energy and Water (MoEW) 6) Afghanistan Renewable Energy Union (AREU)
	Activity 1.2- Technical standards and guidelines developed for design and operation of mini-grids	1) Ministry of Energy and Water (MoEW) 2) Da Afghanistan Breshna Sherkat (DABS) 3) Ministry of Rural Rehabilitation Development (MRRD) 4) Private Sectors 5) Afghanistan Renewable Energy Union (AREU) 6) National Environment Protection Agency (NEPA)
	Activity 1.3- Policy on fostering institutional reform and coordination mechanism among responsible institutions for mini grid development developed	1) Ministry of Energy and Water (MoEW) 2) Da Afghanistan Breshna Sherkat (DABS) 3) Ministry of Finance 4) Private Sectors 5) Ministry of Energy and Water (MoEW) 6) Ministry of Rural Rehabilitation Development (MRRD)
	Activity 1.4- Framework for financial de-risking RE mini-grids designed	1) Ministry of Finance 2) Private Sectors 3) Afghanistan Renewable Energy Union (AREU) 4) Ministry of Energy and Water (MoEW) 5) Ministry of Rural Rehabilitation Development (MRRD)
Output 2: Capacity and engagement of the existing and potential mini-grid market actors and stakeholders strengthened on RE mini-grids **Implementing partner:** Ministry of Rural Rehabilitation and Development (MRRD) **Responsible Parties:** Ministry of Rural Rehabilitation and Development (MRRD)	Activity 2.1 Capacity strengthening activities designed and delivered for government entities on technical, managerial, administrative and financing aspects of RE mini-grids	1) National Environment Protection Agency (NEPA) 2) Da Afghanistan Breshna Sherkat (DABS) 3) Ministry of Energy and Water (MoEW) 4) Ministry of Agriculture, Irrigation and Livestock (MAIL)
	Activity 2.2- Community commitment and local business interest activities designed and delivered for beneficiaries of 16 rural RE mini-grid systems	1) Community Development Councils (CDC) 2) NGOs 3) Ministry of Rural Rehabilitation Development (MRRD) 4) National Environment Protection Agency (NEPA) 5) Da Afghanistan Breshna Sherkat (DABS) 6) Ministry of Energy and Water (MoEW)

	Activity 2.3- Capacity strengthening activities designed and delivered for private sector on designing, operating and maintaining mini-grids	1) Da Afghanistan Breshna Sherkat (DABS) 2) Private Sectors 3) Afghanistan Renewable Energy Union (AREU) 4) Ministry of Energy and Water (MoEW) 5) Research institutes 6) Ministry of Higher Education
		1)
Output 3: Construction of 3 greenfield solar mini-grids and set-up of an "upscaling platform" to facilitate additional mini-grid investments **Implementing partner:** Ministry of Rural Rehabilitation and Development (MRRD) **Responsible Parties:** Ministry of Rural Rehabilitation and Development (MRRD)	Activity 3.1 – Construction of 3 greenfield solar mini-grids	1) Ministry of Energy and Water (MoEW) 2) Da Afghanistan Breshna Sherkat (DABS) 3) Ministry of Rural Rehabilitation Development (MRRD) 4) Private Sectors 5) Afghanistan Renewable Energy Union (AREU) 6) Community Development Councils (CDC) 7) NGOs 8) Ministry of Agriculture, Irrigation and Livestock (MAIL)
	Activity 3.2 – Set up of knowledge platform	1) Ministry of Energy and Water (MoEW) 2) Da Afghanistan Breshna Sherkat (DABS) 3) Ministry of Rural Rehabilitation Development (MRRD) 4) Private Sectors 5) Afghanistan Renewable Energy Union (AREU) 6) Community Development Councils (CDC) 7) NGOs 8) Ministry of Agriculture, Irrigation and Livestock (MAIL)
	Activity 3.3 - Green procurement policy developed and mainstreamed	1) Ministry of Energy and Water (MoEW) 2) Da Afghanistan Breshna Sherkat (DABS) 3) Ministry of Rural Rehabilitation Development (MRRD) 4) Private Sectors 5) Afghanistan Renewable Energy Union (AREU) 6) National Environment Protection Agency (NEPA)
	Activity 3.4 Social and environmental safeguards policy for mini-grids developed and mainstreamed	1) Ministry of Energy and Water (MoEW) 2) Da Afghanistan Breshna Sherkat (DABS) 3) Ministry of Rural Rehabilitation Development (MRRD) 4) Private Sectors 5) Afghanistan Renewable Energy Union (AREU)

8 Mitigation & adaptation co-benefits of proposed intervention

8.1 Mitigation benefits and baseline situation

As discussed in previous sections, the bulk of energy services in the sites are provided by non-renewable energy sources. As such, the proposed interventions seek to replace the following:

a. **Kerosene as lighting fuel.** Kerosene is used almost exclusively across the country for lighting purposes. Although a fraction of households is able to afford locally available solar home systems, they still require kerosene lamps for coverage beyond the 4-5 hours of lighting from the solar PV unit.
b. **Diesel for powering enterprises.** Due to non-availability of centralized grid based power, enterprises are exclusively powered by diesel generator sets. These include shops, markets, irrigation pumps, sewing machines, flourmills, sawmills, fruit and agro-processing units, car wash, automobile workshops and any other form of micro-enterprise.
c. **Diesel powering public institutions**. All government offices, schools, police stations, mosques, health centres and hospitals are powered primarily by diesel generators.

8.1.1 Determination of Emission Reduction from 3 solar mini-grids

Emission reduction deriving from 3 solar mini-grids has been calculated using the CDM AMS-I-L methodology– "Electrification of rural communities using renewable energy"[47] as this methodology is applicable to electrification of a community achieved through the installation of renewable electricity generation systems that displace fossil fuel use, such as in fuel-based lighting systems, stand-alone power generators, and fossil fuel based mini-grids. The mini-grids in Khost, Parwan and Kandahar meet the requirements of the conditions in the CDM AMS-I-L methodology in that they are "small-scale power system with a total capacity not exceeding 15 MW (i.e. the sum of installed capacities of all electricity generating units connected to the mini-grid is equal to or less than 15 MW) not connected to a national or a regional grid".

The methodology assumes three different groups of energy consumers, with accordingly different baseline emission factors:

a) For the first 55 kWh of renewable electricity consumed by each consumer the baseline emission factor is 6.8 (t CO2/MWh);
b) For the facility consumption more than 55 kWh but equal to or less than 250 kWh, the baseline emission factor is 1.3 (t CO2/MWh) for the tranche between 55 and 250 kWh;
c) For the facility consumption beyond 250 kWh, the baseline emission factor is 1.0 (t CO2/MWh) for the tranche beyond 250 kWh.

For the three solar mini-grids in the project, exact numbers of shares of households in the above three categories are unknown. A conservative assumption has therefore been used where 10% is expected to fall in the lowest category, 10% of households are expected to have a maximum consumption of 250 kWh and 80% of households are expected to have an annual energy consumption of more than 250 kWh.

All commercial energy consumption is expected to be higher than 250 kWh per year per commercial facility and will therefore be attributed an emission factor of 1.0 (t CO2/MWh).

The number of households in each of the 3 energy consumption categories per solar mini-grid are shown in Table 14.

[47] https://cdm.unfccc.int/methodologies/DB/CCZKY3FSL1T28BNEGDRSCKS0CY0WVA

Table 14 *Share and number of households in 3 energy consumption categories per mini-grid*

KANDAHAR				
	TOTAL	<55	55-250	>250
Electricity use per category *kWh*				
%HH per category	100.00%	10.00%	10.00%	80.00%
#HH per category	2,081	208	208	1,665
max kWh/HH		55	250	>250

PARWAN				
	TOTAL	<55	55-250	>250
Electricity use per category *kWh*				
%HH per category	100.00%	10.00%	10.00%	80.00%
#HH per category	2,000	200	200	1,600
kWh/HH		55	250	>250

KHOST				
	TOTAL	<55	55-250	>250
Electricity use per category *kWh*				
%HH per category	100.00%	10.00%	10.00%	80.00%
#HH per category	3,725	373	373	2,980
kWh/HH		55	250	> 250

An average emission factor for households as a result of the share of households in each of the 3 energy consumption categories was calculated per year of energy consumption. Table 15 shows the average emission factor for each of the three mini-grids for the first year of operation.

Table 15 *Electricity use in each of 3 energy consumption categories and calculation of average emission factor for households in the 1st year of full operation.*

KANDAHAR				
Electricity use in category *kWh*				
total #HH in category		2,081	1,873	1,665
		100%	90%	80%
nett kWh/HH in category		55	195	355
kWh total in category	1,070,863	114,455	365,235	591,173
	100%	11%	34%	55%
CO2 emission calculation *kg*				
kg CO2/kWh	1.72	6.8	1.3	1.0
kG CO2 total reduced	1,844,272	778,294	474,806	591,173

PARWAN				
Electricity use in category *kWh*				
#HH are in category		2,000	1,800	1,600
		100%	90%	80%
nett kWh/HH per category		55	195	166
kWh total per category	727,049	110,000	351,000	266,049
	100%	15%	48%	37%
CO2 emission calculation *kg*				
kg CO2/kWh	2.02	6.8	1.3	1.0
kG CO2 total	1,470,349	748,000	456,300	266,049

KHOST				
Electricity use in category **kWh**				
#HH are in category		3,725	3,352	2,979
		100%	90%	80%
nett kWh/HH per category		55	195	71
kWh total per category	1,070,863	204,875	653,640	212,348
	100%	19%	61%	20%
CO2 emission calculation *kg*				
kg CO2/kWh	2.29	6.8	1.3	1.0
kG CO2 total	2,455,230	1,393,150	849,732	212,348

By calculating the average emission factor of households per year of energy consumption per mini-grid, annual emission reduction (tCO2eq) was calculated over the 25 year lifetime of the mini-grids. Table 16 shows annual CO2 emission reduction from 3 solar mini-grids in Khost, Kandahar and Parwan over the mini-grid lifetime.

Table 16 *Annual CO2 emission reduction from 3 solar mini-grids in Khost, Kandahar and Parwan*

Kandahar totals														
Project year		0	1	2	3	4	5	6	7	8	9	10	11	12
Annual Energy Usage Domestic		0	522,372	1,070,863	1,097,634	1,125,075	1,153,202	1,182,032	1,211,582	1,241,872	1,238,994	1,235,897	1,232,807	1,229,725
Annual Energy Usage Commercial			223,874	458,941	470,415	482,175	494,229	506,585	519,250	532,231	530,997	529,670	528,346	527,025
Emission factor Domestic:			2.48	1.72	1.70	1.69	1.67	1.65	1.64	1.62	1.62	1.63	1.63	1.63
Emission factor Commercial:			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Annual emission reduction (tCO2eq)		0	1,520	2,303	2,341	2,381	2,421	2,462	2,504	2,548	2,543	2,539	2,535	2,530

Kandahar totals													
Project year	13	14	15	16	17	18	19	20	21	22	23	24	25
Annual Energy Usage Domestic	1,226,651	1,223,584	1,220,525	1,217,474	1,214,430	1,211,394	1,208,365.4	1,205,344	1,202,331	1,199,325	1,196,327	1,193,336	1,190,353
Annual Energy Usage Commercial	525,707	524,393	523,082	521,774	520,470	519,169	517,871	516,576	515,285	513,997	512,712	511,430	510,151
Emission factor Domestic:	1.63	1.63	1.63	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.65	1.65	1.65
Emission factor Commercial:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Annual emission reduction (tCO2eq)	2,526	2,521	2,517	2,513	2,508	2,504	2,500	2,495	2,491	2,487	2,482	2,478	2,474

Parwan totals														
Project year		0	1	2	3	4	5	6	7	8	9	10	11	12
Annual Energy Usage Domestic		0	168,359	727,049	761,446	759,543	757,644	755,750	753,860	751,976	750,096	748,220	746,350	744,484
Annual Energy Usage Commercial			56,120	242,350	253,815	253,181	252,548	251,917	251,287	250,659	250,032	249,407	248,783	248,161
Emission factor Domestic:			4.89	2.02	1.98	1.98	1.98	1.98	1.99	1.99	1.99	1.99	2.00	2.00
Emission factor Commercial:			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Annual emission reduction (tCO2eq)		0	880	1,713	1,759	1,756	1,753	1,751	1,748	1,746	1,743	1,741	1,738	1,736

Parwan totals													
Project year	13	14	15	16	17	18	19	20	21	22	23	24	25
Annual Energy Usage Domestic	742,623	740,766	738,914	737,067	735,224	733,386	731,553	729,724	727,900	726,080	724,265	722,454	720,648
Annual Energy Usage Commercial	247,541	246,922	246,305	245,689	245,075	244,462	243,851	243,241	242,633	242,027	241,422	240,818	240,216
Emission factor Domestic:	2.00	2.00	2.01	2.01	2.01	2.01	2.02	2.02	2.02	2.02	2.03	2.03	2.03
Emission factor Commercial:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Annual emission reduction (tCO2eq)	1,733	1,731	1,729	1,726	1,724	1,721	1,719	1,716	1,714	1,711	1,709	1,707	1,704

Khost totals														
Project year		0	1	2	3	4	5	6	7	8	9	10	11	12
Annual Energy Usage Domestic		0	-	0	1,070,863	1,097,634	1,125,075	1,153,202	1,181,490	1,178,536	1,175,590	1,172,651	1,169,719	1,166,795
Annual Energy Usage Commercial			-	0	458,941	470,415	482,175	494,229	506,353	505,087	503,824	502,565	501,308	500,055
Emission factor Domestic:					2.29	2.26	2.23	2.20	2.17	2.17	2.18	2.18	2.18	2.19
Emission factor Commercial:					1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Annual emission reduction (tCO2eq)		0	-	-	2,914	2,952	2,992	3,032	3,072	3,068	3,064	3,060	3,055	3,051

Khost totals													
Project year	13	14	15	16	17	18	19	20	21	22	23	24	25
Annual Energy Usage Domestic	1,163,878	1,160,968	1,158,066	1,155,171	1,152,283	1,149,402	1,146,529	1,143,662	1,140,803	1,137,951	1,135,106	1,132,268	1,129,438
Annual Energy Usage Commercial	498,805	497,558	496,314	495,073	493,835	492,601	491,369	490,141	488,916	487,693	486,474	485,258	484,045
Emission factor Domestic:	2.19	2.19	2.20	2.20	2.20	2.20	2.21	2.21	2.21	2.22	2.22	2.22	2.23
Emission factor Commercial:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Annual emission reduction (tCO2eq)	3,047	3,043	3,039	3,035	3,030	3,026	3,022	3,018	3,014	3,010	3,006	3,002	2,998

In Table 17, total generation of the three solar mini-grids over 25 years is presented, leading to a total expected emission reduction to be 173,082 tCO2eq. Detailed calculations can be found in Annex IIIb (Financial and Economic model).

Table 17 *Total emission reduction 3 solar mini-grids over 25 year period*

Sectors	Potential for mitigation (kWh)	System for replacement	Emission factor	Useful life of system (years)	Total mitigation potential (tonnes CO_2)
Electricity **Kandahar** [kWh/ 25 years]	41,787,848	Mini Grids	HH: 1.62 – 1.72[48] Comm: 1.0	25	61,123
Electricity **Parwan** [kWh/ 25 years]	23,913,840	Mini Grids	HH: 2.00 – 2.03[49] Comm: 1.0	25	42,409
Electricity **Khost** [kWh/ 25 years]	40,924,989	Mini Grids	HH: 2.18 – 2.23[50] Comm: 1.0	25	69,551
Total emission reduction over 25 years (tCO2eq)					**173,082**

8.2 Co-benefits

The document GCF Insight (2016)[51] highlights 'low-emission and climate-resilient agriculture' as one of the five investment priorities that cut across Green Climate Fund's result areas. With a focus on RE powered agriculture and rural enterprises, the proposed project shall eventually contribute to strengthened resilience to climate change for rural Afghan communities in eight (8) provinces. On the basis of a pan-Afghan analysis, 3 sites have been selected for implementation of a solar mini-grid and another 5 sites were selected for development of Investment Design Reports. These 8 sites are spread of 8 provinces, see the map in figure 5. Some of the perceived benefits of the interventions are highlighted as follows:

[48] Depending on energy consumption, specifically amount of energy consumption in category > 250 kWh/y
[49] Depending on energy consumption, specifically amount of energy consumption in category > 250 kWh/y
[50] Depending on energy consumption, specifically amount of energy consumption in category > 250 kWh/y
[51] https://www.greenclimate.fund/documents/20182/194568/GCF_INSIGHT_2016/dc2b945f-d96a-4f6d-9eeb-3960beee919a

A) Sustaining rural agriculture and agro-enterprises: implementation of 8 mini-grids would be capable to replace about more than 50 diesel powered pumps. The intervention shall enable farmers and other users in the agro value chain to achieve the following:

- *Replace diesel pumps:* Replacement of diesel pumps shall improve local environment, and enable pump owners to avoid recurrent expenses associated with diesel procurement.
- *Management of water resources:* Diesel pumps, whether hired or owned, are usually larger in size and to maximize use are coupled to flood irrigation systems. With electric pumps that can be switched on demand, there would be greater control on water drawn. Smaller sized pumps shall also optimize on losses.
- *Supporting Agro-enterprises:* In addition to pumps, there are a number of rural enterprises, farm-based as well as off-farm, which would be energized as present or ramp up loads.

Farm-based enterprises shall enhance livelihood security for both the owner and other entities that are engaged in the enterprise or in the value-chain and are a vital means to improving resilience to climate change impacts.

B) Health, Education and Public Institutions:

- The implementation of 8 mini-grids can benefit 40 schools. In addition, provision of electricity in homesteads leads to better indoor lighting in evenings, when students can study without affecting their eyesight.
- Altogether 188,010 women and men would be benefitted through the access of improved health services enabled by the use of RE systems in 27 health centres.
- The project will also provide electricity and energy to police stations, mosques, and other public institutions that are engaged in safety, security and overall improvement of society.

C) Other Benefits:

- Implementation of 8 mini-grids would be capable to benefit as many as 675 retail shops thereby providing better livelihood options, not only for the entrepreneur but also for the employees and benefits through the supply and value chains;
- Micro-hydro projects can improve the watersheds and make rural population more resilient to adverse impacts of flood;
- Through the formation of RESCO and other business models, the project can provide new livelihood opportunities to local enterprises who would be able to initiate local renewable energy based businesses. Implementation of projects can also encourage and incubate innovative business models in the local context, as a result of market forces;
- Implementation of 8 mini-grids can benefit 89,000 female population through provisioning of electricity in their houses and their villages for their comforts, safety, empowerment and overall well-being. Preliminary surveys indicate that womenfolk are expected to be key beneficiaries, due to their involvement in enterprise development such as tailoring shops and other home-based enterprises such as milk products;
- Since this would be the one of the largest rural energy programmes in Afghanistan, it would set the path of low-emissions development pathways and would provide relevant policy and regulatory interventions for scaling up and replication of DRE projects in other provinces;
- Through the mini-grid operators, the knowledge on design and use of RE projects will be institutionalized and spread across other provinces;
- The policy on mini-grids would mainstream RE mini-grids as energy access options specifically for improving water and food-security.

9 Innovativeness and effectiveness of proposed interventions

The proposed project introduces innovative methods of designing and implementing RE interventions that are based on the learnings of the previous rural and renewable energy programmes in Afghanistan, while simultaneously introducing contemporary global and regional approaches and concepts that are found appropriate for Afghanistan. Specifically, the following innovations will be introduced in the mini-grid designs:

9.1 Service delivery models

In the context of Afghanistan, the government is committed to provide energy access but is ill-equipped to manage and operate the projects on its own; the communities are not capable to invest in, implement and manage RE projects; and private sector is not yet ready to take the risks of investments in rural energy projects. The public-private-partnership (PPP) framework, designed as Rural Energy Service Company (RESCO) business model, clearly defines the roles of government, private sector and communities while balancing the interests of private sector and the principles of public good. The roles are elaborated as below:

- Government / donor in providing the initial capital investment
- Private sector (large or small companies, formally or informally structured) in providing the services for which they are paid either by the government or can collect money from the users directly
- Communities in ensuring the regular payments for the services rendered and supporting/ contributing towards the upkeep/ security of the project

9.2 Gender inclusive models

The project recognizes the importance of gender inclusion in interventions towards making rural societies climate resilient. Hence, the project not only incorporates RE technologies that would benefit women by giving them access to cleaner cooking fuels, better health and education facilities; but also involves and benefits women enterprises (on the supply side of RE) by involving women agricultural cooperatives and tailoring shops.

9.3 Policy mainstreaming

One of the activities of the proposed project is development of mini-grid policy. This policy will provide a regulatory framework for Building, Owning and Operating RE mini-grids including setting tariffs for mini-grids. The Policy will align mini-grids with the overall RE Roadmap for Afghanistan (RER2032) developed by the Government of Afghanistan under its Ministry of Energy and Water, thereby ensuring the scalability and replicability of mini-grids in Afghanistan.

9.4 Effectiveness

The proposed project is designed for achieving community level adaptation goals and reduction of vulnerability through energy access. Keeping long-term sustainability of such impacts in mind, viability considerations have been built into the RE project design as a key requirement. RE projects utilize natural resources such as wind, solar and hydropower and are inherently environmentally sustainable. As such, they have lower operating costs than current delivery options such as kerosene, firewood and diesel. Further, as the baseline in project area is characterized by diesel/ kerosene/ biomass use the cost of carbon emission mitigation is expected to be low to zero.

Over the long run, RE projects emerge as least-cost options for Afghanistan, which has 70% of land area covered by mountains. Decentralised energy delivery options have higher resource efficiency when compared to the costs of extending the electricity grid to remote sites often located across hilly terrain, with scattered settlements. This is clearly outlined in the Renewable Energy Policy (RENP).

Finally, the project energises enterprises through renewable energy access, which provides additional incomes compared to the current baseline of no or limited energy access. Increased income levels translate to benefits to the rural economy through increased economic activity. Eventually, the interventions shall improve economic standards and provide trickle-down benefits to the region.

9.5 Institution Building

The project will set up institutions for funding and implementation of rural energy projects i.e. the Rural Electrification Department (RED), under DABS, giving a long-term support to rural energy markets, beyond this project. The Rural Electrification Department (RED), under DABS, will undertake all activities related to designing, planning and implementing rural electrification projects including site identification, land acquisition, raising and managing finances and regulatory approvals. Eventually, the RED is expected to manage funding for implementing RE mini-grids coming from government budget and from climate finance support. The above will address specific institutional and financial barriers to adoption of RE technologies in rural energy markets.

9.6 Knowledge creation and learning

The project's knowledge creation and cross-learning potential lies in its approach to using RE systems for strengthening communities' resilience towards climate impact. Many donors and international/ regional organizations are engaged in supporting the development of RE projects in Afghanistan. The proposed project will generate valuable knowledge that will benefit other projects and initiatives in this sector. Simultaneously, it will also help in creating knowledge within the MRRD on good management and governance practices that would be shared with other Ministries and departments.

Specifically, the process of conceptualizing, creating and strengthening the mini-grids RESCOs will be a valuable knowledge product to be applied in other sectors across Afghanistan and in RE sector in other neighboring countries.

Learning is expected to be significant on the impact of energy interventions on climate change adaptation, as would be borne out through the proposed interventions. The body of evidence created shall result in replication and scaling up of similar interventions. Also, the role, scope and efficacy of public-private-partnership (PPP) in RE based projects targeting at livelihoods and productive applications, particularly by integrating them with cooperatives and self-help groups will create valuable experience and learnings.

10 Summary and Conclusions

The Feasibility study supports the Government of Afghanistan's proposal to the GCF with the objective to prepare the rural renewable energy market transformation by a combination of policy design (including grounds for public and private sector financing for mini-grids), capacity building of both public and private sector and development of green procurement and safeguards procedures as well as piloting such procedures for 16 rural renewable energy mini-grids.

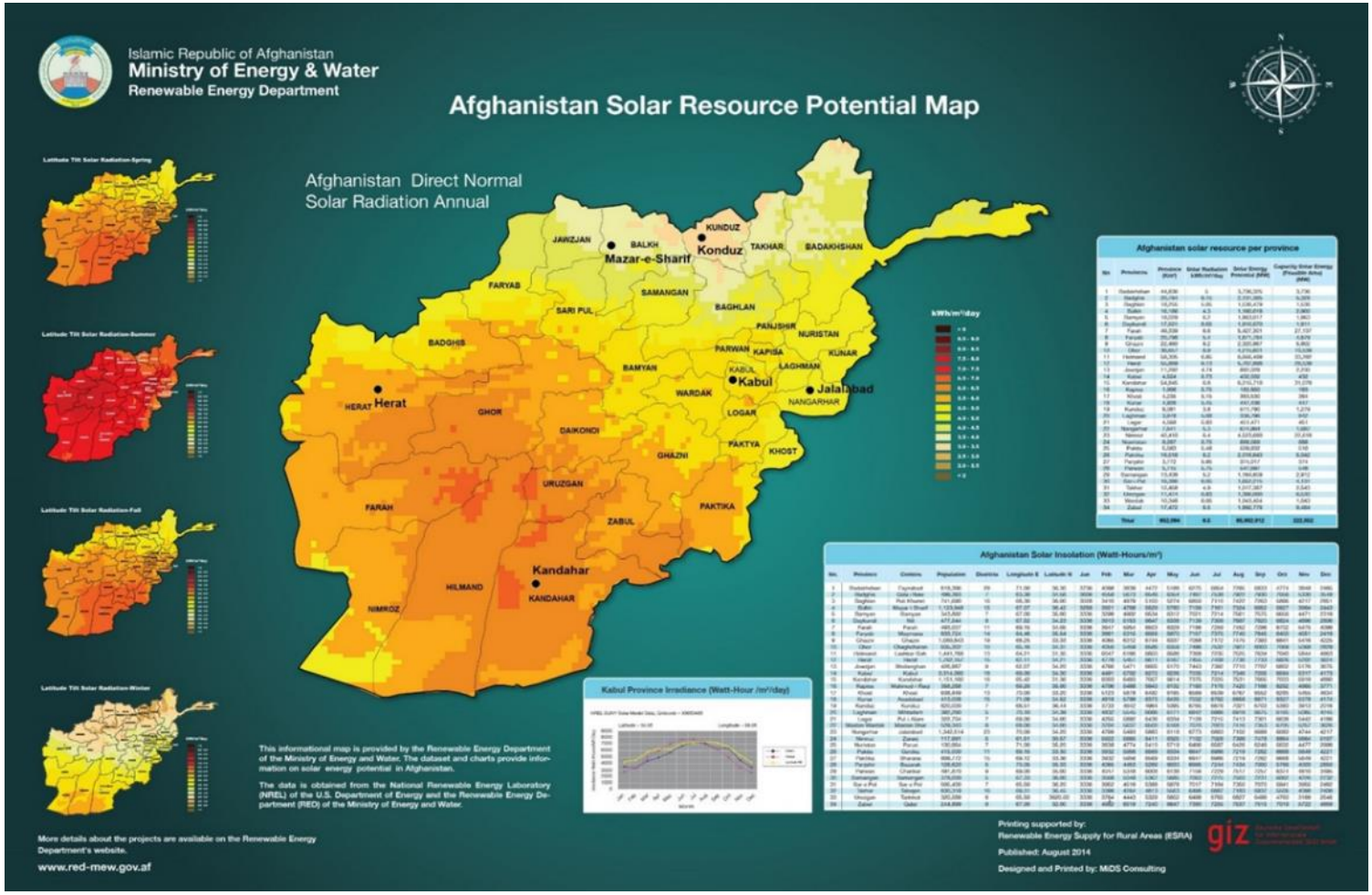
The feasibility adopts an integrated approach to develop RE sector in Afghanistan based on previous experiences (ASERD, INDC, RENP, CCSAP and others.)

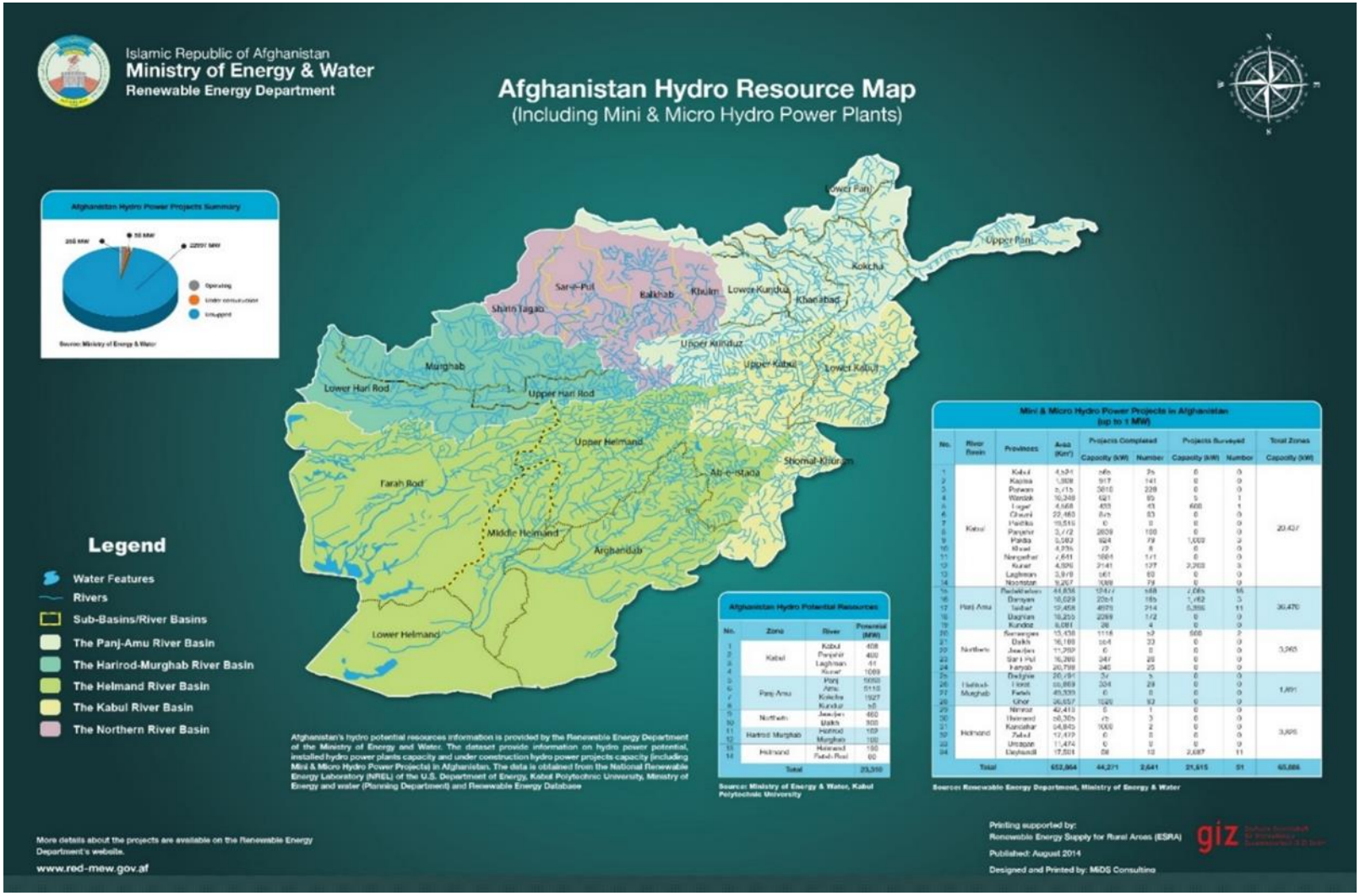
The recommended strategy is based on the lessons from the past experiences of rural energy programmes; simultaneously adopting good regional and global practices, customized for Afghanistan.

The feasibility envisages that beyond GCF intervention, the rural energy projects targeting livelihoods and productive uses would be able to self-sustain in the transformed private sector driven markets, supported by strong policies and able institutions. Further, adequate capacities would have been built both in the public domain, as well as among the private sector for design, operate, monitor and evaluate such projects.

Annexure 1 – Afghanistan Existing Power System

Annexure 2 – Afghanistan RE Maps




Islamic Republic of Afghanistan
Ministry of Energy & Water
Renewable Energy Department
Afghanistan Hydro Resource Map
(Including Mini & Micro Hydro Power Plants)
Afghanistan Hydro Power Projects Summary
Legend
Water Features
Rivers
Sub-Basins/River Basins
The Panj-Amu River Basin
The Harirod-Murghab River Basin
The Helmand River Basin
The Kabul River Basin
The Northern River Basin
Lower Panj
Upper Panj
Kokcha
Sare-Pul
Balkhab
Khulm
Lower Kunduz
Khanabad
Shirin Tagab
Upper Kunduz
Upper Kabul
Lower Kabul
Murghab
Lower Hari Rod
Upper Hari Rod
Upper Helmand
Shiomal-Kiikrum
Ab-e-Istada
Farah Rod
Middle Helmand
Arghandab
Lower Helmand
Afghanistan's hydro potential resources information is provided by the Renewable Energy Department of the Ministry of Energy and Water. The dataset provide information on hydro power potential, installed hydro power plants capacity and under construction hydro power projects capacity (including Mini & Micro Hydro Power Projects) in Afghanistan. The data is obtained from the National Renewable Energy Laboratory (NREL) of the U.S. Department of Energy, Kabul Polytechnic University, Ministry of Energy and water (Planning Department) and Renewable Energy Database
Source: Ministry of Energy & Water, Kabul Polytechnic University
Mini & Micro Hydro Power Projects in Afghanistan (up to 1 MW)
Sources Renewable Energy Department, Ministry of Energy & Water
More details about the projects are available on the Renewable Energy Department's website.
www.red-mew.gov.af
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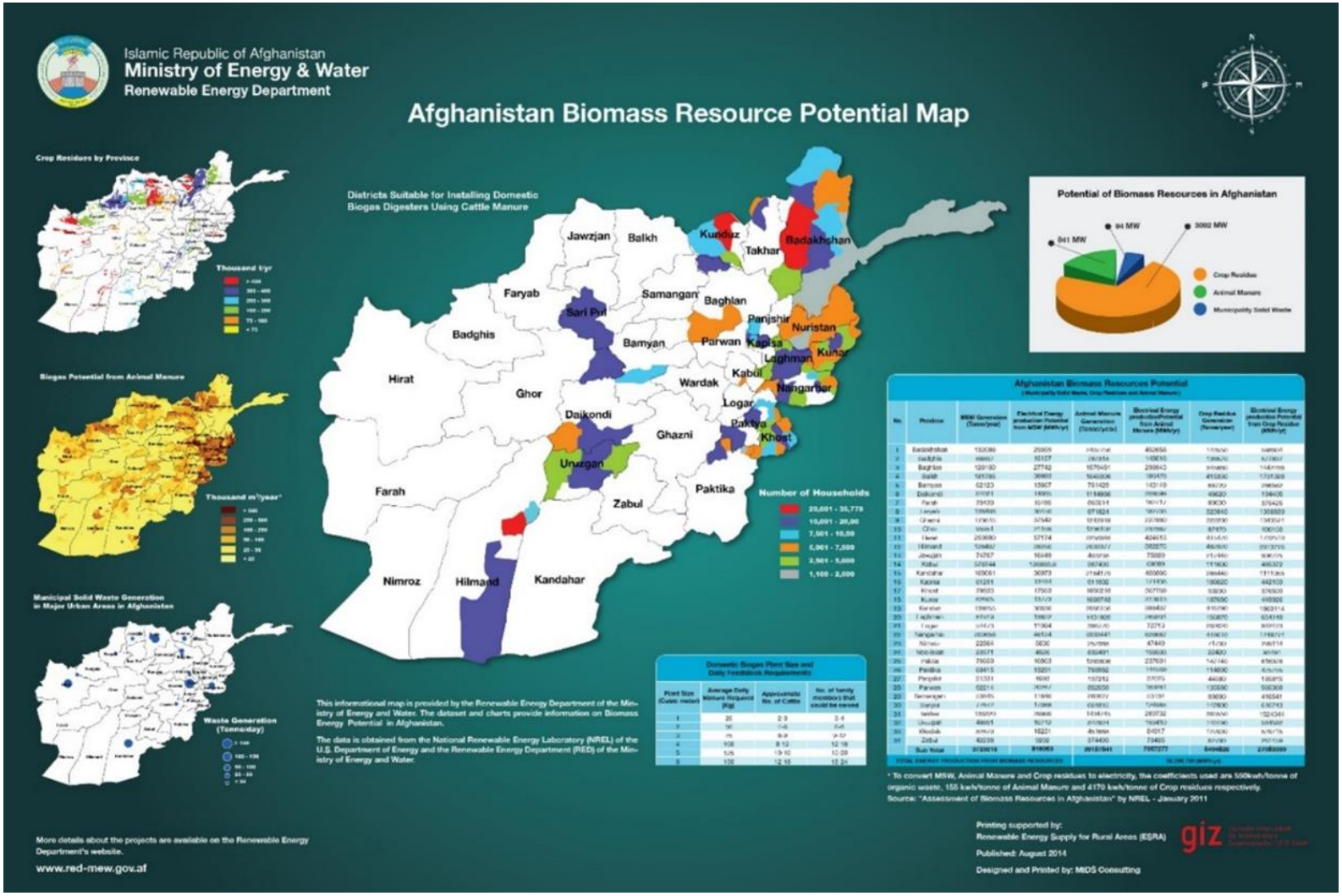
Islamic Republic of Afghanistan
Ministry of Energy & Water
Renewable Energy Department
Afghanistan Biomass Resource Potential Map
Crop Residues by Province
Thousand t/yr
Biogas Potential from Animal Manure
Thousand m³/year
Municipal Solid Waste Generation in Major Urban Areas in Afghanistan
Waste Generation (Tonne/day)
Districts Suitable for Installing Domestic Biogas Digesters Using Cattle Manure
Jawzjan
Balkh
Kunduz
Takhar
Badakhshan
Faryab
Sari Pul
Samangan
Baghlan
Badghis
Bamyan
Panjshir
Parwan
Kapisa
Nuristan
Laghman
Kuna
Hirat
Ghor
Kabul
Wardak
Nangarhar
Logar
Daikondi
Paktya
Ghazni
Khost
Uruzgan
Farah
Zabul
Paktika
Nimroz
Hilmand
Kandahar
Number of Households
20,001 - 35,775
10,001 - 20,00
7,501 - 10,00
5,001 - 7,500
2,501 - 5,000
1,100 - 2,500
Potential of Biomass Resources in Afghanistan
841 MW
94 MW
3002 MW
Crop Residue
Animal Manure
Municipality Solid Waste
Afghanistan Biomass Resources Potential
Domestic Biogas Plant Size and Daily Feedstock Requirements
This informational map is provided by the Renewable Energy Department of the Ministry of Energy and Water. The dataset and charts provide information on Biomass Energy Potential in Afghanistan.
The data is obtained from the National Renewable Energy Laboratory (NREL) of the U.S. Department of Energy and the Renewable Energy Department (RED) of the Ministry of Energy and Water.
* To convert MSW, Animal Manure and Crop residues to electricity, the coefficients used are 500kwh/tonne of organic waste, 155 kwh/tonne of Animal Manure and 4170 kwh/tonne of Crop residues respectively.
Source: "Assessment of Biomass Resources in Afghanistan" by NREL - January 2011
More details about the projects are available on the Renewable Energy Department's website.
www.red-mew.gov.af
Printing supported by:
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Published: August 2014
Designed and Printed by: MIDS Consulting

Annexure 3 - Survey Questionnaire

Economic Feasibility Study Form
فورم سروی مقدماتی و اقتصادی

Province ولایت		Project Type *نوع پروژه*	
District ولسوالی		Project Location **موقعیت پروژه**	
Village **قریه**		# of families تعداد فامیل	
CDC **شورای انکشافی قریه**		Distance **فاصله**	
Average Size of Family **تعد اد متوسط یک فامیل**		Average Income of Families **عایدات متوسط سالانه یک فامیل**	

Land Coverage

زمین تحت پوشش

Types of Lands **نوع زمین**	Irrigated lands (Aabi) **زمین زراعتی آبی**	Rainfed land (Lalmi) **زمین للمی**	Garden **باغ**	Total **مجموع**
Coverage **تحت پوشش**	Jarib **جریب**	Jarib **جریب**	Jarib **جریب**	Jarib **جریب**

Irrigation Pumps

پمپ های آبیاری

Total Number of Water Pumps **تعداد پمپ ها**	Types of Motor **نوع موتور ها**	Covered Land Using Water Pump **آبیاری زمین بااستفاده از پمپ ها**	Frequency of Irrigation **دوران یا وقت آبیاری**	Oil Needed for Irrigating/ Jarib **ضروریت تیل برای آبیاری یک جریب زمین**	Oil Needed for Irrigating/Total **مجموع تیل مورد ضرورت برای آبیاری**
		( ) Jarib **جریب**	( )Times/Year در سال چند بار	( )Liter/Jarib فی جریب چند لیتر	( ) Liter لیتر

Enterprises and Social Institutions

صنایع و مراکز عامه

#	**Enterprises** صنایع	**Number of Units** **تعداد**		#	**Social Institutions** مراکز عامه	**Number of Units** **تعداد**
1	Retail Stores مراکز خوراکه فروشی			1	Hospital/Clinic شفاخانه و کلینیک	
2	Tailoring Units مراکز خیاطی			2	Veterinary Clinic کلینیک حیوانی	
3	Metal Work فلزکاری یا آهنگری			3	Schools مکاتب	
4	Carpentry نجاری			4	Police Stations مراکز پولیس	
5	Flour Mills آسیاب ها			5	Mosques مساجد	
6	Hotels and Restaurants رستورانت ها و هوتل ها			6	Community Centre مراکز شورای انکشافی	
7	Oil Extraction Plants ماشین های تیل کشی			7		

8	LPG Stations استیشن گاز ال پی جی			8		
9	Pump Station تانک تیل			9		
10	Stone Crashing Plant ریگ ریشن یا ماشین های سنگ شکنی			10		
11	Restaurant رستورانت			11		
12	Chicken Farm فارم مرغ داری			12		
13	Oil Process Centre مراکز پروسیس روغن یا تیل			13		
14				14		
15				15		

Current Sources of Energy
منابع موجود انرژی

Solar Systems سیستم سولر				
Beneficiaries مستفید شونده گان	Total Number تعداد مجموعی	# Using Solar تعداد مستفید شونده گان	% Using Solar چند فیصد استفاده از سولر	Remarks ملاحظات
Households فامیل				
Enterprises صنایع کوچک				
Social Institutions مراکز عامه				
Solar Cost قیمت سولر	Solar پنل	Battery باتری	Inverter انورتر یا تبدیل کننده	Other Requirements ضروریات دیگر
Cost in AFs قیمت به افغانی				
Heating and Cooking/Family برای پخت وپز و گرمایش چند فامیل استفاده میکنند	LPG از گاز ال پی جی	Woods چوب	Coal ذغال سنگ	Others دیگر
KG/Year در یک سال چند کیلو گرام				
Unite Price قیمت فی کیلوگرام				

MHP Project (if Applicable) ***پروژه برق آبی کوچک قابل اجرا یا موجود***			
Project Location **موقعیت پروژه**		Turbine Capacity **ظرفیت توربین**	KW کیلووات
Project Implementer تطبیق کننده پروژه		Project Cost قیمت پروژه	AFs به افغانی
# of Beneficiaries تعداد مستفید شونده گان		Cost/KW قیمت فی کیلووات	AFs/KW افغانی
Households *فامیل*		Average Cost قیمت متوسط	AFs/Month در ماه چند افغانی
Enterprises *صنایع کوچک*		Average Cost قیمت متوسط	AFs/Month درماه چند افغانی
Social Institutions *مراکز عامه*		Average Cost قیمت متوسط	AFs/Month درماه چند افغانی
Challenges: **موانع :**			

Main Agriculture Products
تولیدات عمده زراعتی

#	**Products** تولیدات	**Productivity (Kg/Jarib)** تولیدات برحسب کیلوگرام فی جریب	**Price/Kg (Minimum)** کمترین قیمت فی کیلوگرام	**Price/Kg (Maximum)** بلندترین قیمت فی کیلوگرام	**Covered Lands Jarib or %** چند فیصد زمین تحت پوشش بر حسب جریب	**Total Production in a year** تولیدات مجموعی در یک سال
1		Kg/ Jarib کیلو گرام فی جریب	AFS/Kg فی کیلوگرام به افغانی	AFS/Kg فی کیلوگرام به افغانی	Jarib **جریب**	Kg کیلوگرام
2		Kg/Jarib کیلو گرام فی جریب	AFS/Kg فی کیلوگرام به افغانی	AFS/Kg فی کیلوگرام به افغانی	Jarib **جریب**	Kg کیلوگرام
3		Kg/ Jarib کیلو گرام فی جریب	AFS/Kg فی کیلوگرام به افغانی	AFS/Kg فی کیلوگرام به افغانی	Jarib **جریب**	Kg کیلوگرام
4		Kg/ Jarib کیلو گرام فی جریب	AFS/ Kg فی کیلوگرام به افغانی	AFS/ Kg فی کیلوگرام به افغانی	Jarib **جریب**	Kg کیلوگرام
Main Horticulture Products میوهای عمده و تولیدات آن						
1		Kg/ Jarib	AFS/Kg فی کیلوگرام به افغانی	AFS/Kg فی کیلوگرام به افغانی	Jarib **جریب**	Kg کیلوگرام
2		Kg/ Jarib	AFS/Kg فی کیلوگرام به افغانی	AFS/Kg فی کیلوگرام به افغانی	Jarib **جریب**	Kg کیلوگرام
3		Kg/ Jarib	AFS/Kg فی کیلوگرام به افغانی	AFS/Kg فی کیلوگرام به افغانی	Jarib **جریب**	Kg کیلوگرام
4		Kg/ Jarib	AFS/Kg فی کیلوگرام به افغانی	AFS/Kg فی کیلوگرام به افغانی	Jarib **جریب**	Kg کیلوگرام
Challenges: موانع :						

Livestock *(Average/Household)*
مالداری ومقدار متوسط آن بر حسب فامیل

Domestic Animals **حیوان های اهلی**	Caw **گاو**	Sheep/Goat **گوسفند و بز**	Donkey **خر**	Chicken **مرغ**	Horse **اسپ**	
Quantity/Household **تعداد فی فامیل**						

Details of Activities and Enterprises:
صنایع کوچک و فعالیت های آن به طور مفصل

Activity فعالیت ها		**Business/Owners' Name** اسم صاحب تجارت	
Investments سرمایه گزاری		Number of Employee تعداد کارمندان	معاش فی ماه
Type of Generator نوع جنراتور به کیلووات		Fuel Consumption مصارف تیل	Liter/Month چند لیتر فی ماه
Working Hours/Day تعداد ساعات کاری در روز		LPG Consumption مصارف گاز ال پی جی	KG/Month چند کیلوگرام در ماه
Items Used By Electricity از کدام نوع انرژی استفاده می کند		Current Electricity Cost *(if applicable)* *قیمت انرژی موجوده اگر باشد فی کیلووات*	AFS/Month چند افغانی در یک ماه تعرفه برق می شود
Average Cost in a Month قیمت متوسط در یک ماه			
Challenges: موانع			

Activity فعالیت		**Business/Owners' Name** اسم صاحب تجارت یا مالک صنایع	
Investments سرمایه گزاری چقدر افغانی		Number of Employee تعداد کارمندان	

Type of Generator نوع جنراتور بر حسب کیلووات		Fuel Consumption مصارف تیل	Liter/Month چند لیتر درماه
Working Hours/Day تعداد ساعات کاری در روز		LPG Consumption مصارف گاز ال پی جی	KG/Month چند کیلوگرام
Items Used By Electricity از کدام نوع انرژی استفاده می کند		Current Electricity Cost *(if applicable)* *قیمت انرژی موجوده اگر باشد فی کیلووات*	AFS/Month چند افغانی در یک ماه تعرفه برق می شود
Average Cost in a Month قیمت متوسط در یک ماه			
Challenges: موانع			

Activity فعالیت		**Business/Owners' Name** اسم صاحب تجارت یا مالک صنایع	
Investments سرمایه گزاری به حساب افغانی		Number of Employee تعداد کارمندان	
Type of Generator نوع جنراتور به حساب کیلووات		Fuel Consumption مصارف تیل	Liter/Month چند لیتر در ماه
Working Hours/Day		LPG Consumption مصارف گار ال پی جی	KG/Month چند کیلوگرام در ماه
Items Used By Electricity از کدام نوع انرژی استفاده می کند		Current Electricity Cost *(if applicable)* *قیمت انرژی موجوده اگر باشد فی کیلووات*	AFS/Month چند افغانی درماه
Average Cost in a Month قیمت متوسط در یک ماه به افغانی			
Challenges: **موانع**			

Activity فعالیت ها		**Business/Owners' Name** اسم صاحب تجارت یا مالک صنایع	
Investments سرمایه گزاری به افغانی		Number of Employee تعداد کارمندان	
Type of Generator نوع جنراتور بر حسب کیلووات		Fuel Consumption مصارف تیل	Liter/Month چند لیتر در ماه
Working Hours/Day تعداد ساعات کاری در روز		LPG Consumption مصارف گاز ال پی جی	چند کیلو در ماه KG/Month
Items Used By Electricity از کدام نوع انرژی استفاده می کند		Current Electricity Cost *(if applicable)* *قیمت انرژی موجوده اگر باشد فی کیلووات*	AFS/Month چند افغانی در ماه
Average Cost in a Month قیمت متوسط در یک ماه به افغانی			
Challenges: **موانع**			

Annexure 4 - Baseline Survey results

Baseline surveys have been carried out in 56 selected sites across 17 provinces. Surveys were done with the use of detailed questionnaires. These questionnaires were filled up by collecting inputs at the community level. In all sites, the baseline data collection was supplemented by inputs provided by local agencies such as Community Development Council (CDC), local representative of the Ministry of Rural Rehabilitation and Development (MRRD) and local community based organisations (CBOs).

For identification of enterprises and future (ramp up) loads in the sites, Focus Group Discussions (FGD) were conducted with entrepreneurs, farmer groups and other users (such as markets and shop owners). Whenever necessary, traders and other entities responsible for trade and commerce in the sites were interviewed, to ascertain role of movement of goods and services between the sites and the nearest nodal centre (such as district or provincial capital).

Annexure 4 gives a sample questionnaire and a glimpse of the data fields.

Description of different load categories on selected sites

A) Household Load

As can be seen in Table 11, the combined population of the sites, who would be direct beneficiaries from the proposed projects, is about 475,463 (around 63,395 households). Of them, roughly 47% (231,848) are females.

B) Institutional Load

<u>Education centers – schools and colleges</u>

Based on national education system, schools are established at three levels, viz. primary, middle school and secondary school. The national government provides free education at state schools. From age 7 to age 13, pupils attend primary schools where they learn the basics of reading, writing, arithmetic and their national culture. Three years of middle school follow where academic-style education continues. Students must pass an examination at the end of this phase if they wish to study further.

At secondary school, students have a choice between pursuing academics for another 3 years, which could lead on to university, or study subjects such as applied agriculture, aeronautics, arts, commerce and teacher training instead. Both programs culminate in a baccalaureate examination.

Education System in Afghanistan

Education	School/Level	Gra... From	Gra... To	Age From	Age To	Years	Notes
Primary	Primary School			7	13	6	
Middle	Maktabeh Motevaseteh	7	9	13	16	3	
Secondary	Doreyeh Aali	10	12	16	19	3	
Vocational	Vocational in Lower & Upper Middle School	7	72	13	19	6	
Vocational	Technicums	8		14	20	6	Graduates of these institutions are recognized as holding qualifications equivalent to those of post-secondary education.
Tertiary	Bachelor's Degree University level first stage					4	
Tertiary	Master's Degree					2	
Tertiary	Doctorate					3	

Figure 11 Overview of Education System in Afghanistan

Afghanistan continues to attempt to surface from a civil war and an ultra-orthodox regime. The rights of women and a broader curriculum are both gradually being reinstated, as the nation shrugs off its past and attempts to kick-start its economy.

From the surveyed sites, Urozgan has the education centers in all forms, from primary up to university (Shahidano Kalacha in Urozgan has a college), 15 provinces have primary, secondary and high schools, and Farah province just has primary and secondary schools. As Figure 7 shows, Laghman has the highest number of beneficiaries in comparison to the other provinces followed by Sar-e Pol.

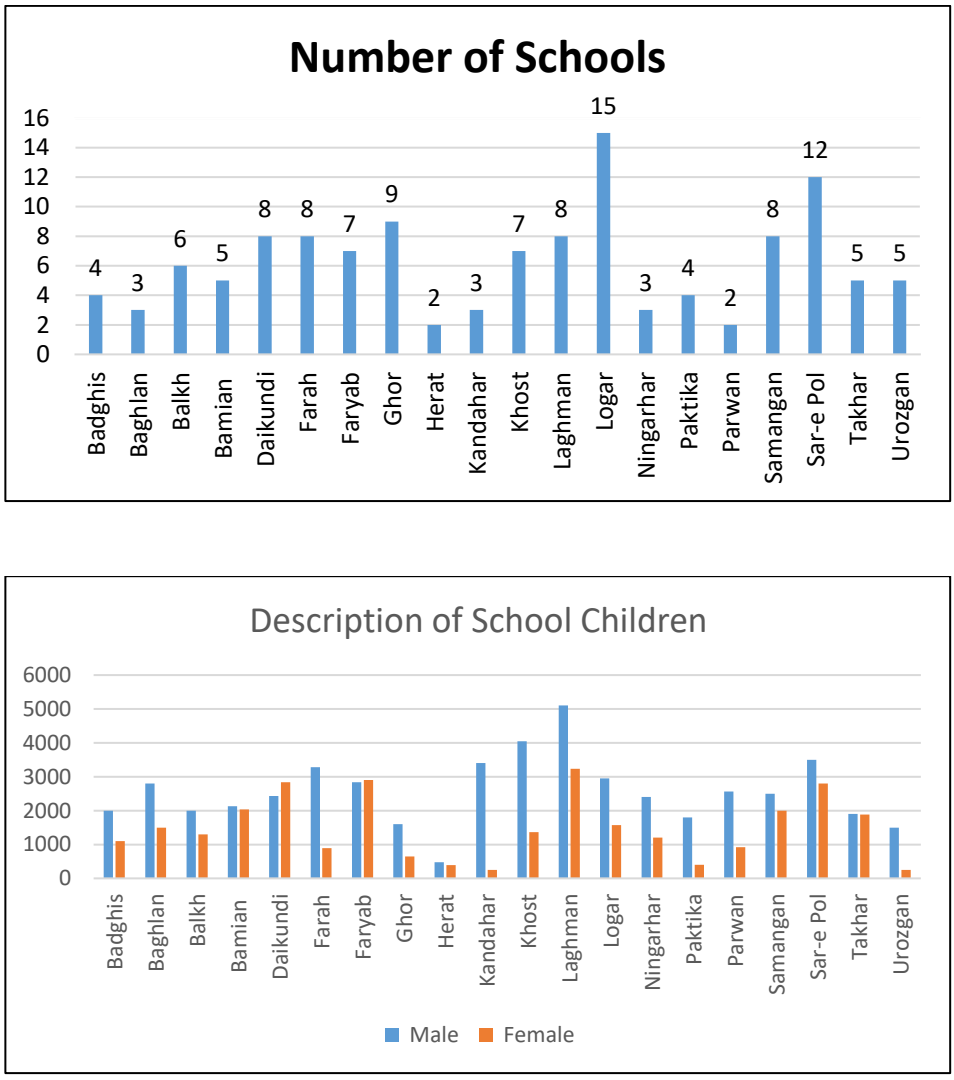
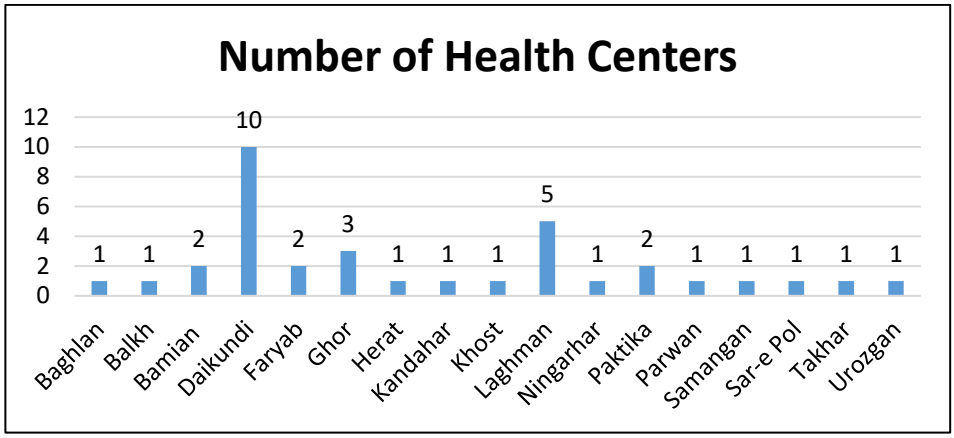


Figure 12 Number of schools and beneficiaries covered by the project

From the project, as many as 113 education centers will be served, which will cover 48,412 males and 27,966 female students.

Health centers

Health services in Afghanistan operate at three levels: health posts (HP) and community health workers (CHWs) provide service at the community or village level; basic health centers (BHCs), comprehensive health centers (CHCs), and district hospitals operate in the larger villages or communities of a district, provincial and regional hospitals comprise the third level. In urban areas, due to a lack of facilities offering basic curative and preventive services, urban clinics, hospitals, and specialty hospitals provide the services that HPs, BHCs and CHCs provide in rural areas.[52] Figure 8 gives a spread of health centres across selected sites and provides the total number of people that would be benefited.



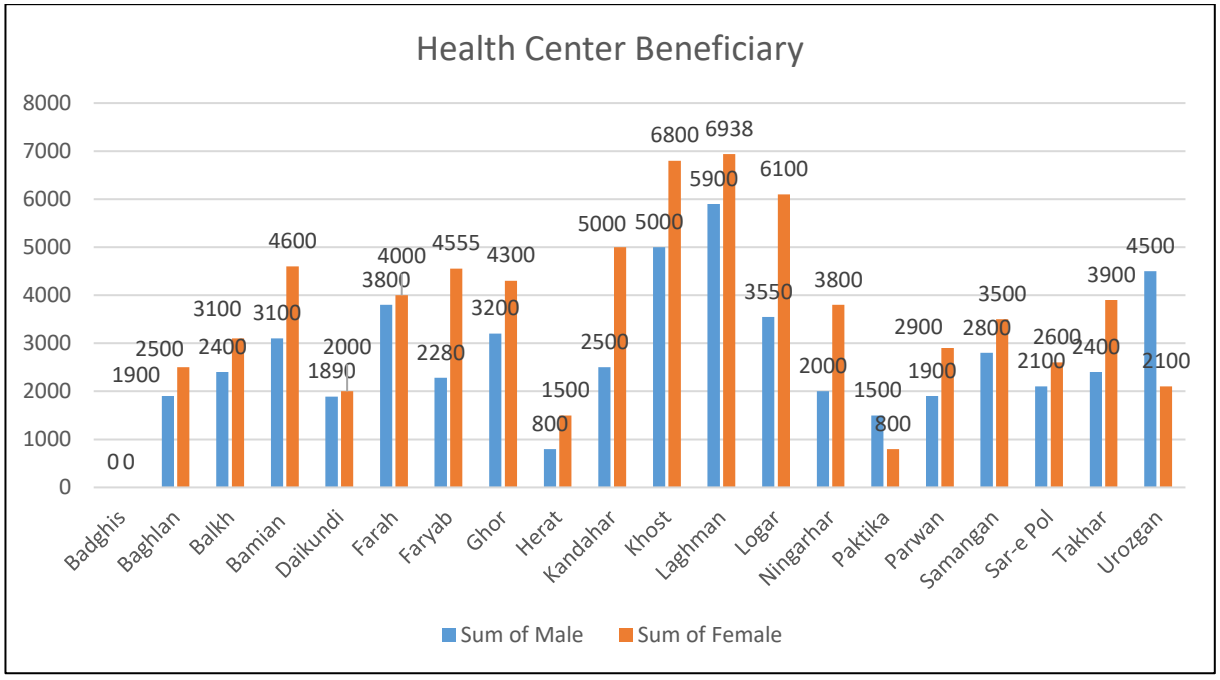


Figure 13 Number of health centers and beneficiaries covered by the project

[52] The Essential Package of Hospital Services for Afghanistan, USAID, Islamic Republic of Afghanistan Ministry of Public Health- 2005

Police Stations

Based on security situation and availability of the resources, police stations are positioned in the districts and villages. Figure 9 shows a typical police station that can be found in most of the villages. Figure 10 shows Laghman has the highest number of police stations between the surveyed provinces.

Figure 14 Police Station

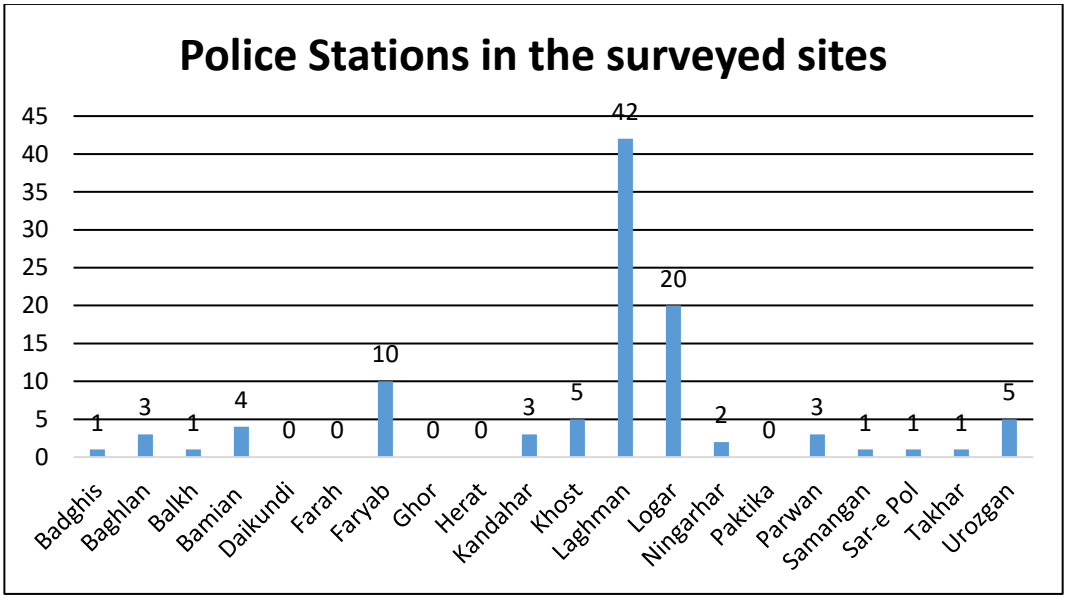


Figure 15 Number of Police Stations

C) Enterprises Load

As discussed earlier in Sections 2.2.1 and 2.2.2, one of the focus areas of the proposed project is to facilitate and accelerate enterprise development. Across all the sites, the following are more commonly observed enterprises.

Tailor

Tailoring shops are one of the most commonly found enterprises across all sites, with an average of about 21 shops per site. All shops have lights; some may have electrically operated sewing machines.

Oil extraction unit

Oil extraction unit are also commonly found across the sites.

Telephone Towers

Telephone towers (base transceiver stations or BTS) need power, which is currently fed by diesel generators.

Carpentry

Carpentry involves sawing and processing of wood to make furniture. This is a more intermittent load, operating at different levels across the day.

Metal works

A common enterprise, metal works involve using sheet and scrap metal to produce metallic items. It also includes some polishing and repair works and are found in a number of sites.

Dairy and Milk Products

Dairy industry is on a growth trajectory in the country due to improving livestock numbers, especially sheep and goat.[53]

Flourmills

It is one of the oldest and most prevalent industries in rural Afghanistan. Most existing micro hydro units are coupled to flourmills. In addition, milling operations are also present for paddy (rice).

Figure 16 Flour Mill in Baghlan Province

Food & fruit storage and processing

Significant potential exists for food and fruit processing units in Afghanistan. Presently there are some electrified storage units in southern provinces, however there is potential for drying, processing (jam, jelly, powder, etc.) for food and fruits that can be carried out using power generated from mini-grids.

Very few of these enterprises currently have access to any modern form of electricity. Most of them are operated by diesel gensets, while few, especially flourmills, are connected with micro-hydro plants. Other than agriculture, these SMEs are livelihood options for rural communities, and have a good potential for expansion if reliable and affordable energy is provided to them. As per the survey, a total of 626 SMEs will be directly impacted with implementation of the mini-grids.

Of the indicative list of enterprises above, a number of them shall be set up once proposed RE projects are commissioned. These loads, defined as 'ramp up' loads (refer Section 2.2.2), are primarily composed of enterprise loads. New enterprises are expected to comprise flourmills, rice mills, other fruit and food processing units, agro-enterprises such as threshers, drip and sprinkler irrigation systems, electricity driven greenhouses, among others.

[53] NRVA 2012

While an exact estimation of ramp-up loads is not possible due to site and economy specific dynamics, one may reasonably estimate that there will be significant addition to existing loads, due to unmet energy demand. As a result, 30% has been conservatively considered as the minimum ramp up potential of the sites.

D) Pumps

In the 25 sites that were identified as suitable for minigide development (see section 5.3), some 2700 existing water pumps were identidied. In terms of occupational profile, across all sites agriculture is the main occupation. In provinces located in cold regions (e.g. Daikundi), agriculture is practised during the short spring to autumn months (3-5), while in other provinces it is six to nine (6 – 9) month engagement in a year. Irrigation, with the aid of diesel pumps, is practised by farmers who can afford the higher costs of diesel. In sites that are located closer to urban centres (such as NawBahar in Urozgan), agriculture is practised by a section of population while the rest are engaged in other activities, especially in the tertiary (services) sector. Reliable and affordable electricity will improve productivity of the farm sector and contribute to the overall health of the rural economy.

Description of energy use

The majority of the selected 16 sites from 11 provinces are located in proximity to the provincial capital or a nodal town, therefore meeting the criterium of accessibility.

Existing energy delivery mode

While a number of loads are non-existent due to non-availability of electricity, some loads such as household electrification and most existing enterprises are met by fossil fuels such as diesel mini-grids and captive diesel generators, kerosene, coal. The average cost of diesel-based electricity is a minimum of 15 Afs/ kWh (0.25 US$/kWh) in most of the cases where it is being used. The state utility DABS sells electricity from diesel generators using a distribution network, in some provincial capitals (Farah, for instance) charging over 30 Afs/kWh.

In six (6) of the sites, there are mini-hydro units that are intermittently connected to a rudimentary mini-grid network, providing for basic lighting in the evening and day-time loads such as flourmills, shops. The MHP electricity is costing the households at 15 Afs/ kWh (0.25 US$/kWh).

There are no solar mini-grids in the sites. There are however, solar home systems (SHS) that provide lighting, basic entertainment (television / radio / player) and communication (mobile charging) for households.

Assessment of Ramp Up energy demand

After enumeration of existing loads, the survey process conducts a community level participatory exercise to determine the level of latent demand, which shall manifest in the form of new energy demand with the introduction of the project. This is called ‘ramp up demand’, and can vary from site to site depending upon several factors such as proximity to trade and market centres, availability of inputs for new enterprises, and the level of enterprise at the site level.

Absence of energy limits livelihood options, which is currently heavily dependent on agriculture and livestock. As a result, climate vulnerability in the sites is high, owing to dependence on precipitation, suitable temperatures and other climatic factors. Livestock mortality is also high on account of rising climatic variability or extreme events. Although there are regional variations across the sites in terms of community-level entitlements and aspirations, there is a serious need for access to energy and infrastructure felt across all the sites.

Estimation of Load

The survey has indicated a total demand of 11.68 MW of electricity (after deducting loads that are currently being serviced by MHP and solar systems) that needs to be serviced in the target area of the proposed project. Most of it is from the residential sector. The domestic load is assumed to be 100 W per household which is in line with the projects designed under Citizens Charter programme.[54] The assumptions considered for the estimation of load is given in Table 12.

Table 14 Load Assumptions

Load Assumptions				
			Lighting Load (kW)	**Other Load (kW)**
Households	per household		0.1	-
	No. of operating hours in a day		5 (Early Morning & Evening)	
	No. of operating days in a year		365	
			Lighting Load (kW)	**Other Load (kW)**
Institutions	Health Centre	per health centre	0.5	3
	School[55]	per school	16*2*24/1000	2
	Police Station[56]	per police station	3*2*24/1000	1
	Mosque	per mosque	0.2	1
	Public Centre	per public centre	0.5	3
	No. of operating hours in a day		8 (Intermittent over 24 hours)	
	No. of operating days in a year		300	
			Lighting Load (kW)	**Other Load (kW)**
Enterprises	Tailory	per tailory	0.2	2
	Oil Extraction	per oil extraction	0.4	1
	Telephone Towers	per telephone tower	0.5	10
	No. of operating hours in a day		8 (Intermittent over 24 hours)	
	No. of operating days in a year		300	
Pumps	kW per pump		7.5	
	% of pumps to be energised using mini-grids		10	
	No. of operating hours in a week		33	
	No. of operating weeks in a year		26	

[54] http://mrrd.gov.af/en/page/69/citizens-charter/introduction
[55] 16 rooms per school, with 2 bulbs of 24W in each room
[56] 3 rooms per police station, with 2 bulbs of 24W in each room

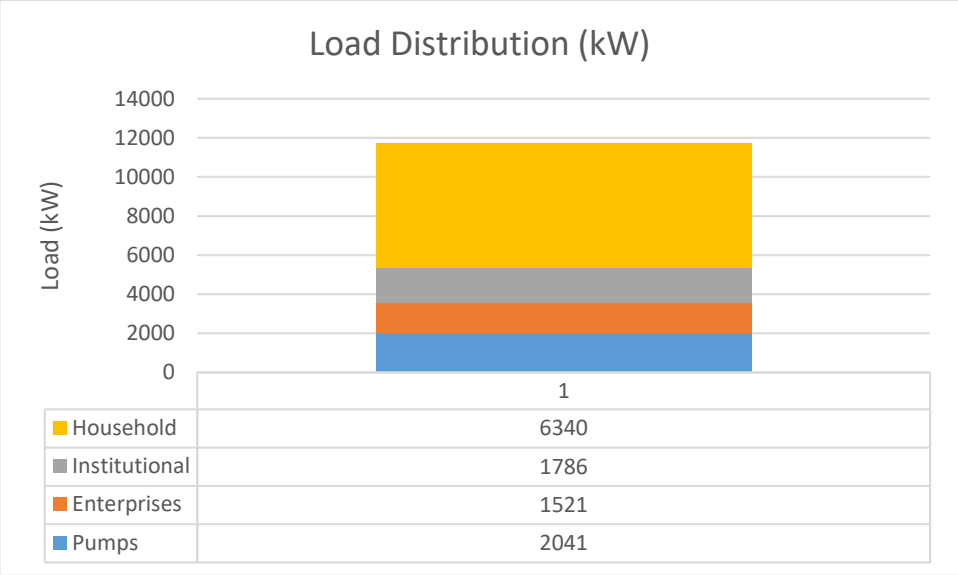


Figure 17 Load Distribution

As Figure 17 shows, bulk of the load comes from the residential segment. This is mostly due to low presence of enterprises in the absence of reliable and cost-effective electricity, together with other limiting factors such as lack of access to infrastructure. However, access to energy– the objective of this project– shall enable generation of additional enterprise loads and thereby change landscape of the load profile over the project's lifetime.

Additional Annexures: Detailed Investment Design Reports (DIDR)

- Annex II – A: The Detailed Project Report of the 1000 kW solar minigrid in Khost Province
- Annex II – B: The Detailed Project Report of the 600 kW solar minigrid in Parwan Province
- Annex II – C: The Detailed Project Report of the 1000 kW solar minigrid in Kandahar Province

Please see in a separated document