Afghanistan Energy Study

Household and Enterprise Surveys

Intermediary Results Report

Household and Enterprise Survey - Afghanistan Energy Project: Intermediary Results Report

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1. Introduction

1.1. Background

Energy at the household, small business and community institution level in Afghanistan is a central pillar in towards building sustainable development and access to better livelihoods for citizens of Afghanistan. Rapid expansion of grid and off-grid electrification is occurring across Afghanistan, with facilitation by a range of national and international actors.

The Government of Afghanistan's policies in the sector are guided by the 2012 National Energy Supply Program with planned boosts in electricity supply and imported capacity enhancement from neighbouring countries. Afghanistan lies between Central Asian states with increasing levels of hydro-electric production and South Asian states such as Pakistan who are experiencing burgeoning demand. There is also a pipeline of projects for enlarging Afghanistan's indigenous electricity generation through hydro-power and renewable production facilities across the country, with transmission and distribution infrastructure to match. The CASA-1000 project is one prominent example. Off-grid and other renewable solutions are being driven by multiple initiatives, including the Bamiyan Renewable Energy Program and a 5.5MW solar complex being constructed in Daikundi.

Despite this, pressing gaps remain as demand for safe, affordable and reliable energy continues to increase across the country. Diverse and difficult-to-access terrain, and areas affected by conflict or control by non-government actors are some of the structural barriers that prevent conventional grid investment and expansion. Other constraints are linked to complex, contextual factors.[1] Households and small businesses are continually creating their own energy solutions, often innovative, and the proliferation of solar panels on rooftops across the country are a visible mark of a rapidly changing sector.

Today, the Government of Afghanistan, donors, private sector actors and civil society organisations require access to quality information and data about the current energy landscape in Afghanistan, in order to better tailor responses to the country's growing energy needs. Knowing what is in use at the moment, challenges in energy provision as well as the ability and willingness to pay of households and businesses are all crucial in being able to scale up energy solutions.

This research sets out to fill some of the existing information gaps. The Household and Enterprise Diary endeavour is part of the World Bank's *Afghanistan Energy Study.* The aim of the project is to collect data on energy patterns at the household and business/community institution level in different Afghan contexts. This includes information on sources of energy and electricity, fuel sources, heating, cooking and lighting as well as willingness, and ability, to pay for better provision of energy.

[1] A micro-level path dependency example is heating. *Bukharis,* a space-heating oven, and *sandalis,* a heater underneath a table with a blanket - are ubiquitous. Coal, wood, animal waste and other biomass comprise the primary fuels, and remain highly dependent on agricultural patterns and seasonal shifts.

For the baseline phase of this 18month-long study, Samuel Hall conducted over 3,000 household surveys, 250 business enterprise and community institution surveys as well as 30 focus group discussions across 30 communities in six provinces. The research participant locations formed a diverse range of communities in terms of histories, cultures, energy solutions, challenges and opportunities.

This intermediary deliverable serves as a field report, presenting an overview of the locations visited and fieldwork conducted. It presents *preliminary* results and sets the stage for the upcoming year-long diary phase during which longitudinal depth will be added and seasonality captured through brief monthly follow-up surveys focusing on energy usage and willingness to pay of respondents portrayed in the baseline survey. This information will be complemented with in-depth case studies.

1.2. Research Questions

Energy usage and consumption patterns
How much energy do households, enterprises and community institutions use? For what? What is the source of energy in different locations and by different demographics? How reliable is this source of energy? To which extent do different options currently exist, and what arbitrage is used to decide between them? How do energy consumption patterns vary depending on the time of the year? How do energy consumption patterns vary depending on factors such as gender, migration background, household demographics and wealth patterns?
Cost of energy, and willingness to pay
What is the current cost of energy for the different target groups? How is energy currently paid for? How much do they stand to gain from improved energy provision? How much would they be willing to / could they afford to pay for said improvement?
Business Enterprise and Community Institutions (BE&CI)
What do business enterprises and community institutions (BE&CI) currently use energy for? What appliances are prevalent in the Afghan BE&CI context? What could BE&CI do if energy supply was scaled up and made more affordable? What is BE&CI willingness to pay for different energy solutions? What is the source of BE&CI energy in different locations and by different demographics? How reliable is this source of energy? How does this impact on business activities?

Figure 1 Talkhakhi, Samangan: A research participant stands with his solitary solar panel. It charges a battery which powers light bulbs and mobile phone charging.

2. Fieldwork conducted for the baseline phase

2.1. Research Tools

To identify and develop the fieldwork research tools, the Samuel Hall team held preliminary meetings with a range of actors across the energy sector, completed a secondary desk review and also conducted the community profiling phase; where field researchers went to each of the thirty (30) communities in the sample and mapped demographics, community geography, an economic profile and an overview of energy patterns.

The research tools included:

- Quantitative Household Surveys
- Quantitative Business Enterprise and Community Institution Surveys
- Focus Group Guidelines for community discussions
- Key Informant Interview Guidelines.

The survey tool was developed and refined with the World Bank staff, before being translated into Dari and Pashto and coded onto the industry standard Open Data Kit (ODK).

- Quantitative Household Survey Themes

The Quantitative House Surveys focussed on general household demographic information, including household members, economic profile (work, income, spending and assets), literacy rates and migration profile. Energy solutions formed one of the core components of the quantitative survey, with the tool focussing on which energy solutions are in use, how they are used, for what purpose, how they are paid for and issues with energy provision. The energy sections consisted of electricity solutions (such as grid, generator and solar), as well as energy used for cooking, heating and alternative lighting (dry-cell batteries, candles). Health questions were also built into various sections of the survey, including the electricity solutions as well as heating and cooking sections. Another major component of the survey was *willingness to pay* for both grid access and different types of solar energy products, with different kinds of payment setups.

- Quantitative Business Enterprise and Community Institution Survey Themes

The Quantitative Business Enterprise and Community Institution Survey matched the Household Survey in obtaining general information (sector, type of business, size in both staffing and area, years of operation, revenue and expenses) and energy solutions. To find out *how* businesses enterprises and community institutions used their energy, the most important tools for the business and the energy needs for their usage were explored. Willingness and ability to pay for grid and solar solutions were explored in depth.

- Focus Group Discussion Themes

The Focus Group Discussions tool expanded on key sections of the quantitative tools including the intersections of energy and health. Issues and problems, including with access, affordability and utility were highlighted. Household and business enterprise aspirations for energy were explored. How energy affected different genders, and how energy plays a crucial role in women's day-to-day lived-experience also formed a core component of each focus group discussion.

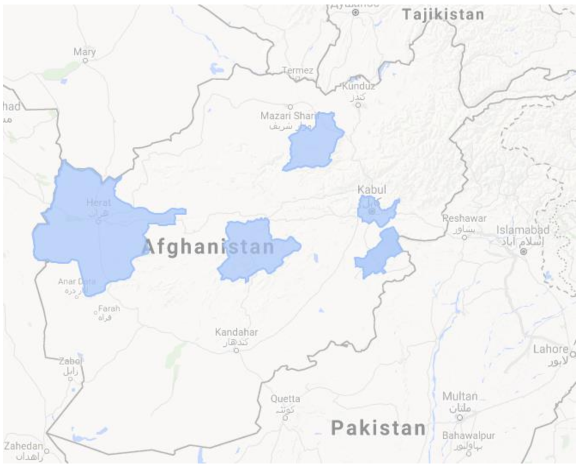
Table 1 Fieldwork targets for the baseline phase

	Kabul	Samangan	Herat	Daikundi	Paktia	Total
Communities	6	6	6	6	6	30
Household surveys	600	600	600	600	600	3,000
Business and enterprise surveys	50	50	50	50	50	50
Focus groups (men/women/businesses)	6	6	6	6	6	30

2.2. Sampling and timeline

Table 2 Selection criteria for the provinces surveyed

Electrification rates	Provinces
Highest	Kabul (pilot province)
Expected to grow	Samangan
Connection to the gri possible	Paktia
Connected to Iran	Herat
Off-grid solutions	Daykundi



The five sample provinces represented the different categories of electrification characteristics (with Herat being placed in the fourth category of being connected to Iran):

Table 3 Electrification rates across the provinces of Afghanistan

Electrification rates	**Provinces**
Highest	**Kabul**, Balkh, Kandahar, Kunduz (and Herat)
Expected to grow	Badakhashan, Baghlan, Faryab, Helmand, Jowzjan, Laghman, Nangarhar, Parwan, **Samangan**, Sar-e-Pol, Takhar, and Wardak.
Connection to the grid possible	Badghis, Bamyan, Ghazni, Ghor, Kapisa, Khost, Kunar, Logar, **Paktia**, Paktika Panjshir, Uruzgan, and Zabul
Connected to Iran	Nimruz, **Herat**
Off-grid solutions	Nuristan, **Daykundi**, Fayab

The participant communities were selected to represent urban and rural locations, cover different districts in the provinces and were stratified random to fulfil these first two categories, along with communities deemed accessible after security assessments. Within these communities, households were surveyed randomly through a grid approach. Field team leaders, with the assistance of the community focal points, would map the community and divide it into a grid (taking into account population density in both densely populated urban areas and sparsely populated rural zones).

Figure 2 GPS coordinates of household interviewed in Ghaf, Daikundi

Based on this improvised map, enumeration areas were chosen and enumerators dispatched with a goal to having each enumerator cover approximately the same size of population. Within their grid, enumerators were encouraged to attempt to interview the inhabitants of every third dwelling.

Business Enterprise and Community Institutions

A wide range of businesses and community institutions with distinct energy usage patterns were surveyed across all five provinces in purposive selections. While some rural communities in the sample (such as Qarya Dasht in Daikundi) were almost entirely agrarian and only had a few small retail shops, many communities had a broad span of home-enterprises, mobile-vending and more traditional businesses that engaged with energy in disparate and sometimes novel ways.[2]

The sampling was designed to cover major sources of economic growth in different contexts in the sample provinces. It was also designed to explore energy access issues, productive energy load, the potential for scaling up business activity in the event of improved energy access, etc. This range of enterprises and their varying tools; from ice-cream making machines, lathes, computers, to chicken coop equipment, provide an impression of the drivers of the Afghan economy in 2018.

The fieldwork was conducted in a compressed time period to mitigate deleterious effects of seasonality, including changes in daylight hours, weather and temperature.

[2] Examples include an embroiderer in Daikundi who used a solar home system to power her sewing machine. A barber in Shewaki, Kabul Province used a large wooden boiling system to provide hot showers and baths to patrons for a fee.

Figure 3 Fieldwork plan

	W1							W2							W3						OFF
	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
Province	8/4	9/4	10/4	11/4	12/4	13/4	14/4	15/4	16/4	17/4	18/4	19/4	20/4	21/4	22/4	23/4	24/4	25/4	26/4	27/4	28/4
Kabul				Pilot																	
Herat											Pilot										
Sam.										Pilot											

	W4							W5							W6						
	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
Province	29/4	30/4	1/5	2/5	3/5	4/5	5/5	6/5	7/5	8/5	9/5	10/5	11/5	12/5	13/5	14/5	15/5	16/5	17/5	18/5	19/5
Herat																					
Sam.																					
Paktia				Pilot																	
Daikundi					Pilot																

2.3. Fieldwork and team

Field teams were comprised of local enumerators in every province, except in Daikundi which was covered by the Kabul team. The Field teams were trained and managed by Samuel Hall Field Coordinators. Two Team Leaders supported field coordinators and oversaw the teams in every province.

In all thirty communities, Samuel Hall Field Teams would speak to Community Focal Points in the preceding days before the start of data collection. On the day fieldwork in the community started, the Field Teams would enter the village and meet the Community Focal Point, who would describe the geography of the village, its boundaries (for example, if a village directly bordered another village such as Langar in Kabul Province), and provide other logistical information and support.

The field team would then spread out and commence random sampling of houses for data collection within the specified geographic area of the village, with support from Team Leaders and Field Coordinators.

Figure 4 Shewaki, Kabul Province: The participant is on the left, enumerator on the right and a Kabul Team Leader is sitting in on the survey (centre)

Community focal points

The "Community Focal Points" are local ambassadors of this long-term research project. They were initially brought on board to liaise with participant communities over the year-long longitudinal part of the study and prevent attrition. However, the Focal Points proved to be a strong asset throughout the baseline phase. They provided on-the-ground knowledge of the geographical and human terrain of their respective communities. When walking with enumerators on their random sampling tours, a member of the community would open the door to a trusted member of the area who would help explain the research and its purpose. Across all 30 villages and urban areas, Community Focal Points could point out community institutions and small businesses, as well as locating other members of the community that the field-teams could speak to in order to gain a better understanding of the energy context of the area. The contribution by the Focal Points in the baseline phase augured well for their role as a key liaison with the research communities during the longitudinal phone surveys as well as the qualitative seasonal case studies.

Figure 5 Focus groups in Kabul province

The qualitative and quantitative data collection was complemented by Field Key Informant Interviews (KIIs), conducted by project research staff and the Field Coordinators. A range of actors were contacted to provide qualitative depth and a local but broader perspective on the energy landscape in a particular district or province. This included interviews with local DABS representatives, government officials, civil society organisation staff and electricity generation hardware vendors (such as solar home system sellers).

2.4. Challenges

Security

Four separate incidents during the fieldwork stage presented challenges and led to refined and tailored danger mitigation strategies.

- **Terrorist attacks against voting centers**

A terrorist attack occurred against a voter registration center inside a school in Dasht-e-Barchi on 22 April, 2018. The field team had originally planned to conduct fieldwork in Dasht-e-Barchi on that date but through a combination of factors, including the ongoing grid electricity outages, were instead collecting data in Karte Naw (the other side of Kabul). The attack reinforced Samuel Hall's precautions for field team safety. Polling stations were in schools which were part of the Business and Community Institution Sampling. Following the incident, field teams were instructed to select schools that were not being used as voter registration centers, and to avoid lines of people registering to vote.

- **Afghanistan-Pakistan security force skirmish in Paktia**

Additional precautions were taken after a skirmish and cross-shelling between the security forces of Pakistan and Afghanistan on 16 April, 2018 in Paktia province. The incident took place in the border region of Dand-e-Patan district in close proximity to the participant community of Patan Kalai. The field and project teams kept in close communication with sources on-the-ground, including the Community Focal Point to stay abreast of any further security developments and ensure the safety of the data collection teams during the Paktia field phase.

- **Mujahedin Commander in Daikundi**

Before data collection commenced in one of the sampled districts of Daikundi, the field teams learnt about an active Jihadi commander who lived in the area. The commander was purported to have 70-80 armed people working for him as part of a group sometimes resistant to the Afghan National Unity Government (NUG), having also been a previous ally to the Taliban regime. While the commander was not said to be in conflict with the government, the Samuel Hall teams were wary of the potential of the threat for kidnapping and disruptive efforts against the data collection.

Upon the standard presentation of the letter of authorisation to the district governor, authorities there also voiced concerns. The Field Coordinator and the Community Focal Point approached the Community Development Council (CDC) and local elders to assist in communicating with the commander about safety and access issues. After successfully communicating information about Samuel Hall and the aims of the project, the field-team were granted safe access for data collection and the commander even participated in an interview about energy issues in his area of influence.

- **Armed men in Paktia**

The most serious security incident occurred in one of the six Paktia communities, (de-identified here for security reasons), on the last day of data collection for the baseline phase. As the team were finishing the last of the surveys for the day, the Field Coordinator noticed a group of armed men astride motorcycles watching the field team. The armed men wore turbans in the Taliban-style. Following Samuel Hall duty of care protocols, the team gathered quickly and returned to the nearest town via an alternative route. The Field Coordinator reported the incident immediately and ensured all enumerators returned to their homes safely.

Grid Transmission Attack and Outages

Figure 6 A pylon downed during fieldwork. DABS official image.

On the night before fieldwork commenced (Friday the 13th of April), one of the pylons on the transmission route for electricity from Uzbekistan and Tajikistan to Afghanistan was destroyed in Baghlan Province, with police placing blame on Taliban militants. The attack cut most of the grid electricity supply to Kabul, with only intermittent supply in the city over the days that followed. It was thus decided to delay data collection in the areas concerned by this incident in order to mitigate potential biases in terms of outages recorded.

Network Issues

Charkh Telephone Coverage

Figure 7 Deep valley in Charkh

Households in Charkh are dispersed through a valley and up the valley-side. In the deeper parts of the valley near the valley-floor, there is no phone reception. While villagers living at the bottom of the valley have mobile phones, they usually walk and climb for 5 to 15 minutes up the hill to find telecommunications reception to make calls.

This was deemed a potential risk to the completion of the phone survey diary phase in this community. Upon discovery of the telephone network issues, the field teams reported the findings to the project team. The risk of automatic attrition of villagers in the lower reaches of the valley in Charkh was mitigated by including a new participant set in the village of Narlej in a nearby valley.

Additional community

After the network coverage issues in Charkh, Meramoor District in Daikundi Province, a decision was made to extend fieldwork by one day to prevent the automatic attrition of approximately half a village. The entire 100 household sample set was completed in Charkh, before one additional day of data collection (50 households), was conducted in Narlej village in the valley to the west of Charkh. Narlej was chosen due to its geographic proximity and similar demographic and energy patterns to Charkh.

Survey Interest

On several occasions, Samuel Hall field team members were approached by individuals who demanded that their household be surveyed. The Community Focal Point would explain the randomness of the sampling and its purpose and importance; as well as wider aspects of the research project, diffusing tension and conveying the benefits of the project.

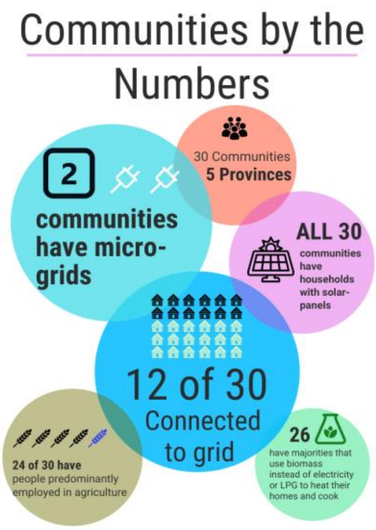
3. Location contexts

Energy patterns in Afghanistan does not fall into easy binaries such as grid and off-grid or urban and rural. Differing contexts exist between and within provinces, districts and communities. The following section begins to explore these diverse location profiles.

Nota bene: More detailed information is presented on the associated project website.

Community profiles

The Community Profiling approach was an innovative research tool that assisted in developing a nuanced picture of the social, economic and energy landscape of participant communities. The profiling phase was conducted before the commencement of the survey and focus group data collection. It consisted of a mapping exercise to gain a preliminary and broad understanding of the communities. The community profiling captured characteristics such as demographics, economic activity, migration dynamics, infrastructure and, of course, energy sources and usage. The data and information that was collected provided a base to further refine the research methodology and tools.



A. Kabul

Figure 8 Surveyed communities in Kabul province

Kabul is the capital of the province and the country, holding the seat of the national government and the majority of Afghanistan's commercial sector. Kabul lies at an elevation of approximately 1800 metres above sea level and is situated on an important trade route between Central Asia and Pakistan.

Both the city of Kabul and the wider Kabul province has a mixture of grid-connected and non-grid communities.

Urban Kabul Communities

Karte Naw, Khair Khana and Dasht-e-Barchi represent the urban Kabul localities. They cover tens of thousands of households, so a neighbourhood segment was chosen in each to represent a community energy sample.

Kata Bolandi, Dasht-e-Barchi[3] - *Kata Bolandi* is located to the south-west of the center of Kabul. Kata Bolandi is not connected to the grid, although infrastructure has been in place for some years. Entrepreneurs have set-up a large diesel generator that acts as a mini-grid for some households in the area. Many of the dwellings in the community are built with mud-bricks, connected by unpaved roads and informal infrastructure.

Sayed Noor Mohammad Shah Meena, Karte Naw - The Karte Naw community of Sayed Noor Mohammad Shah Meena is located in the south-west of Kabul. It consists of medium-density housing, with paved roads and relatively good infrastructure provision. Like the wider area of Karte Naw, the area is home to a wide range of economic activities including banks, mechanics, food stores, TV repair shops and clothing outlets. The area is almost entirely connected to the grid.

Hasa-e 315, Khair Khana - *Hasa-e 315* and the wider area of Khair Khana is located over the hills to the north-west of Kabul city centre. Khair Khana is experiencing expanded construction of new residential buildings and paved roads, with developing commercial buildings and institutions present in the area.

[3] Please follow the hyperlink for a more detailed description of the locations.

Rural Kabul Communities

Deh Yahya - Deh Yahya, in Deh Dabz District, is a community situated north of Kabul airport on the other side of a range of hills, with the city of Kabul sprawling towards it. Many of the residents are returnees from Iran or Pakistan. The community is located in the hills and has a stream flowing nearby. The area is densely populated and predominantly residential - with most shops clustered on the main road. Deh Yahya has no grid connection. Off-grid solutions including stand-alone solar home systems are in use by many households.

Langar - Langar is an agrarian village in Qarabagh district in the far north of the province. Community elders in Langar have been petitioning for grid-connection for over three years; encouraged by the fact that the community is located adjacent to a village (Daudzayee) that is already connected to the grid.[4]

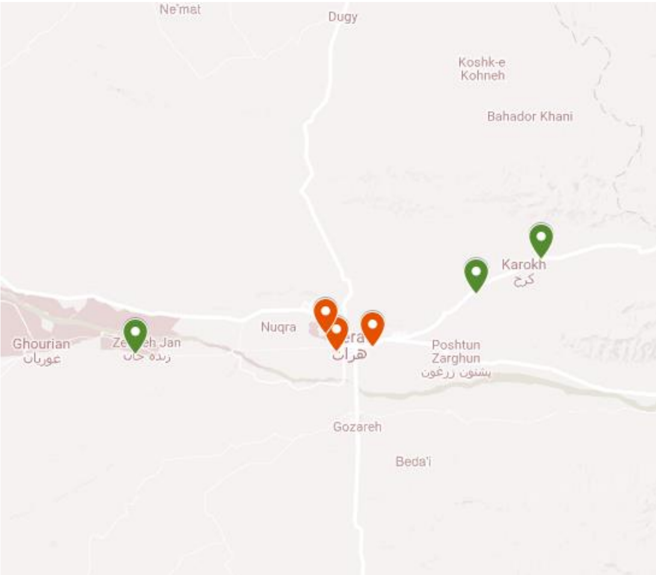
Shewaki - Shewaki, like Deh Yahya, is also slowly being encroached upon by Kabul's urban sprawl, but remains relatively rural with a built-up town center. The town-center has a range of businesses and services. The majority of Shewaki's households and enterprises are connected to the grid, but areas on one side of the town center and also farmhouses in agricultural land outskirts do not (yet) have a grid-connection.

Figure 9 Shewaki center and surroundings

[4] It was pointed out to the research team that a powerful minister was born and owns land in Daudzayee.

B. Herat

Figure 10 Surveyed communities in Herat province



Herat Province is one of the largest provinces in Afghanistan by population and is an important trading province. It is located in the west of the country and shares a border with Iran in the west and Turkmenistan in the north.

Herat Province includes one of the major cities in Afghanistan, Herat which has reliable, imported electricity from Iran. Outside Herat City, rural areas are experiencing some levels of grid electrification expansion, with many communities continuing to utilise off-grid solutions.

Herat Urban Communities

Jebraeel (Nahia 12) - The new urban township of Jebraeel is divided into two communities, one forming a part of Nahia 9 and the other a part of Nahia 12.[5] The community sampled, Jebraeel Nahia 12, is based on a grid of 21 streets. 16 of those streets are connected to the grid. Most of the houses are concrete or made of bricks. The streets are unpaved but the nearby main road is paved. A large mosque and a number of shops line the area.

Shaalbafaan - This community is located in the vicinity of Herat city and is densely populated. Most of the houses are concrete, with several multi-storey buildings. Almost all roads and streets in Shaalbafaan are paved and there are many commercial premises and shops on each street. Shaalbafaan is connected to the grid.

Naw Abad Shuhadaye - The community is a densely populated urban area lying on flat ground close to the Badghis – Herat Highway. All the buildings in the area are 2 – 3 storey concrete buildings. Many of the households are constructed from brick and concrete. Naw Abad Shuhadaye contains many mosques and shops, and all the main and sub-roads are paved. The community is connected the grid.

[5] A nahia is a municipality administrative area.

Figure 11 Jebraeel, Zendeh Jan district

Herat Rural Communities

Qala-e Sharbat[6] - Located in Karukh district, the village of Qala-e Sharbat is located in hilly terrain. Most of the dwellings are constructed from mud and the streets and roads are unpaved. The majority of people are engaged in agriculture. Qala-e Sharbat does not have a connection to the grid. Community members utilise off-grid solutions, with solar home systems being prevalent.

Majghandak - Majghandak is a village of Karukh district and located alongside the Herat-Badghis highway. Almost all of the houses are mud. This area has wide agricultural lands and gardens that are irrigated from the nearby river and deep wells. Roads and streets in the community are unpaved. There are a few shops in the village but more shops are located on the main road. The community is not connected to the grid. A Pico-Hydro Power system is available in the village but only functional in the winter when there is sufficient water in the stream to power the turbine. Stand- alone solar panels are a common sight.

Malikiha - The community of Malikiha is a sprawling village located in Zendeh Jan district west of Herat City. Part of the village, consisting of a few hundred households, is connected to the rid. The majority of houses are made of mud. The village is surrounded by farmlands and orchards and a few shops exist in the area.

Figure 12 Malikiha village

[6] Literally 'Fort of Syrup'

C. Samangan

Figure 13 Surveyed communities in Samangan

Samangan province lies in the north of Afghanistan. Located between Balkh and Kabul, a major electricity transmission line from Uzbekistan runs through the province with growing numbers of communities connected to the grid. Samangan is predominantly agrarian, with tracts of fertile and green valleys surrounded by arid deserts.

The communities in Samangan blur the distinction between urban and rural. Although three communities are located close to the center or Aybak (the district and provincial capital), they are considered agricultural villages with the majority of community members engaged in livestock, agricultural gardens (nuts and fruit), and farming.

Figure 14 Built to last? An electricity pole in Chawgai

Chawghai - Chawghai is a small village with approximately 160 households in Aybak District. Although close to the center of the provincial capital of Aybak, most of the community members are engaged in almond farming. Many residents have migrated abroad. The village has reliable grid electricity, but access to services such as schools, health facilities and paved roads is poor.

Mula Qurban - Mula Qurban is an agrarian village situated close to Aybak center, with desert hills to the north. Many residents work in daily wage labour in larger Afghan cities (including Mazar-e Sharif and Kabul), or have emigrated abroad. The majority of community members work in agriculture. A primary school was built in the village by the National Solidarity Program (NSP). Mula Qurban is almost entirely connected to the grid.

Figure 15 Dalkhaki village, Samangen: electricity poles without transmission lines stretch along the road

Dalkhaki - The village of Dalkhaki, in Aybak District, lies at the foot of a mountain of the same name, about 30 minutes north of Aybak town center. Dalkhaki has partial grid infrastructure in place but has not been connected to the grid. Dalkhaki is spread out on either side of tracts of farmland and then further divided into areas tied to the four different mosques spread across village.

Lab-e-Aab - Lab-e-Aab is a village near the border of Balkh lying in a fertile valley in north-eastern Samangan. It is located in the north-eastern Feroz Nackhir District. The village is surrounded by orchards, vineyards, agricultural gardens and farmlands. Lab-e-Aab is not connected to the national grid, although many residents expect the community and their households to be connected within the next year, with grid infrastructure already in place in the village.

Yakatoot - Yakatoot is a village situated on a plain close to the main AH76 Highway between Mazar-e Sharif and Aybak in the Hazrat Sultani District. It is located on more arid ground than the fertile valley region around Aybak. Yakatoot is connected to the grid. Household dwellings are predominantly made of mudbrick and roads are unpaved. Many of the villagers of Yakatoot are engaged in agriculture, mostly on wheat farms but also grape and almond orchard gardens. Many young people have migrated overseas to find work.

Dawlatabad - Dawlatabad, in Hazrat Sultani District, lies at the foot of hills on the edge of the main valley running through Samangan. Dawlatabad is connected to the grid. Agricultural gardens, livestock and farming are the major livelihoods sources. Roads are unpaved and service infrastructure is limited, with a school located in a neighbouring village and health workers visiting the village every three months. Most of the houses are made from mudbrick.

Figure 16 Overlooking a part of Dawlatabad Village from the hills. Beyond the green pastures and farmland in the distance is the AH76 Highway and major import electricity transmission line, between Mazar-e Sharif and Aybak (and eventually onto Kabul).

D. Paktia

Figure 17 Surveyed communities in Paktia

Paktia is a mountainous province in Eastern Afghanistan bordering Pakistan.

Grid connections were being set up in the capital of Gardez while baseline fieldwork was ongoing. Rural areas of Paktia use non-grid electrical solutions. Paktia is known for its forests, with wood contributing to the province's as well as wider Afghanistan's wood consumption for energy.

Paktia (Gardez Communities)

Baala Deh - Baale Deh is a community near the center of Gardez. It has not been connected to the grid, and people use off-grid solutions such as Solar Home Systems. Although close to the urban center, a majority of people in the community own nearby agricultural farmlands which are irrigated from streams and *kariz* (a system of water wells connected by underground canals used for irrigation and drinking water).

The community previously had access to a Pico-Hydro System built by the government, but it is no longer functional due to successive droughts and lack of water. The community sports 14 mosques and a small number of shops.

Bano Zai - This village is flat and roads inside the village are not paved. The majority of people are involved in agriculture. The single storey mud houses are interspersed across a large area and have gardens and orchards between them. The key non-residential buildings in the village are 10 mosques, a clinic and a school. This village is not connected to the grid, and off-grid solutions are in use.

Habib Kala - Habib Kala is a community located approximately one kilometre from two nearby major roads. Almost all dwellings in the community are mude made and the roads inside the village are not paved. The majority of community members are engaged in agriculture, working on farmlands and in agricultural gardens. The main sources of irrigation water are deep wells and *kariz*. There are a few shops inside the village along with 7 mosques. Habib Kala has not been connected to the grid.

Paktia (Chamkani and Dand-e-Patan Communities)

Mandokhail - Mandokhail lies in the Chamkani district of Paktia. The wider district of Chamkani lies across two intersecting valleys to the east of the provincial capital, Gardez, with Mondakhail located along one of the valleys. The majority of people living in Mandokhail are involved in agriculture, and tend to farmlands and gardens. A large system of *kariz* flows through the middle of the village and is the primary source for irrigation water. Houses are interspersed over hills and flat terrain, and there are surrounding pine forests. Mandokhail is not connected to the grid and many households utilise stand-alone solar panels.

Figure 18 Mandokhail village, Paktia

Narqese - Narqese is located close to the Pakistan border in hilly terrain. Narqese lies in the hills north-east of Chamkani center and household dwellings are located over the range of hills. The surrounding mountains and hills are covered by Walnut Trees and Chilgoza Pines. The village has farmlands and is irrigated by 4 different systems of *kariz*. The community is not connected to the grid. A clinic, schools and shops line the nearby Chamkani road.

[Patan Kalai](#) - Patan Kalai in Dand Patan District is situated on the border with Pakistan and the terrain is a mixture of flat and hilly areas. A river (*Kolaye Seand*) flows to the south of the village and the majority of the households and the agricultural lands lies between the river and the main road to the north. The houses are made from mud. There are a number of mosques in the border village, and a few local shops. However, people usually shop in the district bazaar as it contains a large market. This community is not connected to the grid.

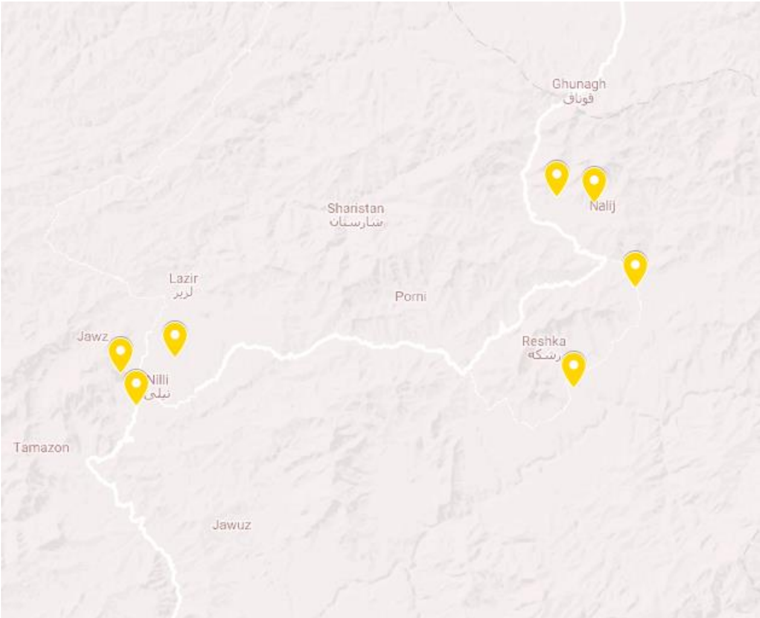
Figure 19 A presidential tweet

The President of Afghanistan, Ashraf Ghani tweeting about the inauguration of the Arghande-Gardez Power Line and Gardez Sub-station, on 1 April, 2018. It shows the ongoing and rapid changes in the energy sector, and directly affected sampled communities in the Household and Enterprise Diary Study with grid connections occurring at the same time the research was ongoing.

E. Daikundi

Daikundi is a rural province located in the central highlands of the country. The province is situated in the traditionally ethnic Hazara region known as the Hazarajat. The provincial capital is Nili. The province lies across high mountains, with Nili situated over hilly terrain and many villages in Daikundi located in valleys. Communities in Daikundi are not connected to the grid. DABS does conduct small operations in the province, but the service is limited to government facilities and some small businesses (i.e. hotel, restaurants, shops). DABS provides diesel power to customers from 8am to 4pm every day.

Figure 20 Surveyed communities in Daikundi



Qarya-e-Dasht - Qarya-e-Dasht[7] is located approximately 30 minutes by vehicle from the center of the capital. While community members can access basic goods and services from a small number of shops in the village, they usually purchase the bulk of their goods and services from the main market Old Bazaar in Nili. Households in Qarya-e-Dasht are spread out and dwellings are made of mud and stones, with the majority of houses not having surrounding walls for protection. The lack of water and the sandy soil of the area has led local farmers to grow almonds which are drought-tolerant and can grow in sandy soil.

Qarya-e-Dasht is not connected to the grid. Wells are used for drinking water and some households have installed moveable solar panels on their wells to assist in pumping water.[8] Many households have access to television media through satellite dishes.

Figure 21 Dasht village, Daikundi

Sang-e-Mum - Sang-e-Mum in Nili District lies in a valley and is surrounded by rocky mountains on all sides. Its major source of water is fountains that are abundant in the spring season but not in summer or winter. The Lazir river lies approximately 12 km away. Most of people are engaged in agriculture, with smaller numbers of community members involved in daily wage labor. The main agricultural product are almonds, but the area has recently experienced prolonged periods of drought. There is one school in the village for both boys and girls. Sang-e-Mum is not connected to the grid. Many community members have access to deep-water wells and withdraw water using solar power.

Sar-e-Nili - Sar-e-Nili is a village neighbourhood of the provincial capital of Daikundi. The village is hilly and almost entirely surrounded by rocky mountains. The village is full of trenches with houses being built along the rocky hillsides. Most of the houses are constructed from adobe bricks with wood ceilings. Community members are usually engaged in agriculture or daily wage labor. Many young people have moved to Iran for work.

The Community Development Council (CDC) built a hydro micro-grid system in 2011 but the system ceased to work after one month of operations. Machine parts were reportedly stolen by thieves and now the hydro-system does not function.

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7 Qarya-e-Dasht literally means 'Village of the Desert'

8 The moveable solar panels do not require batteries as energy storage or because two 250 watt solar panels are able to withdraw water from a well to the surface

Figure 22 Remains of a pico-hydro system in Sar-e-Nili, Daikundi

Khuja Chasht - Khuja Chasht is located in Shahrestan District, in the hills with high mountains to the west and the Helmand River to the east. The village is not densely populated, with mud houses spread across a large area on the hills. Along with farming, villagers also herd sheep and produce of *gelam* and *nemad* carpet products from sheep wool. There is one primary school but no secondary school in the village. The nearest clinic is in the district center, approximately 20 minutes drive from Khuja Chasht. Khuja Chasht village is not connected to grid. A diesel-powered mini-grid operated in the village but broke down in 2011.

Ghaaf - Ghaaf village in Shahrestan District is a sparsely populated village with the single-storey mud households spread over a large area. The village is located in hilly and mountainous terrain approximately lying approximately 20 kilometres away from the Helmand River.

There is a secondary school for boys and a secondary school for girls in the community. This community is not connected to grid.

Figure 23 Households in Ghaaf, Shahristan District, Daikundi

Charkh - Charkh, in Meramoor District, is a large valley which consists of more than 1200 households spread across 6 Community Development Councils (CDCs). Most of the people living in Charkh valley are engaged in agriculture. Many young people migrate to Iran and Pakistan to search for higher paying job opportunities. Charkh village is located in rugged hilly terrain surrounded on three sides by mountains. The village lies next to a river that flows during the spring season, but usually runs dry in the summer. The houses in the village are constructed of mud and the community is not densely populated, with houses spaced 100 to 200 metres away from each-other across hills. This community is not connected to grid. Six households in the community installed a Pico-Hydro System on the river that flows through the valley, generating electricity in the winter and spring but not in the summer or fall because of the river water levels.

4. Preliminary Findings and Analysis

4.1. Overview of respondents' demographics and economic profile

A. Households

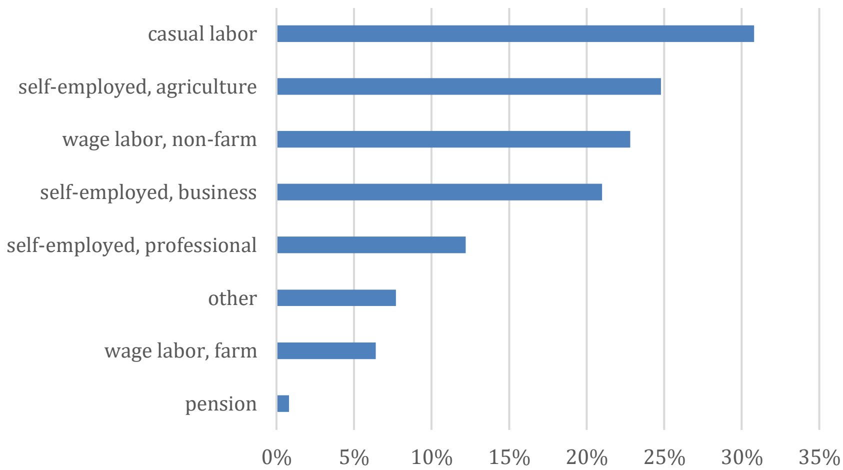
The sample analyzed for this research consists in 3,061 households and 253 businesses / institutions across five provinces. Almost half of the household respondents were female while the vast majority of business / institution respondents were male. This might be a contributing factor to the lack of literacy in the household sample: indeed, only 37% of household respondents could read or write. Besides household respondents, the research team interviewed representatives of 179 businesses of different sizes, and of 74 community institutions (schools, mosques, health facilities and public facilities) across the five provinces. Almost exclusively male and comprising business owners / employees, medical staff and teachers, wakils and administrators, this sample was largely (76%) literate.

The interviewed **households** consisted in ten members on average (median of eight).

The most prevalent sectors contributing to the interviewees' livelihoods are agriculture (32%), construction (30%), trade (16%), and the public sector (13%).

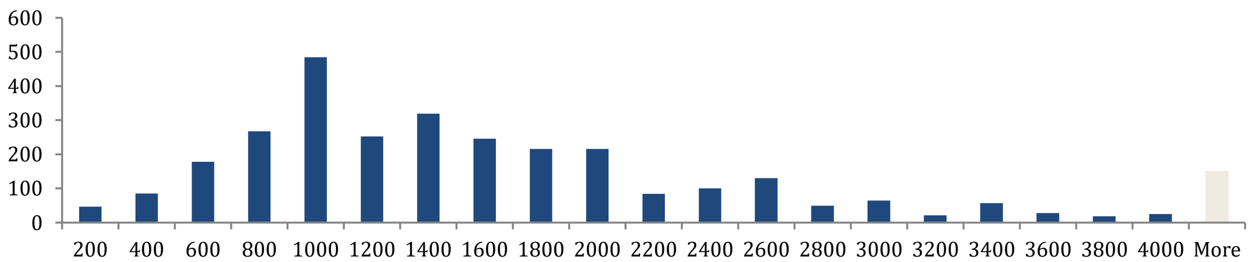
16% of interviewed households earn an income with a home-based non-agricultural activity, most commonly related to embroidery and tailoring.

Figure 24 Household respondents' primary sources of revenue (% of interviewed households)



The average monthly income per household members varies considerably, with a mean of AFN 1,800 and a median of AFN 1,300.

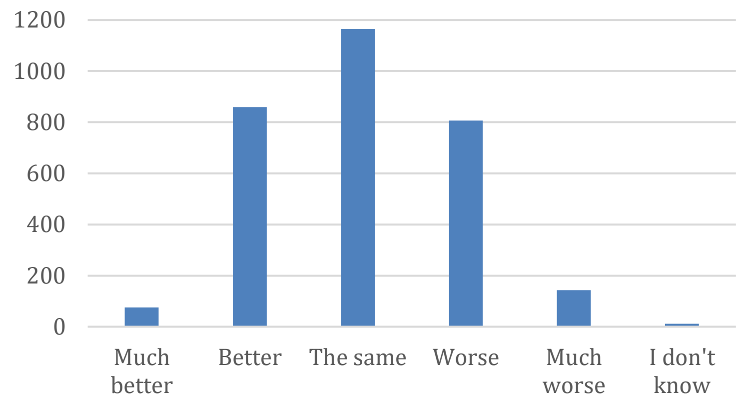
Figure 25 Histogram of reported monthly income per household member (# of respondents, income in Afghanis)



Doubtlessly owing to the sectors which figure prominently in the livelihoods of the sample (agriculture and construction), this income is highly seasonal: some three quarters of respondents note that their income varies over the course of the year.[9]

The worst months for livelihoods are the winter months, between December and March. These are times when the 20% of respondents who do not have access to any type of credit will traditionally be facing more dire circumstances than their peers who are able to borrow.

Figure 26 Economic situation compared to others around you (# of respondents)

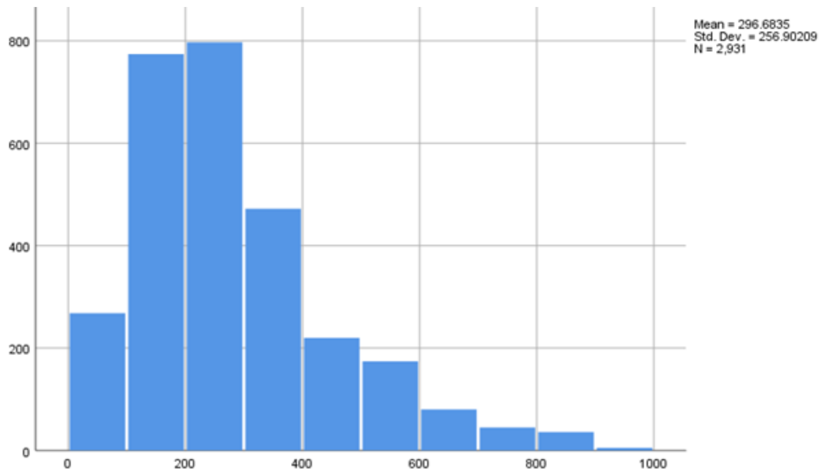


Household respondents for the most part feel that they resemble the average of their peers in terms of economic well-being.

Compared to one year ago, more household respondents feel that they are faring worse (36%) economically than better (25%).

Data on reported household expenditure is notoriously unreliable, as was illustrated again in the sample interviewed for this research.

Figure 27 Histogram of household spending on food, per person, over the past seven days (# of respondents, spending in Afghanis)



One valid proxy is the spending on food (which, unlike housing, education and celebrations, will be something every household does spend money on, with some leeway in terms of cost).

[9] This is the case particularly in Herat (80%) and Samangan (85%), compared to Kabul (70%).

Figure 28 Dwelling of a Hazara family in Charkh, Kabul

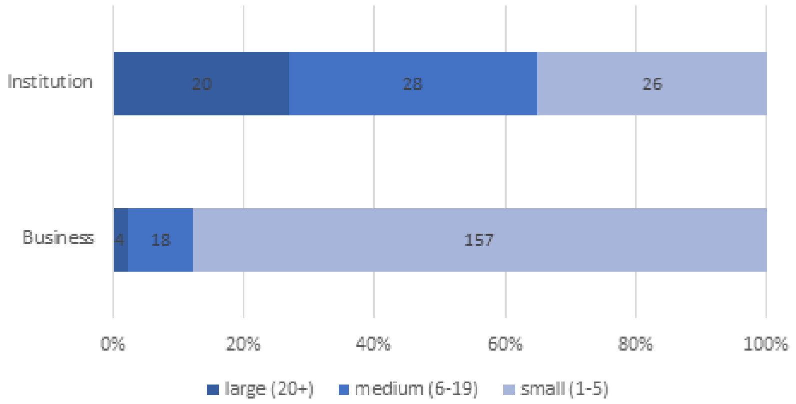
The vast majority of respondents (94%) owns their dwelling and thus does not have rental costs. The most common type of dwellings are single-story houses occupied by only one household (whose prevalence ranges from 53% in Herat to over 80% in Paktia and Samangan), shared single-story houses (12% overall) and shared multi-story buildings (overall 9%). The former two are commonly constructed of mud bricks, while the latter is made of brick / stone. The most common material for the roof is wood.

B. Businesses and community institutions

The interviewed **business and institution establishments** vary considerably in size, with an average number of employees of five for businesses, and 20 for community institutions.

The larger the businesses, the more likely they were to be registered (usually with the municipality).

Figure 29 Size of the interviewed establishments (# of employees, % of enterprises and institutions surveyed)



The sample contained eleven factories[10], twelve offices (mainly government-related), 21 mosques, 27 schools and 123 shops.

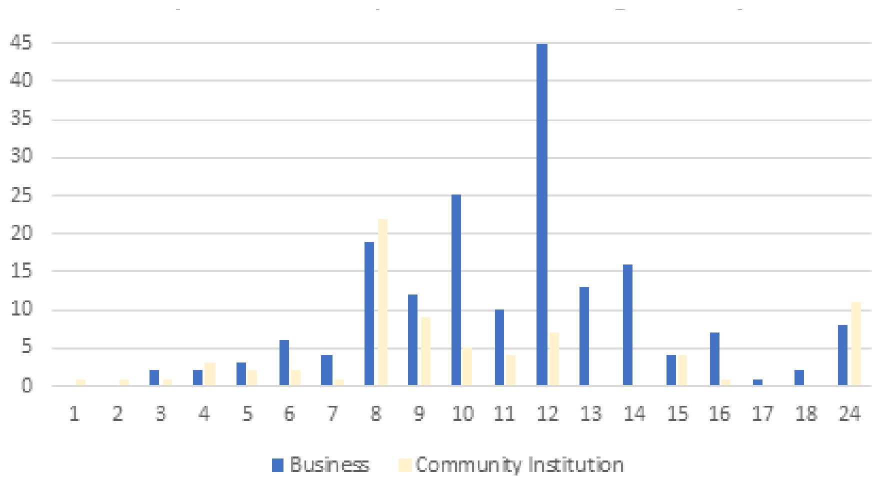
Representing a diverse picture of the Afghan economy, the latter include, among others,

grocery story, metal workshops and tailors but also shops dedicated to mobile and computer repair, ice cream parlors and gas stations.

[10] Carpentry, metal works, milk, salt, shoes and tyres...

All interviewed establishments save nine are active year-round, usually for eight hours or more .

Figure 30 Reported hours of operation on an average workday (# of responses)



Reported monthly revenue by employee varies widely, ranging from AFN 21,700 on average for businesses to AFN 7,100 for community institutions.

Table 4 Reported monthly income of surveyed businesses and community institutions

		Mean (AFN)	Median (AFN)	Std. Deviation	#
Business	large	2770	3200	2473	3
	medium	91250	8000	237900	18
	small	13941	7500	20637	154
Institution	large	6277	3470.588	10413	20
	medium	4304	0	7860	27
	small	10637	2250	33992	26

Nota bene: Reported operating cost fluctuates too much to be deemed reliable in light of the small sample, and will be further explored in qualitative interviews over the course of the coming year.

Most of the interviewed businesses and institutions occupy a single storied-building by themselves. One community institution in four occupies a building with several stories.

Figure 31 Single-storied businesses in Karte Naw, Kabul

Community institutions have occupied their building for 15 years on average, while businesses usually only moved in over the course of the past five years. Size of the space occupied varies widely, but revolves around a median of 6m by 4 meters for businesses and 40m by 25m for community institutions.

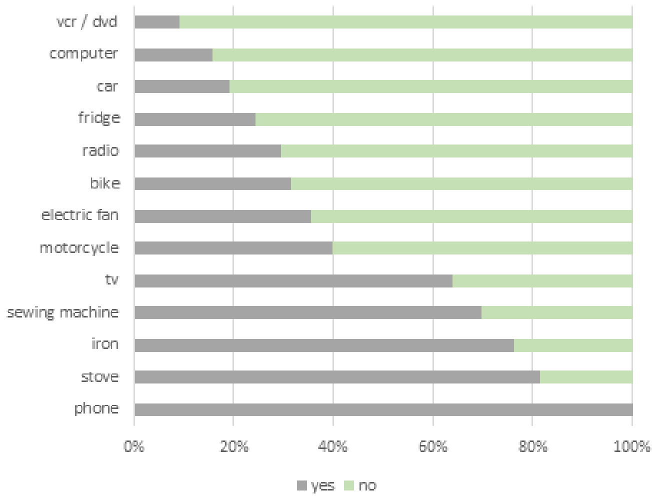
Businesses commonly rent their space (54%), while most institutions occupy publicly administered property (67%). The building materials reflect those of residential buildings.

4.2. Energy usage

A. Assets and tools

Household Asset ownership varies depending on (and thus can serve as a proxy for) socio-economic status and type of environment. Some assets however are ubiquitous: all of the interviewed households have at least one cellphone in the family, and over 80% own a stove. Irons and sewing machines are very common.[11] The most frequently owned large asset wholly dependent on electricity is a television set.

Figure 32 Asset ownership (% of total household respondents)



The most important uses of energy according to usiness and institution respondents is lighting (68%), followed by computers (67%), space cooling (41%) and produce tooling (29%).

Figure 33 Commonly used tools for businesses and community institutions

In qualitative discussions, respondents stressed that lighting and the ability to charge their phones were by far the most prominent needs. The same source of energy is generally used for both, even when households had a broader energy mix.

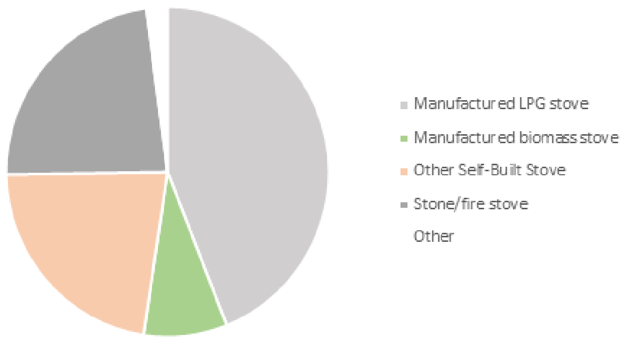
[11] Both are commonly operated without electricity.

In terms of prospects for the near term, respondents are fairly optimistic, with some 60% overall stating that they expected the future of their business / institution to be better, or much better, than is currently the case.

B. The bare necessities: cooking and heating

The most commonly used stove for both households and businesses / institutions[12] run on gas. Qualitative discussions also suggested that many households use more than one form of energy for cooking - both gas and wood or waste as fuel, depending on both the type of stove or ownership of a tandoor or bread oven, for example, or depending on the comparative availability and cost of gas versus wood, dung or other biofuels.

Figure 34 Types of stove in use (% of total household respondents)



We use liquid gas for cooking, because there is not anybody to bring us other things. But in the case we can find other materials for cooking like wood, animal droppings and anything else, then we will use that as well to save our money.

Woman from Malikiha, Herat province

Stoves are mainly of Iranian design. They are most commonly fueled by LPG / cooking gas (42%), followed by wood (27%) and animal waste / dung (20%). Cooking fuel is reportedly readily available, without seasonal fluctuations, to 71% of the interviewed respondents, with another 19% finding it "mostly available".

Cooking usually (65%) takes place inside the dwelling in a designated area, but it is not unusual for it to occur in a separate dwelling (17%) or outdoors (12%).

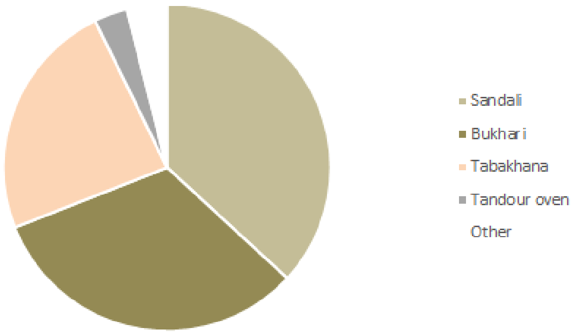
Figure 35 Step into my kitchen

[12] of which about one third provide food to their employees on a daily basis.

Approximately one respondent in four stated that their stove also functioned as a heater.

The most common space heating solutions are :

Figure 36 Most common heating solutions (% of total household respondents)



- Bukhari, a furnace style space heater;
- Sandali, similar to bukhari but situated under a table covered with a heavy blanket;
- Tabakhana, ducted central heating with a central furnace.

The most common fuel for heating is wood, used by two thirds of respondent households, followed by dung (42%). But other fuels including twigs and thorns are comparatively common at over 20%, reflecting the usage of heating solutions that can burn anything. Types of biofuel used by households can vary widely and be mixed dependent on seasonal availability.

We burn clothes, papers and pistachio shells.

Woman from Shaalbaafan, Herat province

Compared to biomass, coal is relatively rare: only 217 out of over 3,000 interviewed households report using it as a heating fuel on a regular basis. Businesses and institutions tend to use wood and gas heaters.

When asked about the spending on fuels used for cooking (over the past month) and heating (over the past year given that heating material is commonly purchased in bulk in the fall), household respondents' answers displayed considerable variation, and qualitative research confirmed that costs may vary widely depending on what fuel is used, how it is collected, and where it comes from - for example, the use of dung from home agriculture, or of gathered wood, means that these sources are free in terms of economic costs, though opportunity cost or life impacts may be high.

Table 5 Reported household spending on cooking and heating

		Money spent on cooking fuel (past month	Money spent on heating fuel (past year)
N	Valid	2,963	2,873
	Missing	98	188
Mean (AFN)		1,856	15,217
Median (AFN)		1,000	10,000
Std. Deviation			18,973
Minimum (AFN)		0	0
Maximum (AFN)		50,000	250,000

A single household uses up to 2,800 kg of wood in a year, and each kg costs AFN 15. The cost of wood and liquid gas is not fair to poorer families who do not have electricity, or solar. People also use coal in their bukharis and sandalis, but it is really not healthy.

Key informant interview, Engineer and senior advisor MEW

Cooking and heating are not always perceived as detrimental to one's health. If a third of respondents reported that a household member suffered from a cough due to fumes from cooking and/or heating, one in four reported eye problems and one in ten a minor injury having occurred in the household, 60% said that cooking and heating had not had any negative health impacts on them or their families.

Health concerns related to energy that were discussed in qualitative research were varied, but the most common were indeed breathing problems or coughs and eye problems. However, there were also many instances noted of injury or accident in the focus groups, including minor burns but also accidental death as a result of fire, explosion or electrocution. In the qualitative interviews, health concerns are frequently mentioned in relation to aspirations for "cleaner" energy.

We use coal as an energy source and we put it in the sandali to warm the room, but it is dangerous for our health and it causes us headaches and low blood pressure. If we could afford it, we would use electricity as a source of energy because it's safe and clean. (...) Using dung while cooking causes us some health problems such as breathing problems, eye problems and headaches. Currently I am suffering from breathing problems - I can't walk for minutes and I know it's all because of using dung and its smoke that we use for cooking and the furnace.

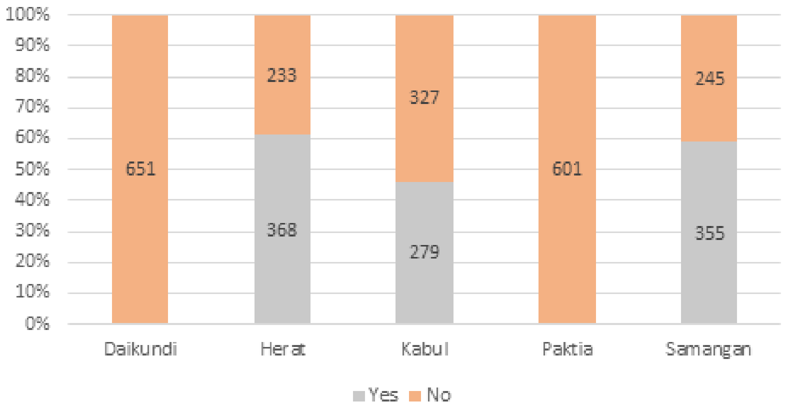
Women's focus group, Khwaja Chasht, Daikundi

4.3. Energy profiles across the surveyed locations

A. Up and coming: Grid electricity

Overall, approximately one third of the households surveyed for this project benefit from a connection to the grid.

Figure 37 Is your household connected to the grid? (# household respondents by province)



Among those, people in Herat have had grid the longest and those in Samangan the shortest time. Nine years in Naw Abad Shuhadaye, less than three years in Chawghai.

The split for businesses and institutions closely mirrors that of households, even if they appear on the whole slightly more likely to be connected to the grid.[13]

[13] For instance, five of the interviewed establishments in Daikundi sported a grid connection, compared to zero households. In Herat, the share of connected establishments was above 70%.

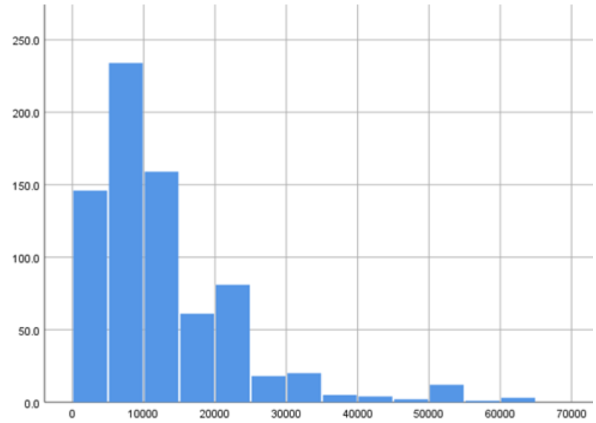
For those who have grid, business, institution or household, it is without exception the primary source of electricity.

In my house the only energy source is grid power, we use it for lights, charging our cellphones and watching television.

Female FGD Participant - Kart-e Naw, Kabul

The price of the grid connection is not reliably reported, but fluctuates around a median of 9,000 AFN for households - considerably higher than the official cost.

Figure 38 Reported price of household grid connection (# of household respondents, reported price in AFN)



When you want to get connected to the grid as a household, single phase costs AFN 3,500-6,000 for the meter installation, cable, box and paperwork. For businesses, the cost of a 3-phase connection is AFN 28,000-30,000.

Key informant interview, DABS power engineer

When asked who was paid to provide this grid connection, the actors mentioned the most frequently are DABS, followed by "the electrician." DABS is also most commonly recognized as the actor who gets paid for grid electricity. Bills are technically based on usage, and usually paid for at the bank.

Almost everyone (98%) has a working meter. Those are not usually shared for households, although ten percent of business and institutions do report using the same meter as others, with the number of other users ranging from one to seven.

Figure 39 Household meters, Karte Naw, Kabul

Table 6 Reported electricity usage and expenditure

		Households			Businesses / institutions		
		Reported last payment	Reported last usage	Reported cost / kWh	Reported last payment	Reported last usage	Reported cost / kWh
N	Valid	939	594	592	81	71	71
	Missing	2,122	2,467	2,469	172	182	184
Mean (AFN)		2,441	456	7.6	10,315	741	14.9
Median (AFN)		1,391	200	5.6	3,138	276	9.6
Std. Deviation		3,539	1,411	11.5	23,193	23,193	9.6

Although it fluctuates dramatically, these costs per kW are roughly in line with the figures quoted by DABS:

The price of electricity is dependent on usage.

- ❑ *0-200 kW: AFN 2.5 per kW*
- ❑ *201-400 kW: AFN 3.70 per kW*
- ❑ *401-700 kW: AFN 5.75 per kW*
- ❑ *701-2000 kW: AFN 8.25 per kW*
- ❑ *·Above 2000 kW: AFN 10 per kW*

This way poor families are able to pay their bills. They consume less and will pay less. The rate for commercial and government buildings is AFN 12 per kW no matter what their consumption.

Key informant interview, DABS power engineer

While some interviewees did agree that their energy was affordable, there were many complaints regarding the high cost of grid power - and it was often reported that households might use grid power only for lighting, or small activities like charging phones, due to the high cost of energy from the grid. In qualitative discussions, interviewees reported the challenges of high energy bills for grid power, though as with the responses to the quantitative survey, reported costs varied, as did attitudes toward how expensive power was.

The problem is that it's very expensive now; before it was not that bad but now our bill is 1,200 AFN in a month. The wiring system is not good also. Our bill comes in every two months, my brother sends us money for it because my father is not able to pay that. (...) We have a lot of problems regarding this issue. Meters are not functioning very well; the electricity price is very high. We can afford to pay the bill as well because we are not very poor people. But it is very expensive and we still can't use the refrigerator and the washing machine.

Women from Chawghai, Samangan

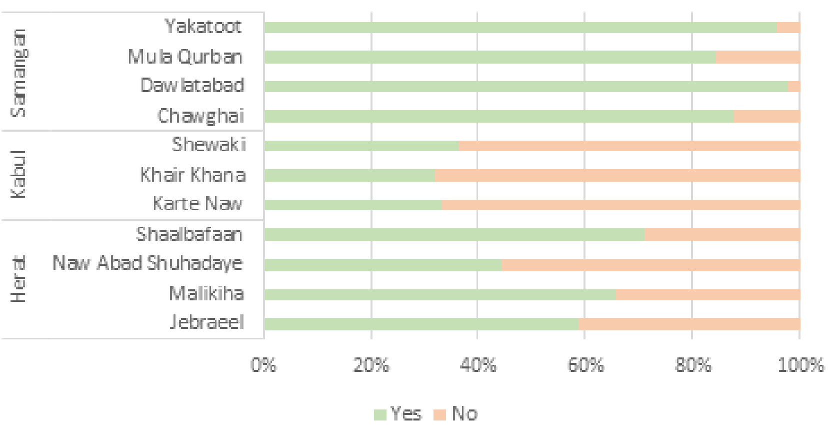
In addition, the costs of commercial fees in this setup is greatly regretted by the interviewed business owners, who regularly spend a third of their monthly income on energy expenses.

Monthly I allocate 35% of my income for the energy expenses. I make 1,000 AFN on good days, but 350 go right into my electricity bill! This is the only reason that I can't take my business ahead in a better and more advanced way.

Owner of an internet café, Herat

Business owners and household respondents alike frequently suffer from fluctuations in the performance of their grid electricity, particularly in Kabul.

Figure 40 Is the performance of electricity the same year-round? (% of household respondents in locations which have a grid connection)



Our services suffer great seasonal variations. Consumption of power tends to triple in winter, when households use it for heating. Within 24 hours there are power outages.

Key informant interview, DABS Energy Control Engineer

The same type of seasonal variation can be found in the number of hours of grid availability, and usage. While in Herat and Samangan grid is reportedly available 24 hours per day, in Kabul it only appears to be working for 16 hours on average. Undoubtedly as a consequence, household respondents in Kabul spend fewer hours per day benefiting from grid electricity. Outages in Herat are a rarity, outages in Samangan are also not a common occurance (2 outages per week, costing zero to one hour of electricity). In Kabul on the other hand, respondents report five to six outages per week in the spring.

When such a blackout occurs, it is rare for the sampled households to have any sort of backup for appliances. 43% of interviewed representatives of businesses / institutions are without backup should should their grid electricity fail. For lighting, the most common backup are rechargeable lamps (24%), LPG lamps (20%) and dry-cell torches / flashlights (21%).

It is thus unsurprising that it is only in Kabul that "supply" and "grid interruptions" were listed as one of the most serious problems related to grid electricity (46% and 51% of household respondents respectively). The quality of grid power also varied across the groups interviewed in qualitative research, with unreliable power - either in terms of weak voltage or variations in voltage - noted when discussing grid power and usually decreasing willingness to pay for power.

Our electricity disconnects many times in a day which can cause damage to our electronic devices. (...) Our main problem with electricity is... the lack of electricity! Sometimes when we want to make bread we make dough and then we wait all day for electricity. In winter, most of the days we won't have electricity because of technical problems. During the days in winter we will have only 5 to 6 hours electricity

FGD, Karte naw, Kabul province

In Herat, the main problem is the cost: two thirds of household respondents connected to the grid noted that the price was a serious issue (compared to 28% in Kabul and 50% in Samangan). 60% of business / institution respondents noted that the grid fluctuations had caused damage to tools and appliances, an issue also noted by respondents in qualitative research for both households and businesses, who had lost appliances or were simply unable to power the appliances they needed.

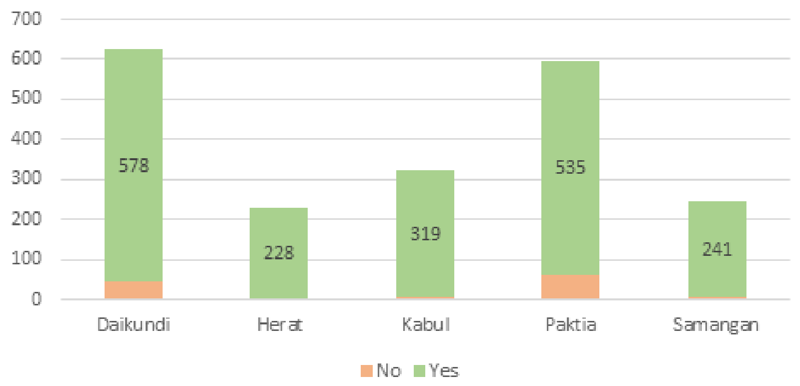
Gas is expensive to use, but we can't use the electricity for all our needs because it's quite expensive. It's more comfortable to use than anything else, but it just costs too much.

FGD, Shaalbaafan, Herat province

Finally, it is important to note that those who are not currently connected to grid electricity, be they businesses or households, generally expect to be in the near future.

Rare is the respondent who is not certain that within a year or two his or her households / establishment will benefit from a grid connection.

Figure 41 Do you expect to get a grid connection in the future? (# of households which do not have a grid connection, by province)



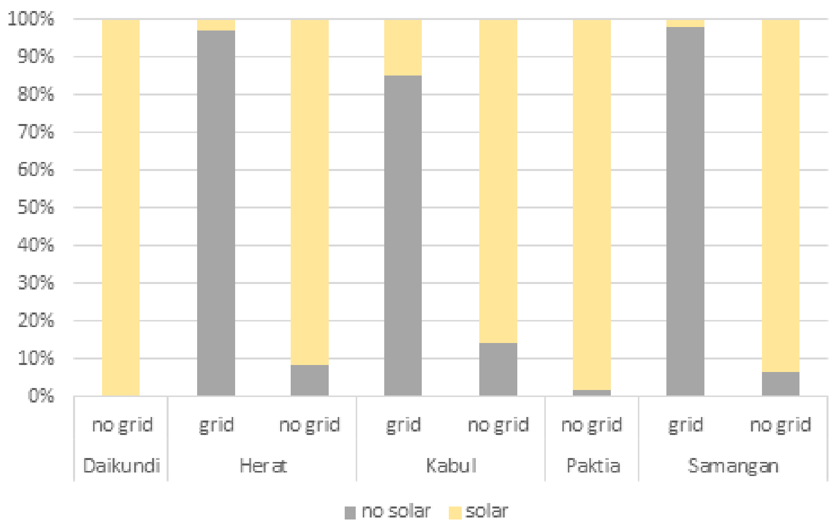
B. There's always the sun: a prevalent alternative to grid

Figure 42 A common sight across Afghanistan

Solar is by far the most common energy solution in our sample, with two thirds of respondents (2,025 out of 3,061) stating that it was an important part of their energy mix.

The location of solar is inversely related to the existence, and reliability, of grid electricity.

Figure 43 A valid alternative? Household grid penetration vs solar usage in provinces studied for this research. (% of total household respondents per province)

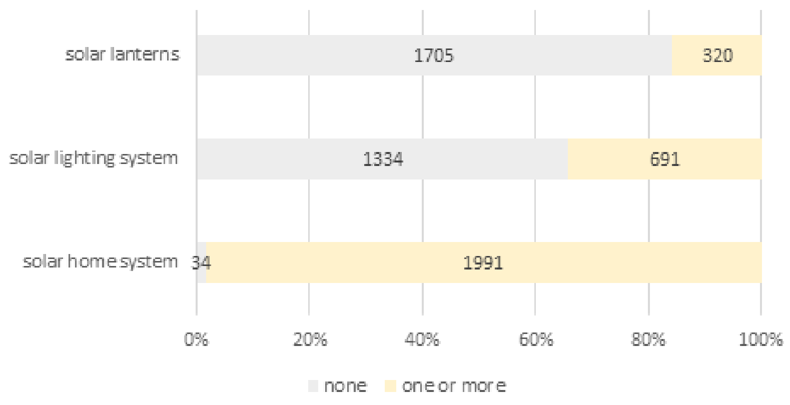


Solar energy appears to be considerably more common for households than for businesses and institutions, with close to 100% of household respondents in Daikundi and Paktia stating they had a solar device, compared to fewer than 60% of interviewed business / institutions in those locations.

Similarly, in the other provinces, only approximately one business / institution respondent in five noted that solar was a part of the energy mix at their workplace, compared to 40-50% of households. Small businesses are more likely than their larger counterparts to use solar energy, most commonly in the form of a solar home system.

The most common solar device owned by household respondents is a solar home system, and usually households own only one of those. Solar lighting systems and solar lamps are comparatively less common. It is rare for households to have more than one solar home system, but not uncommon to have more than one solar lantern.

Figure 44 The most popular solar solutions (# of household respondents using different solar devices)



Households were asked to provide detailed information on their main solar device, which was usually a solar home system.

The most commonly cited manufacturers of solar home systems in use are Chinese (800+ respondents) and Indian (600+ respondents, with TATA being one of the few well-known brands).[14] Japanese, American and Iranian SHSs are also in use but appear to be comparatively less common.

These devices had been in use for five to six years on average already, and they had usually (81%) been purchased (rather than received for free).

Figure 45 Dalkhaki, Samangan: Suboptimally positioned solar panel

With the purchase usually came a training: 70% of owners of solar devices declare having benefited from a training on the usage of their main solar device.

We have many problems with customers who don't know how to use solar - but we can send people to assist. We can teach people how to use their systems, and we give two to five days of training for those who purchase our packages as part of their cost of buying.

Sun Solar (solar retailers), Herat

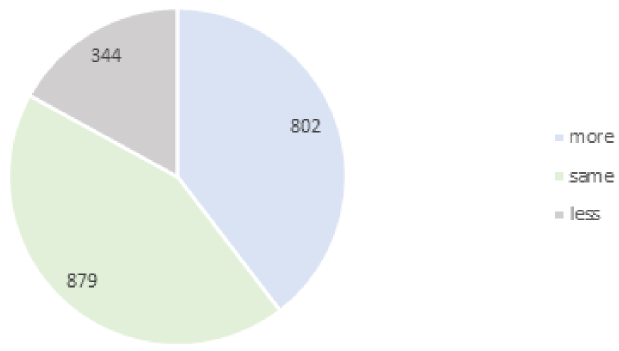
Table 7 Summary information on solar panels in the sample

		Width panel (cm)	Length panel (cm)	Capacity (W)	Purchase price (AFN)
N	Valid	2007	2008	1778	1598
	Missing	1054	1053	1283	1463
Mean		60	98	90	9438
Median		50	100	70	7000
Std. Deviation		28	50	60	9498

The number of bulbs that can be separated from each other varies but most commonly ranges between two and six (for households), two to 12 for businesses. Approximately one household in four, and one business in two, that owns a solar home system also has an inverter.

[14] *The quality of the solar panels that are being imported to Afghanistan is not reliable. They don't last.*
Key informant interview, ADB energy specialist

Figure 46 Solar lighting usage compared to earlier times (# of household respondents using solar lighting)



Some geographic differences can be noted in the uptake of solar over time. Compared to the first time they used solar energy, household users of solar solutions in Kabul are more likely to be using it more (47%) than those in Herat (32%).

However, in qualitative interviews, many participants noted that they would readily switch from solar to grid power - which they perceive as more reliable - due to the problems they had had with their solar power systems.

Over three quarters of interviewed household users of solar energy solutions report that their energy supply does not fluctuate over the course of the year, though qualitative findings did suggest more variation - usually based not on seasons but on 'bad weather'. Rather, problems linked to solar energy are linked to the fact that it is not considered strong enough to power large devices.

The only energy source we have at home is solar. It is not sufficient to operate the washing machine, water pump and other electric machines. If we increased the number of solar panels, we could do so but otherwise it is too weak.

Community member focus group, Kabul

Battery problems are another common (58%) concern. Among the business and enterprise respondents whose establishments use solar energy, close to half note that fluctuations in supply had damaged tools and equipment at their place of work.

Solar energy has a lot of fluctuations. Lights get damaged, as often as three times a week. Each time it costs us AFN 100 to replace. I know a shopkeeper whose place burned down because of solar. The solar device we use now cost AFN 3,500 and we have had it for five years. But we have had to change the battery after one year.

Community member focus group, Daikundi

Injuries on the other hand are rare, though they do occur according to qualitative interviews, and mostly as a result of problems with solar batteries catching fire or exploding.

Without exception, respondents use their solar device for lighting. For households, other popular use cases include charging mobile phones (83%) and entertainment / watching TV (30%). Businesses and institutions, to the extent that they use solar energy, often power their electronic devices in this fashion.

Our resource for lighting is solar power. We have used this system for 10 years. We have received a panel for free almost 10 years ago, and we still use it today for lighting and charging mobiles. We bought another solar home system last year. And we are using the power of this system for lighting, charging mobiles and computers, and switching on the television.

FGD, Khwaja Chasht, Daikundi province

Solar power and agriculture

Mohammad is a villager who uses his 500W solar device to irrigate his garden, providing water to 150 almond and 50 apple trees. His AFN 20,000 system is not strong enough to reach the upper parts of the hill, but it can withdraw up to one inch of water from the well and irrigate the entire surface of the garden in ten days.

This was not possible in the past, because the stream runs dry part of the year. The system is autonomous - it withdraws water from the well and pumps it into a pool every days from 7am to 4pm, without any batteries!

Figure 47 Mohammad's garden, Sar-e-Nili, Daikundi

C. Common backups: Generators and rechargeable batteries

Generators

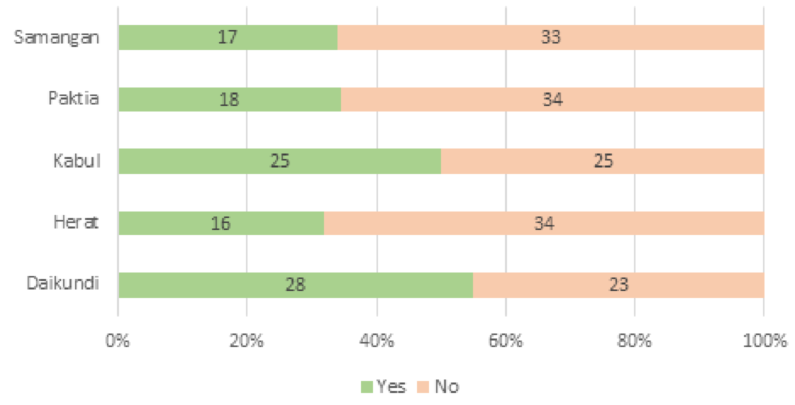
Household usage of generators does not appear to be frequent: 104 respondents out of over 3,000 stated that their household relied on them for energy. Over half of these (54) were in Kabul province. Generators are rarely the primary source of electricity (and thus likely mainly used as backup for grid electricity). Households generally own one generator only, and have exclusive usage. Generators tend to be most used in the cold winter months (when other sources of energy are less reliable). Their fuel, usually gasoline, is readily available in the winter months at 40-50 AFN per liter.

Generators owned by respondent households were usually purchased, with the cited price fluctuating widely but revolving around a median of AFN 11,500 (and an average of AFN 14,000). The age of the generators of the households interviewed ranged from zero to 20 years, but most commonly, generators have been in use for 5-6 years. The costs of repair over the past year are non-negligible, with a mean of AFN 3,600 (and a median of AN 1,500).

Generators are normally used only for a few (mean 3, median 2) hours a day, with their usage limited perhaps by the noise – the most concerning problem for the generator owners among the sample interviewed.

The most common household usage for generators is water pumps (50) and lighting (44), followed by mobile phone charging, appliances, work-related energy usage and entertainment.

Figure 48 Generator use by sampled businesses and institutions (# of interviewed business / institution respondents)



Businesses and institutions tend to rely on generators more frequently, particularly in the provinces of Kabul and Daikundi.

Again, the most common number of generators is one, but large establishments are more likely than small ones to have at least one "backup" generator. Generators belong to one establishment and are not commonly shared. The most common usage for generators among business and institution respondents is powering electronic devices (56%), powering a pump (47%) and lighting (46%).

We use a 6.6 horsepower generator , it can produce 7.5 kW power. We use it in the mornings, and from six to noon it uses up two liters of diesel. The cost is AFN 50 per liter. We use our generator to power the TV, the lights and the water pump. We have 45 lights - solar energy would not be strong enough to power these all at once.

Hotel owner, Daikundi

The average price cited for the generator in use by businesses and institutions stands at AFN 39,000 (median of AFN 27,000). Generators used by businesses / institutions are powered by diesel or petrol, of which the average institution / businesses uses approximately 50 (median) litres per month in the spring.[15]

In terms of problems, two thirds of businesses and institutions remark upon the fragility of the generator, which tends to break, about half find it costly and one in four criticizes the fluctuations in electricity supply. Although permanent injuries caused by generators are rare for the sample interviewed for this project, over half of business respondents note that equipment had been damaged due to the generator.

[15] Seasonal variations in usage will be explored in the upcoming diary phase.

Rechargeable batteries[16]

114 households (3.7%) of the sample noted that rechargeable batteries were part of their energy mix. As was the case for generators, battery usage appears to be clustered in certain locations.

While they are almost unheard of in Daikundi, they appear to be comparatively more common in Samangan (particularly in the location of Takhaki, close to the grid but not – yet- connected to it) and Herat (again, near places connected to the grid but not as yet connected itself).

Individual households will normally (85%) own only one rechargeable battery. Only a minority pays to recharge them, usually a few hundred AFN per month. The batteries in use by the interviewed households are not strong enough to power large appliances, a fact noted among their most important limitations. They are almost exclusively used for lighting and charging mobile phones.

Businesses and institutions interviewed do not commonly rely on rechargeable batteries as part of their energy mix (12%), and where they are used they are mostly used for lighting.

Rare solutions: Mini-grid and Pico-Hydro energy

Mini-grids are a rarity among the sample of households interviewed for this research, with only 42 out of a total of over 3,000 noting that such isolate grids were part of their energy mix. Those were located in the Kabul district of Dasht-e-Barchi, and their mini-grid system is powered by diesel.

Here we have local generator electricity that can switch on one television and three lights. Its price is 900 Afghanis each month. Every night, we have electricity for two and half hours. It stops at 9 pm every night.

Men's FGD, Dasht-e Barchi, Kabul province

Only eight out of 253 business / institutions stated that a mini-grid was part of their energy mix.

In the same vein, the sample interviewed for this study contained very few households connected to a pico-hydro system. The majority of the 54 pico-hydro beneficiaries were located in the community of Majghandal in Herat (35 households) and Charkh in Kabul (15 households). These pico-hydro systems are shared. They have been in place for two to ten years. Seasonal variations are by far the most important challenge – indeed, the system generates electricity in the winter and the spring, but not in the summer and the fall.

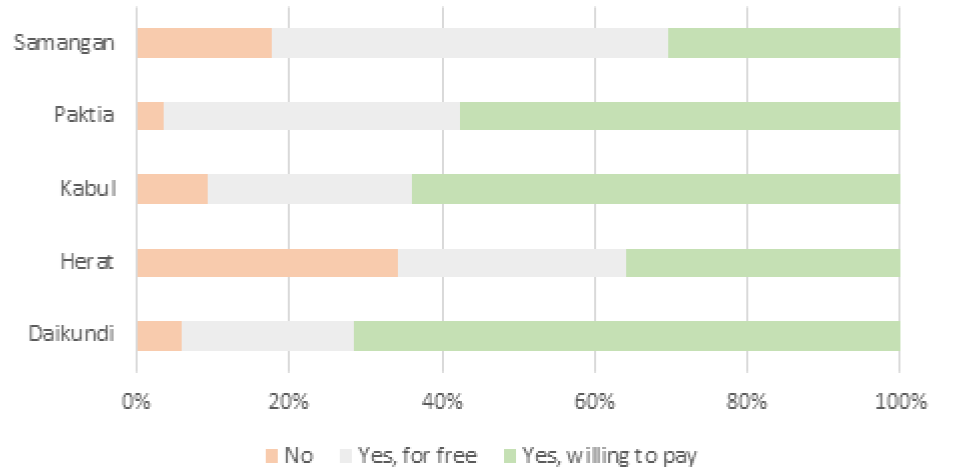
Only one business / institution respondent out of 253 (a tailoring shop in Herat) stated that their establishment relied on pico-hydro systems for their energy needs.

[16] Note that the fact that the most common charging mechanism cited for these batteries indicates that there might be some confusion in terms of solar energy compared to rechargeable batteries. This will be explored further over the course of the coming twelve months.

3.3. Aspirations for better energy, and willingness to pay for it

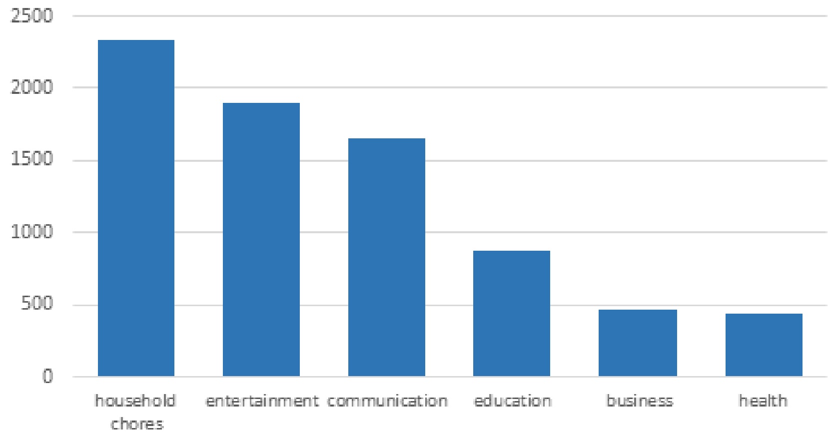
A. Household aspirations

Figure 49 Would you like your electricity to be better? (% of interviewed households)



When asked what they would use better electricity for if they had it, household-related chores were by far the most common answer, followed by entertainment and communication.

Figure 50 The expected advantages of better electricity (# of interviewed households households)



In the qualitative interviews, respondents spoke of how much difference energy could make in their daily lives and in the work around the household - using washing machines rather than washing by hand, or vacuuming rather than scrubbing floors - both women and men being quite aware of the impacts of energy on household work and its potential benefits.

If we had better energy, we would use the best electric devices at home, such as washing machine, tailoring machine, vacuum cleaner, fan and other things. In fact, these are the main needs of a family and women really need those things at home, but unfortunately, we don't have better energy/electricity and can't use those appliances

Men's FGD, Majghandak, Herat province

Also very common in the qualitative research was a simple focus not just on health, economic activities or household work, but on quality of life - the ability to cool or heat for comfort, watch television, read or study in evenings, and entertain guests in well-lit, comfortable homes.

If we could have better electricity, then since we have a washing machine I would use it and wash all the clothes in the washing machine, but since we don't have enough electricity we can't do that. And we also have water tank - if we had better electricity we could buy a water pump and use it to fill the tank with water. And, if we could have better electricity, we could use it in winter for heaters and cooking. In summer we could use the refrigerator, and we could watch television, and we could study using a computer!

Women's FGD, Sar-e Nili, Daikundi province

Potential gains in agriculture

Villagers in rural communities would often speak about a desire for enhanced electrical solutions; whether it was grid connection, generators or solar panel and battery systems to help draw water from waterways and to then pump water from reservoirs to their agricultural lands. This intersection of agriculture and electricity occurred time and time again in rural communities across the five provinces. It was spontaneously brought up during interviews; on a *willingness to pay* question, one head-of-household said he would not need anymore electricity for his home as he already had lighting and could charge his mobile, but he would want something with the capacity to help him on his farmland. It was also discussed at some length in focus group discussions and in general conversations with key informants and community leaders.

Figure 51 A villager in Samangan standing on top of a water reservoir, with a generator pumping water from the river below.

The reservoir stores drinking and irrigation water, especially for the dryer months. Many villagers across the different provinces spoke about how they desired solar, generator or grid electricity to be able to pump water for their agricultural irrigation needs.

Potential gains in women's home-based economic activities

Sabera does embroidery at her home. Her embroidery machine operates by solar power. Sabera invested AFN 25,000 in her solar device. Over time she has had to replace six batteries, at a cost of an additional AFN 20,000.

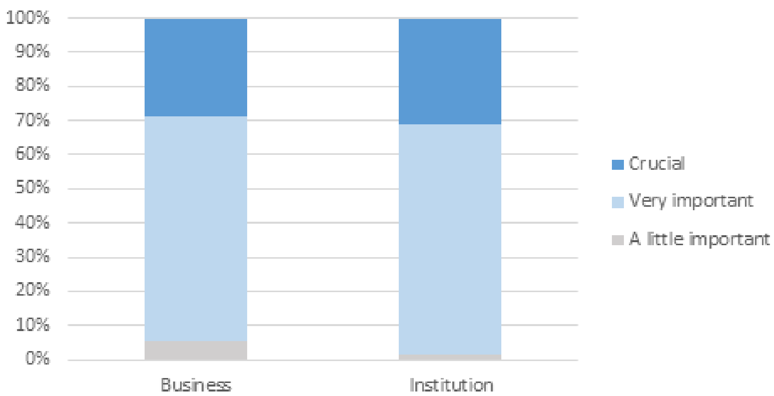
Figure 52 Sabera's Embroidery Business at home run by Solar Power, Sang-e-Mum, Daikundi

I learned about embroidery in Iran, and I have been doing it for nine years. I earn more than AFN 5,000 a month. I could make much more if I had access to the grid. I could expand my business, even train other girls in the village.

B. Business and community institution aspirations

The importance of electricity is universally acknowledged by business and institutional respondents, with two thirds of both business and institution respondents noting that it was "very important" and an additional 30% stating that working without electricity was simply not possible.

Figure 53 Importance of electricity at the workplace (% of interviewed businesses / institutions)



80% of surveyed businesses and institutions note that their workplace had suffered from a lack of electricity – the same number would expect their sector to "grow a lot" if supply of electricity were to improve and become more affordable.

Indeed it is the lack of supply and the cost of electricity which prevents respondents from using more powered tools.

If electricity were more readily available and affordable, the immediate changes made would be an upgrade in equipment for 70%o of respondents, and working longer hours for 60%. A third of business and institution respondents state that it is likely their establishment would both become more productive, and employ more people.

Ghulam Haidar is a teenage entrepreneur that started up an Ice-cream Shop near a school.

I have invested AFN 150,000 in this business. The diesel generator alone cost 30,000. A large part of my income every month is spent on fuel. If I had access to the grid, I would halve my operating costs and double my profit.

Figure 54 Ghulam Haider's Business, selling Ice-cream to school girls, Sang-e Mum, Daikundi

C. Potential welfare impacts

The important investments in improving energy access in Afghanistan have been justified on the assumed beneficial effects of access to electricity, often presented as fostering economic and social development. Empirical evidence is however weak and casts some doubts on the gains of electrification. In this brief section, we present preliminary estimates relating to the causal impact of grid connection on several dimensions of welfare.

The direct effect of electrification on welfare refers to its capacity to improve workers productivity, and hence to increase income. Electricity provision can be seen as a positive technical shock that may modify the nature and the amount of work done, through extending the working days. Results of instrumental variable analysis show that being connected to the grid significantly increases by 8% the food expenditures over the last 7 days, a proxy for income less subjective to recall and measurement biases. This income effect translates into an increased resilience: grid connection does appear to significantly decrease income fluctuations.

The labor supply can also be modified when a household is connected to electricity. Some domestic tasks, such as cooking or collecting firewood, become less time-consuming. The use of electrical appliances increases the efficiency and productivity of some labor tasks. When the electricity is used for domestic tasks, the time saved thanks to the access to electricity translates often by an increased amount of hours spent on the labor market, especially for women. However, when electricity is used for market activities, all possible scenario of the use of the labor time-saved can be found. In the case of Afghanistan, results show no significant increase in the total number of working people in the household.

Grid connection has however some positive externalities on child labor as it reduces the use of child workforce by 19%. This suggests that women should have substitute children in the labor market.

School attendance does not increase with the grid connection. This result can be explained by the fact that school participation depend on school facilities that may not have changed with the household connection to the grid. This combined evidence suggests that electrification encourages children to increase their non-market activities (leisure, housework).

To sum up, access to electricity may have positive direct impact on food expenditures and income resilience, and some interesting externalities regarding child labor. However, it does not translate to an expected increase in the school attendance, possibly because this outcome depends on parameters external to the household (such as school facilities or quality).

Nota bene: These preliminary results will be further explored over the course of the coming weeks and months, and findings will be presented in a separate analytical note drafted in collaboration with the research team's academic partners from the *Centre d'Études et de Recherches sur le Développement International.*

D. Willingness to pay

The demand curve of a service or device such as grid power or a solar home system is an estimate of the degree of penetration (subscription to the service) that might result for each price-point in a range. To estimate this curve, each respondent was presented a hypothetical price to be connected to the grid and asked whether he/she would be willing to pay that amount. The prices were randomly selected from a uniform distribution between zero and the estimated average cost of connecting a household to the local grid, to simulate different levels of subsidy. The following section briefly presents *preliminary* demand curves as derived from the baseline surveys.

Revealed preference or stated preference ?

The survey was designed to approximate the demand curve through inference from stated preferences regarding a respondent's willingness to pay a given random proportion of the approximate unsubsidized cost of connection or distribution of a power source. Although some information was collected about current behaviours among respondents regarding their current expenditures, the information is not sufficient to directly estimate revealed preferences.

Under revealed preference theory, one must assume that consumers have complete freedom of choice over one or more options to fulfill their power consumption requirements. However, in the case of solar, generator, or grid power, the balance between fixed and marginal costs and sunk investment effects render this approach inapplicable. The alternatives are also not equivalent in terms of their utility, as while solar may suffice for charging a mobile phone or providing some nocturnal lighting, generator or grid power are required to provide heating or cooking power. Furthermore, it is unclear under what option environment these choices are made and whether the price being paid is at any kind of equilibrium consumption level.

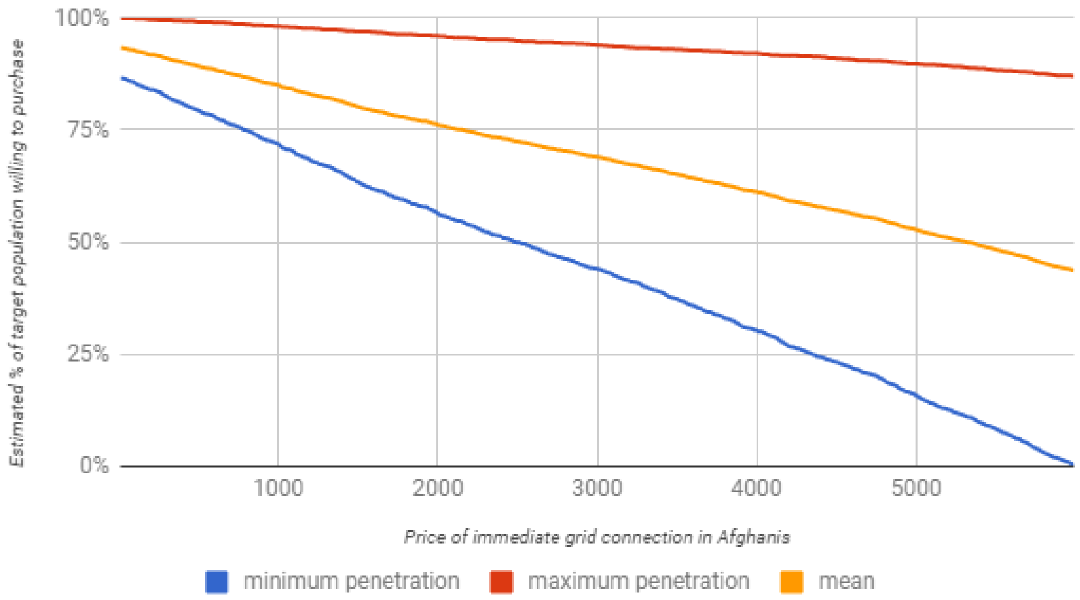
- **Willingness to pay for a grid connection**

Household and business / institution respondents not currently connected to the grid were asked if they would be willing to pay X for a connection to the grid "tomorrow, if it were possible".

Based on information obtained from the World Bank project team, the maximum values were set at AFN 30,000 for businesses / community institutions and AFN 6,000 for households. The amounts presented to the respondents were random below this bound.

The preliminary results, to be refined further over the course of the diary phase, show that the demand for a grid connection is quite elastic when it comes to minimum penetration (i.e., the blue line, which represents the percentage of respondents who would be willing to pay the quoted price, or a higher one)[17].

Figure 55 Preliminary demand curve: Immediate grid access for households



The relatively steady maximum penetration (i.e. the red line which illustrates the percentage of respondents unwilling to pay the quoted price, or less) indicates that a certain small segment of the population are simply not willing to pay for a grid connection no matter what the price.

[17] Offering a grid connection at AFN 2,000, one might thus expect to get *at least* ≈60 % of uptake, and *at most* ≈ 95% of the target client base.

Reading the preliminary demand curve estimates

The willingness to pay computation is an enveloping bounds estimate derived from stated preferences at a single price point for each respondent. At any given price point P, we can assume that any respondent who stated that she would pay P or more will also pay P, thus the minimum penetration rate is the proportion of respondents stating that they would pay P, or more than P. (Respondents who stated that they would pay a lower price, on the other hand, do not inform the penetration rate at price P.) In other words, **the minimum penetration represents the share of respondents who stated that they were willing to purchase the good / service at the proposed price, in addition to all those who stated that they were willing to purchase the good / service at a higher price.**

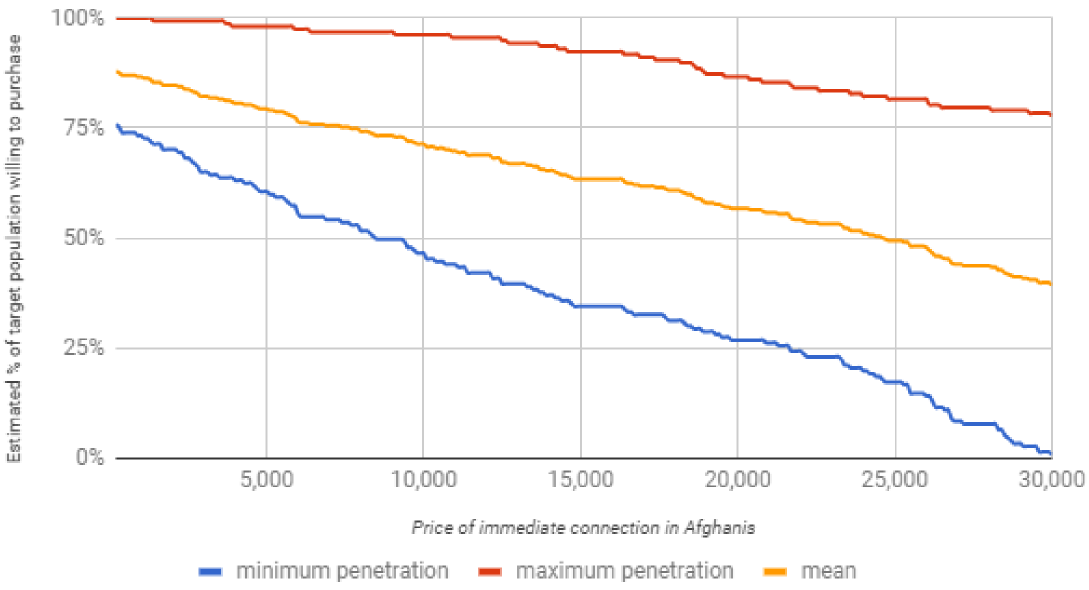
Similarly, it can be assumed that respondents who stated they would not be willing to pay a price below P would also be unwilling to pay P for the commodity. Thus the proportion of respondents who did not indicate that they were unwilling to pay P or less represents an estimate of the maximum possible penetration a point P. (Respondents who indicated that they were unwilling to pay more than P likewise do not inform this estimate.) In other words, **the maximum penetration represents the share of respondents who stated that they were *unwilling* to purchase the good / service at the proposed price, in addition to too those who stated that they were unwilling to purchase the good / service at a lower price.**

These enveloping bounds represent the full measure of information provided by the available information, without making assumptions about the underlying form of the demand curve. The difference between these two curves at a price point P represent the proportion of the sample that did not inform the demand curve estimate at that price.

Assuming that the chosen sample is representative of the Afghan population as a whole, the range between the maximum and minimum penetrations represents the best estimate of where the willingness to pay for a given good / service lies, based on the information at hand and without assuming any underlying confounding variables. The research team will attempt to narrow down the range through follow-up interviews in the months to come. In the meantime, the midpoint between the minimum and maximum penetrations is presented as an estimate of true WTP at a given level of subsidy.

For businesses and institutions, the demand curve is less narrow in the low price ranges, implying that there are certain economic and institutional actors (25% of those consulted) who simply do not feel the need to be connected to the grid.

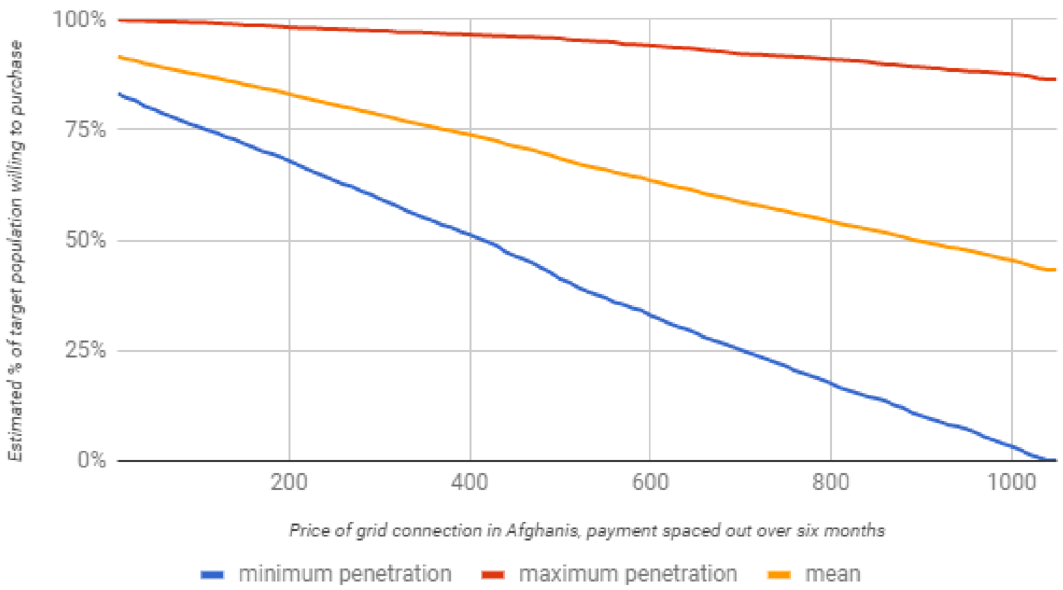
Figure 56 Preliminary demand curve: Immediate grid access for businesses and institutions



No, I am not ready to pay the government for a grid connection. It is their job to provide the country with better facilities. If I could afford to pay for it myself, we would not need the government! They should support entrepreneurs, to that we in turn can sell better services to the people! The government collects a lot of money from businessmen!

Focus group, Naw Abad Shuhadaye, Herat

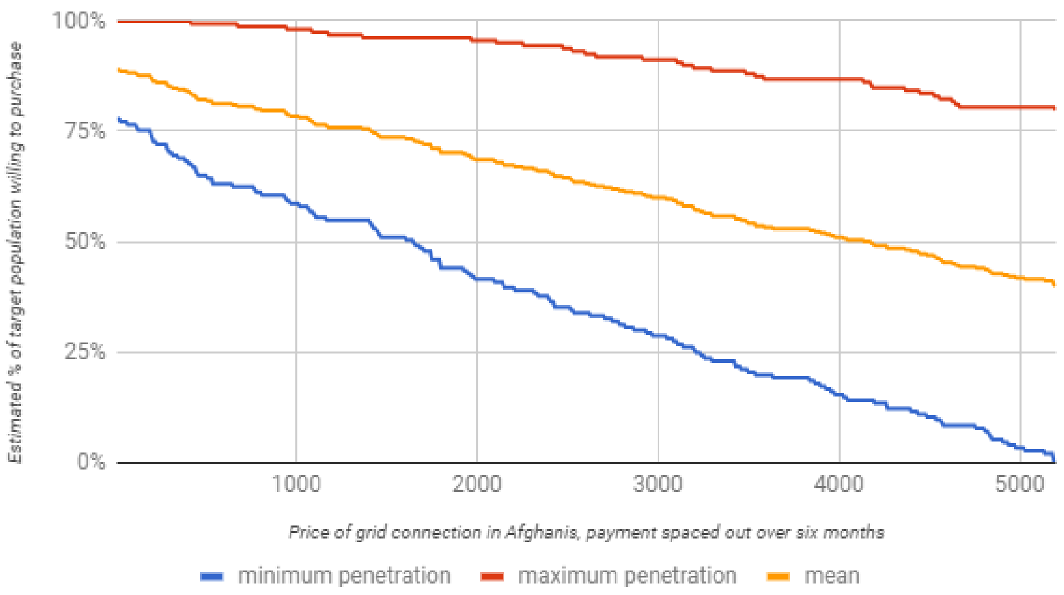
Figure 57 Preliminary demand curve: Grid access, payment spaced out over six months, for households



When aiming to assess the willingness to pay for a grid connection if the payment could be spaced out over six months, the curves are relatively similar to the ones relating to immediate payment, indicating that the notion might not be easily understood by the average respondent.

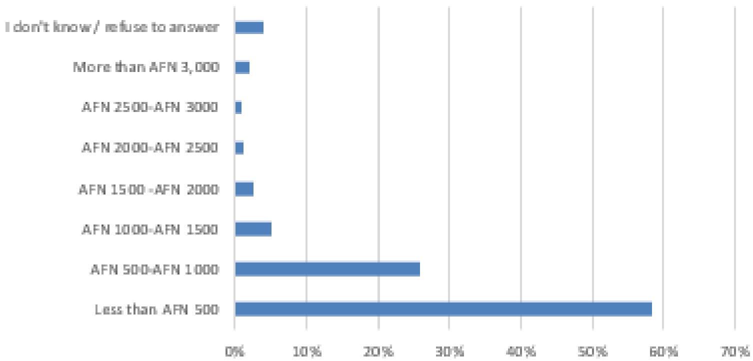
Indeed, qualitative interviews indicate that any sort of regular payment tends to be more associated with running costs / electric bills rather than the actual grid connection.

Figure 58 Preliminary demand curve: Grid access, payment spaced out over six months, for enterprises and institutions



When asked how much they thought their monthly electricity costs would be if they did get a grid connection, the vast majority of household respondents cited very modest amounts. The majority of business and institution respondents (overall) concurred, citing expected rates below AFN 1,000 per month.

Figure 59 Estimates of monthly electricity spending by non-grid households (% of households not currently connected)



Compared to this "guess" however, the professed willingness to pay as per the qualitative interviews appeared to be higher:

If we could have access to better energy and use electric tools, I could pay AFN 1,000 for it. Beyond this I could not afford it.

Community member focus group, Malikiha, Herat

If we could have access to reliable grid power, which we could use for washing machines, irons, electric heating and other types of machines, I think we could pay 2,000 to 2,500 AFN for it.

Community member focus group, Sar-e-Nili, Daikundi

- **Willingness to pay for solar power**

Willingness to pay for solar power solutions should be assessed keeping in mind some important caveats.

1. Almost everyone who does not have grid already has some sort of solar device
2. Grid is largely preferred to solar power, as solar energy is perceived, rightly or wrongly, as unable to power large devices
3. Almost everyone who does not have grid now expects to get it in the near future.

Within three years after getting grid power, all of us sold our old fuel lanterns, solar home systems and solar lanterns at the bazaar in Aybak. We all use grid now. No one has a stand-alone power system anymore.

Shura member in Dawlatabad, Samangan

The demand curve for a solar home system for rent looks perfectly elastic, with willingness / unwillingness to pay for an SHS at a given price changing in parallel.

Figure 60 Preliminary demand curves for SHS for rent, for households

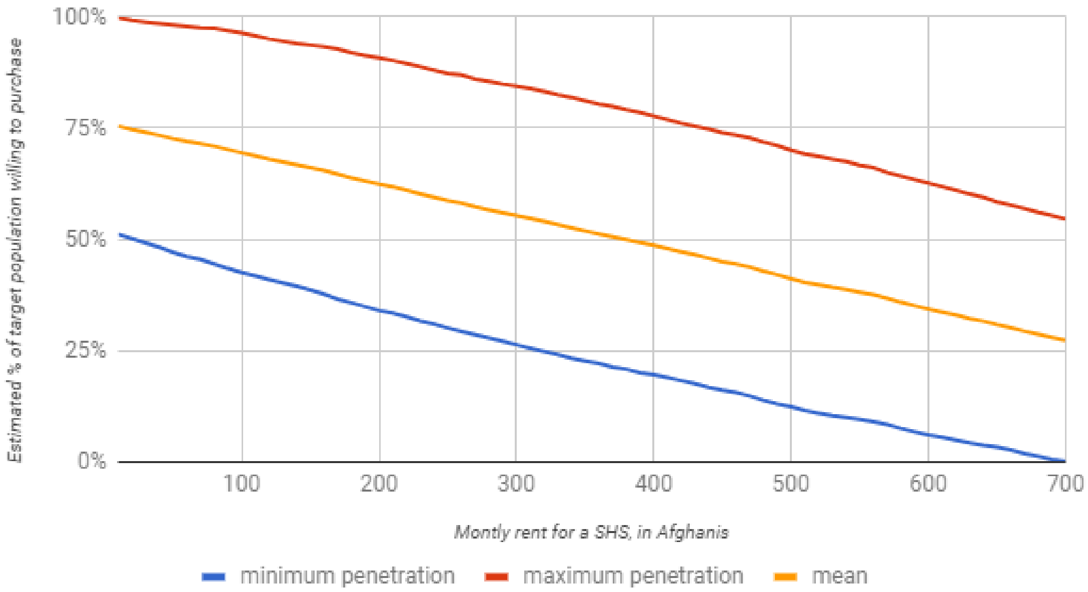
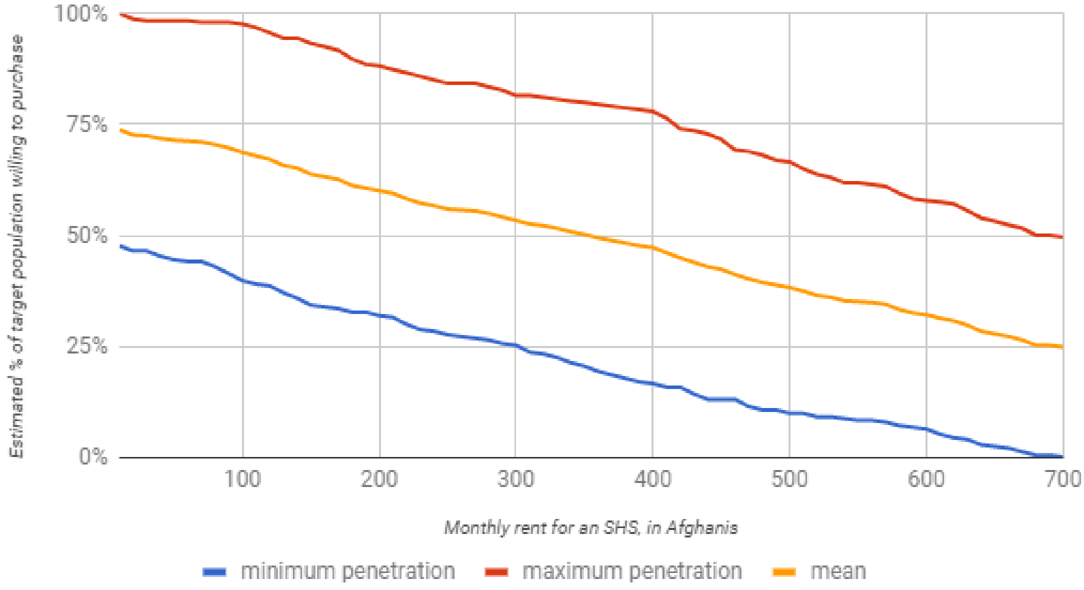


Figure 61 Preliminary demand curves for SHS for rent, businesses and institutions



It is important to note that 50% of interviewed households and businesses / institutions are currently not eager to accept a rented solar home system even for free, meaning their demand is already currently met in this regard.

Future analysis will aim to narrow the space between the minimum and maximum penetration, and aim to shed further light on the demographics falling into those willing, and those unwilling, to pay a given rate.

Solar energy is not trustworthy, it cannot produce electricity for a long time. I would not pay more than AFN 500 for it each month.

Community focus group, Sar-e-Nili, Daikundi

If solar functioned as well as grid, I would pay AFN 700 per month. Else not even 400. It cannot meet our needs.

Community focus group, Shaalbafaan, Herat

Figure 62 Preliminary demand curves or SHS, financed over 24 months, for households

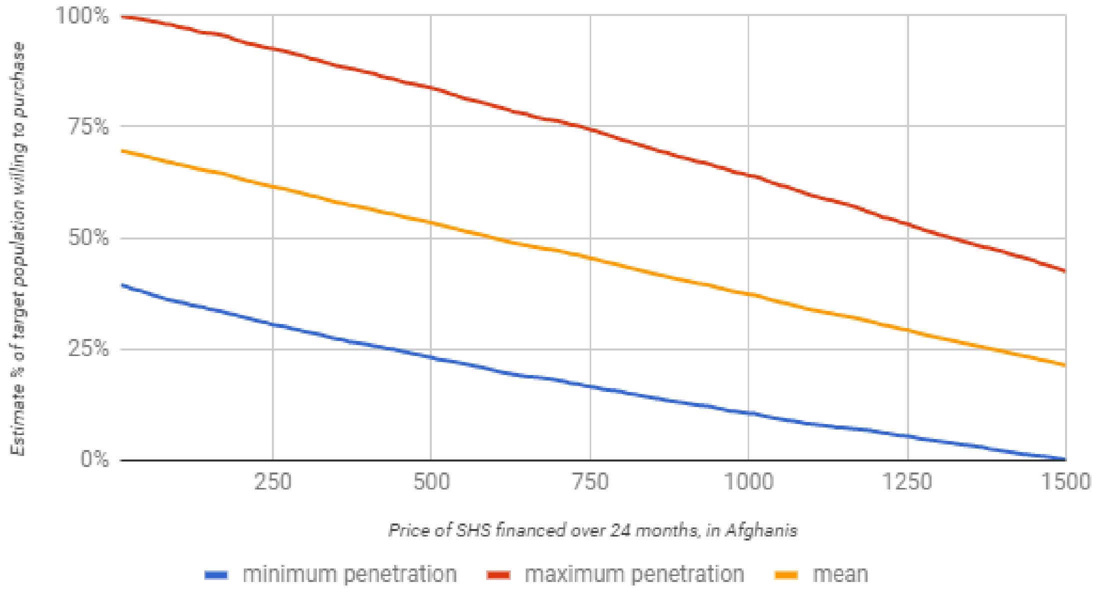
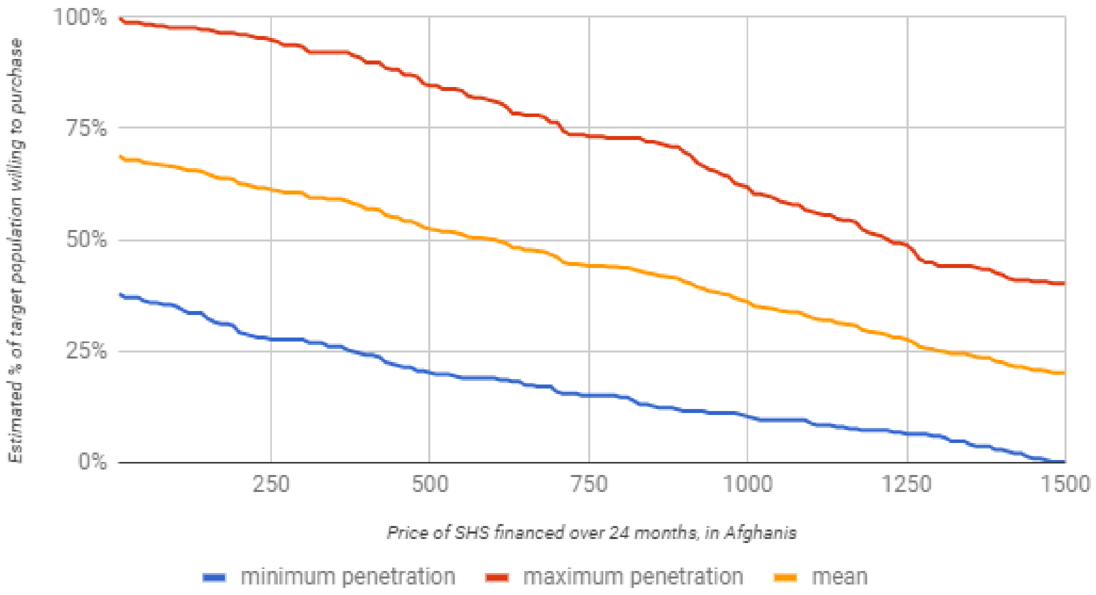


Figure 63 Preliminary demand curves for SHS, financed over 24 months, for businesses and institutions



Nota bene: The demand curve for an SHS financed over two years actually gets narrower in the higher ranges, which is unusual and will be further elucidated over the course of the coming year. Indeed, it is possible that that difference between renting such a device and financing it is not clear in the Afghan context.

Figure 64 The future, or a relic of the past?

Finally, demand for solar lanterns is limited and drops quickly as prices rise. At AFN 2,000, no more than 50% would accept the offer - and, indeed, the percentage might well lie closer to the blue "minimum penetration" at below 10%

Figure 65 Preliminary demand curves for solar lanterns, for households

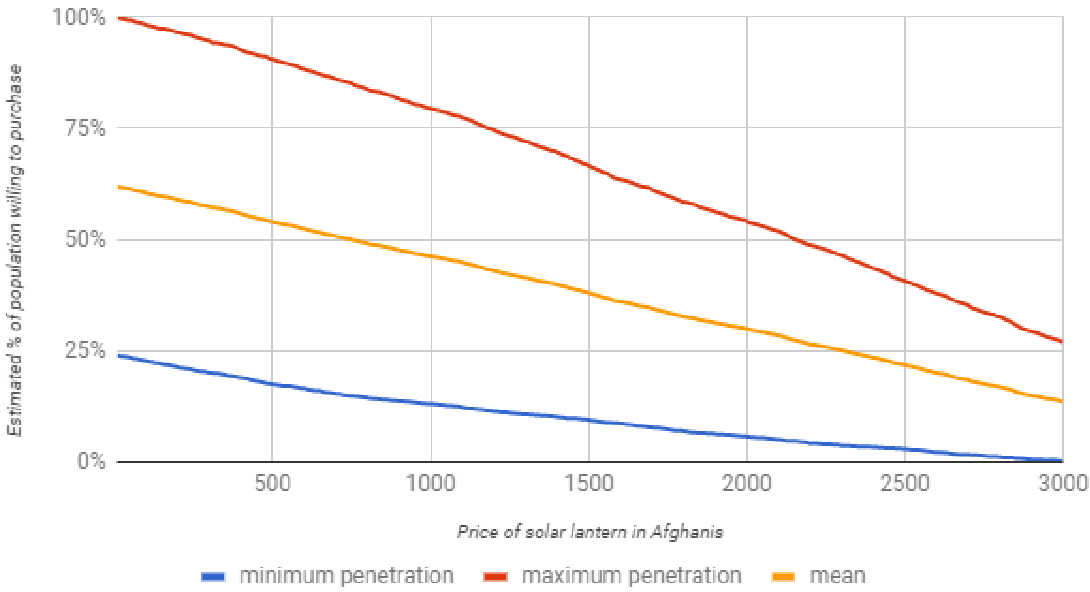
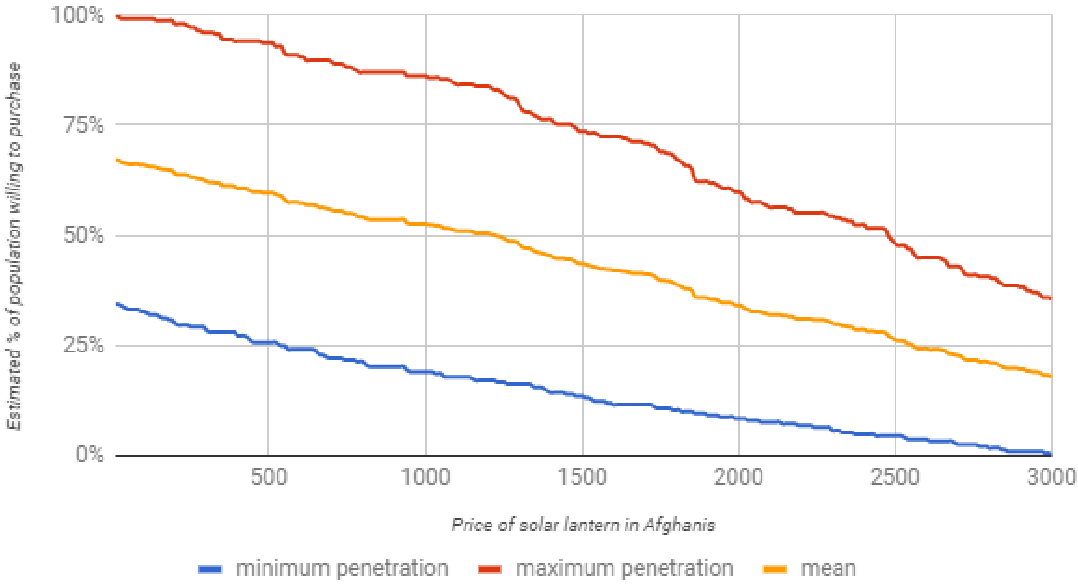


Figure 66 Preliminary demand curves for solar lanterns, for businesses and institutions



In summary, preliminary results suggest that households, enterprises and community institutions display an elastic willingness to pay to obtain a grid connection. As would be expected, the lowest and highest expected penetration rates are in a narrower band in the lower price ranges. Compared to actual expenditure on electricity by those who are already connected to the grid, their expectations are low in terms of running cost. Compared to grid, and, indeed, in light of an imminent expected grid connection for the majority of interviewed non-grid respondents, willingness to pay for solar appears to be less pronounced.

Nota bene: Using an approach as described in Annex 2, these ranges will be further narrowed down over the course of the coming twelve months. The final deliverable will further explore results through faceting with respect to locations, and the socio-economic profiles of the respondents.

4. Next steps: longitudinal energy diaries

Seasonality is a key aspect of energy consumption and affects usage patterns in multiple ways. Household heating constitutes a major energy demand during the colder months in the Afghan climate. Lighting needs also change with differentials in daylight-hours (with daylight hours increase approximately 1 hour each month over spring). Winter has a two-fold inverse effect on energy in provinces like Kabul - demand rises sharply while supply decreases (due to hydropower shortages for grid-supply). Instead of a one-time snapshot that does not factor these variables, the energy study was designed to mitigate or capture the effects of seasonality over a year-long period.

The baseline data collection was intentionally conducted over a relatively short period of time in order to mitigate the risk of skewed results as the weather changed over the spring months. And the upcoming longitudinal diary and case study exercises will offer deep understanding on changing energy consumption patterns throughout the seasons.

The energy diary phase will consist of a monthly survey of households or enterprises / institutions which will be conducted by phone. The tools used for this purpose will focus on :

- Energy usage
- Changes in energy access or availability
- Willingness to pay

This will allow for the generation of a quantitative data set on year-long seasonal profile of household energy usage. The period of recall for this diary will be approximately one week - households will be asked to pay attention to their energy usage over the course of one week per month, and then will be asked to report on this in the monthly phone survey.

Furthermore, based on the findings of the qualitative data collected throughout the baseline phase, as well as any relevant findings from the Household Survey, a qualitative case study tool has been developed to explore key issues around the impacts of energy usage on different types of households.

Case studies will be conducted across all provinces, with a total of 10 households. Each household that will be studied will be visited four (4) times over the course of the energy diary phase – once each season / approximately every three (3) months. Households will be visited for a few hours by a qualitative enumerator to be interviewed for the case study, and multiple members of the household will be interviewed – preferably at least one male, one female, and one child.

Kabul	Herat	Samangan	Paktia	Daikundi
2 households	2 households	2 households	2 households	2 households

Key areas which the case studies will investigate will include:

- Gendered impacts of energy usage
- Impacts of energy usage on education
- Impacts of energy usage on income generation
- Impacts of energy usage on health
- Challenges and aspirations

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ANNEX I: Reported prices of selected energy-related goods and services in the communities visited for this research

Province	**Community**	Grid Connection	Generator	Solar lantern	SHS	Solar battery	Diesel (litre)	LPG (kg)	MiniGrid Connection	Wood (ser =7kg)	
Kabul	Dasht-e-Barchi		10000	1050	4000	8000	50	60	5000		150 Amp 8000
	Karte Naw	20000	8000	500		18000	41	60			
	Khair Khana	15000	15000		5000	4000	47	60			
	Deh Yahya		5000 - 30000	600				60		100	
	Langar		15000		5750	7000	50	65			200 Amp 7000
	Shewaki	7500	6000		2200	3700		55			
Samangan	Mula Qurban	20000	12000	250	12000	8750	46	60			Grid costs Mula Qurban
	Chawghai	10000	8500	250	10000	3000	46	70			
	Talkhaki		3750	400	11000	5000	45	50			
	Dawlatabad	5000	5000	450	9500	5250	46	60			
	Yakatoot	13500	9250	375	7500	4750	46*	60*			*not in use due to cost
	Lab-e-Aab	5000	9250	400	8500	5750	50	60*			*gas rarely in use
Paktia	Baala Deh		16250	1750	18750	5000		65		74	LPG is much less used than wood for heating and cooking in Baala Deh
	Habib Kala		25000	2000	25000	5250		60		91	
	Bano Zai		40000	1000	40000	5000		50		88	100 Amp Battery
	Narqese		40000	2667	26667	5333		68		77	
	Mondakhail		unclear	3333	28333	unclear		52		83	
	Patan Kalai		28333	unclear	21000	16000		50			
Herat	Jebraeel	21000	5000		6000	4000		54			
	Shaalbafaan	8500	10000		10000	6000		50			7000 - 10000 dependent on on distance to junction

		Naw Aba Shuhadaye	*10000*	*10000*		*4500*	*8000*		*48*			*75 Amp system*
		Majghandak		*7000*		*4500*	*6000*		*50*	*Free*		
		Qala-e-Sharbat		*8000*		*7500*	*3000*		*50*			*Only 5% of the community uses LPG for heating, although more use it for cooking*
		Malikiha	*16500*	*9000*	*500*	*8000*	*3500*		*60*			*Residential: 5 Afs kW; Commercial: 12.5 Afs kW*
Daikundi		*Qarya Dasht*		*Discrepancies*	*450*	*8000*	*7000*	*50*	*70*			*100 Amp Battery*
		Sar-e-Nili		*3000*		*5000*	*6250*	*55*	*65*			*2000 Afs for a low-capacity generator, 4000 Afs for a small Tiger generator that generates 1kW*
		Sang-e-Mom		*8000*		*11500*	*8000*	*55*	*70*			*Generator: 4000, 8000 or 12000 Afs dependent on capacity*
		Ghaf		*8000*		*8500*	*6000*	*55*	*70*			*Generator: 4000 - 12000 Afs*
		Khuja Chasht				*10000*	*5250*	*55*	*70*			
		Charkh				*10000*	*6250*	*58*	*73*			

Prices were taken from interviews with key informants in each community, and were given as estimates. Community profilers would sometimes triangulate figures by looking at prices in bazaars or shops, or by speaking with shopkeepers.

If a price range was given by key informants, and/or multiple key informants gave different prices, the midpoint/average price was used. Price ranges could be wider based on the capacity and quality of items fo sale (e.g. generator or solar battery).

Prices are rounded to the nearest Afghani

ANNEX II: Estimating the demand curve

The demand curve of a service such as grid power is an estimate of the degree of penetration (subscription to the service) that might result for each price-point in a range. To estimate this curve, each respondent was presented a hypothetical price to be connected to the grid and asked whether he/she would be willing to pay that amount. The prices were randomly selected from a uniform distribution between zero and the estimated average cost of connecting a household to the local grid, to simulate different levels of subsidy.

To estimate the demand curve, then, for each price point p respondents were divided into four groups:

- $A(p)$: respondents who were offered a price at or above the reference price and responded, "yes";
- $B(p)$: respondents who were offered a price at or above the reference price and responded, "no";
- $C(p)$: respondents who were offered a price below the reference price and responded, "yes"; and
- $D(p)$: respondents who were offered a price below the reference price and responded, "no".

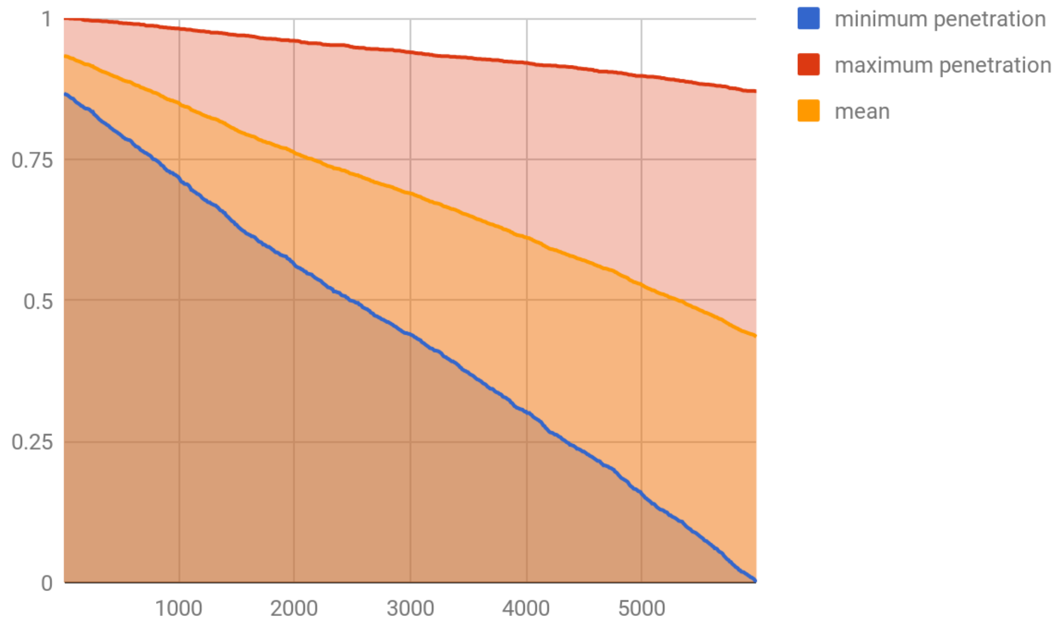
Of these four groups, only two provide information with respect to the demand curve. Respondents in group $A(p)$ at a given reference price p can be presumed to subscribe at that price while those in group $D(p)$ can be presumed not to subscribe. Thus we know that the penetration rate $r(p)$ at price p is at least $A(p)/N$ and certainly no more than $(N - D(p))/N$, thus

$$\frac{A(p)}{N} \leq r(p) \leq \frac{N - D(p)}{N}$$

Since $N = A(p) + B(p) + C(p) + D(p)$ the difference between the lower limit and the upper limit is:

$$\frac{B(p) + C(p)}{N}$$

and thus our uncertainty is proportional to the number of low-priced "yes" responses and high-priced "no" responses.



As we can see from the table above, our survey data provided us with a relatively narrow estimate in the lower price ranges, but very little precision in the upper ranges, representing a paucity of sample data in that price range relative to the variance in yes/no responses. Going forward, we can improve the precision of our estimate by concentrating our random hypothetical prices in the upper range.

As a result, we recommend including further WTP questions going forward, informed by responses to the previous questionnaire. The following algorithm will minimize survey length while maximizing information gain for each of the five WTP questions.

For the first diary round, if the respondent said "no" in the baseline, choose a random price between zero and the price proposed to the respondent in the baseline, with a higher probability for higher prices in this interval. If the respondent said "yes" in the baseline choose a random price between the price proposed in the baseline and the maximum price, with higher probability for higher prices.

For each round after that, for each of the five WTP questions:

Determine the breadth of the uncertainty interval for this respondent. Let a be either the lowest price the respondent has said "yes" to, or 0 if she/he has never said "yes". Let b be the highest price she/he has ever said "no" to, or the maximum for that question, if she/he has never said no. The breadth of the uncertainty interval is $b - a$.

1. if the uncertainty interval is less than, say, 10% of the total possible interval (0-6000 afg in the graph above), move on to the next question. We have the precision we need.

2. if the uncertainty interval is wider than our threshold, choose a price at random within the uncertainty interval, with higher probability for higher prices and propose this price, asking whether the respondent would pay this price for this service.

    a. if the respondent answers no, this price becomes the new maximum b for the next round
    b. if the respondent answers yes, this becomes the new minimum a for the next round.

Over the course of the year, this should allow us to estimate the demand curve within a few percentage points, without lengthening the average survey unnecessarily.

Furthermore, the following suggested **alternative approach** will be explored for the demand curve calculation:

It is possible to estimate a demand curve through regression analysis by assuming that the demand curve is rapidly diminishing linear combination of a covering basis for the family of all theoretically possible demand curves. One commonly used demand curve basis is the set of exponentials e^{-kP} with *k* = 0,1,2,3…

By limiting the number of basis functions to $k \leq K$ such that

$$Q = \sum_{k=0}^{K} \alpha_k e^{-kP},$$

subject to the constraint

$$\sum_{k=0}^{K} \alpha_k = 1,$$

we can use a logistic regression to compute an exact demand curve which minimizes the residual error in a theoretical exponential probability binomial distribution.

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