

The World Bank

Asia Sustainable and
Alternative Energy Program



Mongolia

Development Impacts of Solar-Powered Electricity Services

January 2014



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Acknowledgments

The objective of the report is to shed light on the development impacts of solar-powered electricity services in Mongolia. The target audience includes development professionals and government officials that are engaged with rural electrification programs based on solar home systems. It is hoped that the results of the analysis presented in this report will be a source of inspiration for and help make informed decisions on rural electrification.

This publication is an impact evaluation report on a World Bank operation titled “Mongolia: Renewable Energy and Rural Electrification Access Project (REAP).” Completed on June 30, 2012, the operation was jointly funded by grants from the International Development Association (IDA P099321), the Global Environmental Facility (GEF P084766), and the Government of the Netherlands.

Upon completion of REAP, two surveys were conducted with the aim to assess the impact of the distribution of solar home systems (SHS) on the nomadic herders in Mongolia. The first, conducted by a local consulting firm, was a sample survey of about 800 herder households. The second, conducted by a World Bank team, involved in-depth interviews with twelve herder households.

This report is a summary of the findings and conclusions of the above surveys. It was prepared by a task team that included Peter Johansen (Task Team Leader and Senior Energy Specialist), Ivy Cheng (consultant) and Roberto La Rocca (consultant). The World Bank team would like to thank the Mongolian Ministry of Mineral Resources and Energy and the Energy Authority for their collaboration

and candid feedback. It would also like to give special recognition to the staff of the former Project Implementation Unit of REAP, in particular its Director Dorj Purevsuren, for his continued support, local insight and guidance throughout the process.

The report builds on the “Implementation Completion and Results Report of REAP” (Report Number ICR00002151, dated December 17, 2012) and an associated paper titled “Capturing the Sun in the Land of the Blue Sky, Providing Portable Solar Power to Nomadic Herders in Mongolia” published during project implementation. It drew from the two publications and benefitted greatly from information collected by the various task teams during the course of project preparation, appraisal, implementation, supervision and completion review. The contribution of the teams under the leadership of Salvador Rivera and Migara Jayawardena is also acknowledged.

The World Bank would like to gratefully acknowledge the contributions of the Asia Sustainable and Alternative Energy Program (ASTAE) for its financial support towards the surveys and the preparation of this publication.

Acronyms and Abbreviations

Aimag	Equivalent to province	MDG	Millennium Development Goals
ASTAE	Asia Sustainable and Alternative Energy Program	MMR	Maternal Mortality Rate
EA	Energy Authority	MMRE	Ministry of Mineral Resources and Energy
CFL	Compact Fluorescent Light	MNT	Mongolian tugrik
GDI	Gender Development Index	REAP	Renewable Energy and Rural Electricity Access Project
GDP	Gross Domestic Product	PV	Photovoltaic
GII	Gender Inequality Index	Soum	Subdivisions of Aimag, equivalent to counties or districts
GOM	Government of Mongolia	SC	Soum Center
HDI	Human Development Index	SSC	Sale and Service Center
HIV	Human immune Deficiency Virus	SHS	Solar Home System
IEC	International Electrotechnical Commission	STIs	Sexually Transmitted Infections
ICR	Implementation Completion and Results Report	UNPFA	United Nations Population Fund
IDA	International Development Association	Wp	Watt peak
kW	Kilowatt		

Currency Unit

Exchange Rate Effective as of January 23, 2014

Mongolian Tugrik (MNT)

MNT 1,694 = US\$1.00

Executive Summary

Mongolia is a vast landlocked country with a relatively small population. Other than those living in the capital city and a few urban centers, the rest of its citizens (about 35 percent or one million people) are geographically disbursed throughout the rural countryside. Among them about three quarters are nomadic herders living in portable tents (gers). Given the immense logistical and climatic challenges, rural electrification was largely undeveloped until the Government launched the National 100,000 Solar Ger Electrification Program in 1999.

The World Bank-assisted Renewable Energy and Rural Electricity Access Project (REAP) was conceived in 2006 to help revitalize the Government's ambitious initiative which had been showing signs of stagnation after delivering over 30,000 portable photovoltaic solar home systems (SHS). At its conclusion in 2012, over 67,000 SHS had been delivered to herder households country-wide and the goal of electrifying 100,000 gers under the Government's Program was successfully met. This translates to an overall coverage of about half a million people which corresponds to about two thirds of the nomad population and one sixth of Mongolia's total population. The Program was very successful in increasing national energy access, which is now over 90 percent compared to a pre-program level of 67 percent¹ mainly due to the Ger Electrification Program. This remarkable achievement came at a moderate total cost—the smart subsidies and Program support provided by REAP amounted to around US\$12 million² over the 5-year implementation period.

Upon completion of the Project, beneficiary surveys were conducted to assess the developmental impacts of the delivery of solar-powered electricity services on the herder households. The first was a structured sample survey of 789 households and the second involved in-depth interviews with a dozen households. The surveys show a high level of customer satisfaction among owners (over 93 percent) and that herders consider their units to be reliable and the capacity adequate to cover their appliances—typically lamps, a television set cum satellite desk, and a charger for mobile phones. More than six years after these systems were purchased, more than

90 percent are still in use and some households have even acquired additional units. The surveys show that the impact on the herders has been very significant—switching from candles to florescent lamps; from radio to television; and from cumbersome and rare in-person communication to cell phones with coverage throughout most of the wide expanse of the Mongolian steppe.

Increased productivity and income are the most often cited advantages of the electrification in the survey. The availability of on-demand and higher intensity lighting makes it easier for adults to continue to work at normal pace, relax, read and take care of their families after dark. It also gives their children more time to read, study and have fun after the evening meal. Television and mobile phones enable timely information gathering and exchange, e.g. access to reliable and current market information on livestock and food prices informing the herders' business transactions. Access to the latest weather reports and warnings also helps herders avoid danger and minimize property losses.

The electrification has enabled the near-universal adoption of the mobile phone, which by itself has brought about a sea change in the way the herders communicate within their families, among themselves, and with the outside world. The phone has, to a large extent, replaced the need to embark on often long and arduous journeys just to deliver or pick up a message. It is frequently used to facilitate business dealings, consult with acquaintances and professionals, and arrange for appointments. It also makes it effortless for couples to stay in contact with each other when separated by the migratory lifestyle; for parents to stay in touch their children who customarily attend boarding school; and for relatives, friends and neighbors to chat and organize social functions.

According to the surveys television not only brings news, weather reports, business information and entertainment to the ger dwellers, it is also a popular and effective means of delivering health education. Such information usually comes in the form of healthcare guidelines, discussions on common diseases, and tips on preventive care. Another very popular innovation brought about by access to electricity is televised cooking shows that discuss the nutritional values of different foods; demonstrate various cooking methods; and introduce healthy ingredients and recipes. Parents commented that these

1. World Bank—DataBank (2013).

2. Roughly 50 percent funded by the Government of Mongolia, 40 percent funded by a grant from the Government of the Netherlands, and the remainder funded from a grant from the Global Environment Facility and a credit from the International Development Association.



programs help them make more informed menu choices and their children develop good habits and practices.

The wide adoption of SHSs and the subsequent improvements in access to electricity services have positively impacted intra-household dynamics, partially addressing gender inequality-related issues. The majority of the women interviewed indicate that the newly-gained access to stable electricity has translated into significant time-savings, which in turn, allow for increased time spent on personal care, parenting, learning and work diversification. Following the installation of SHSs, women's household-related decision making enjoys a higher degree of freedom and male herders put higher value on a woman's work contributions towards the overall level of household income.

The lifestyle of the Mongolian herders is to respect and blend in with nature. However, for a greater part of the year herders live with the risk of inclement weather making it very tough and sometimes dangerous to cope when isolated. Electrical lamps and mobile phones make herders feel safer for themselves and their animals, particularly after nightfall. Knowing that support is only a phone call away in case of emergencies also gives herders a sense of security that they never experienced before. Considering the country's current economic boom the importance of this comprehensive rural electrification and the positive impact felt by the beneficiaries cannot be underestimated. The Ger Electrification Program has greatly contributed to ensuring that the nomad community, with strong connections to the Mongolia's

rich history and culture, is able to maintain its long-established way of life without being left behind.

The popularization of SHSs also brings about other impacts and opportunities beyond the household level. With almost two thirds of the herders having access to electricity, the demand for consumer electronics and electrical appliances and equipment has increased significantly. The fast growing demand for SHS-compatible appliances represents business and employment opportunities and introduces a new commercial market. In turn, the existence of this market and the awareness that electricity can improve quality of life promotes the growth of the ger renewable energy market, for instance resulting in multiple and larger solar installations powering appliances with higher electricity needs such as refrigerators. This leads to a virtuous cycle where the increased coverage creates a critical mass of users that can sustain retail and maintenance business meaning that the SHSs stand a better chance of being well maintained and reaching their design life of twenty years.

In fact under REAP the SHSs were inspected and certified to meet stringent quality standards to minimize potential breakdowns and reputational risks in a novel market. The establishment and functioning of a network of Sales and Service Centers (SSCs) and the introduction of a manufacturers' warranty practice were key elements in the creation of a sustainable market for SHSs. It is recommended, however, that the Government extends and strengthens the maintenance and repair service network and continues to monitor the performance of the SSCs and the extent to which they continue to provide support to the rural population.

The positive feedback from the herder households demonstrates that some early misconceptions about solar home systems such as safety and reliability concerns have now been fully dispelled. The successful completion of the Ger Electrification Program is widely recognized as an important achievement and a major development milestone for Mongolia. It provided a solid foundation for the government and its partners to turn their attention to GOM's next target, namely, universal rural electrification by 2020 under the Government's National Renewable Energy Program.

Introduction

Country and Sector Background

As shown in Map 1.1 below, Mongolia is a geographically vast and landlocked country, which covers a territory of over 600,000 square miles, but has a relatively small population of about 2.9 million. Of the total, about 1.2 million people live in the capital city of Ulaanbaatar and another estimated 600,000 live in small urban centers. The rural population of Mongolia is comprised of the remaining one million or so people who are geographically dispersed throughout the countryside in sparsely populated areas. Among the rural residents,

about a quarter of them live in small settlements known as “soums” (subdivisions of Aimag equivalent to counties or districts), and the other three quarters (700,000–800,000 people, or about one quarter of the country’s total population) are nomadic herders living in portable traditional tents known as “gers,” generally set up at least 5–15 km from each other.

While Mongolia’s economy remains underdeveloped, it is experiencing a major mining boom in recent years due to increased international interest in the country’s vast mineral wealth. Activities associated with this boom

MAP 1.1 MONGOLIA



Source: World Bank.

have propelled economic growth to unprecedented double digit levels (17 percent for 2011). By the end of 2011, Mongolia's GDP had swelled to over US\$8.5 billion from a low base of US\$1.1 billion at the turn of the millennium. Despite the rapid growth that is transforming Ulaanbaatar and its vicinities in a dramatic fashion, it has hardly touched, much less benefited the country's rural population. In fact, with high inflation (around 15 percent since 2010) and increasingly wider income disparity, they are being left further behind.

One obvious indicator of urban rural disparity is in the access to electricity. The power sector of Mongolia is essentially made up of three markets: the largest covers all grid-connected regions and cities; the second covers soums served by stand-alone systems (mini-grids) operated by local administrations; and the third covers the widely scattered nomadic herders. At the end of the twentieth century, most herders and the hubs serving them, known as soum centers (SC), had little access to steady power supply. Consequently, while the million or so rural residents represented over 35 percent of the country's population, their share of power consumption amounted to less than four percent of the total. The herders' share is particularly dismal—a mere one percent even though they accounted for about one quarter of the country's total population.

The Government of Mongolia (GOM) was keenly aware of its rural residents' predicament and was committed to bring about development in the rural electrification sector while preserving the herders' traditional lifestyle. However, the task to improve their lives and welfare is especially daunting given the immense logistical and climatic challenges (with temperature often dipping below 30 Celsius during the long frigid winters). That said, Mongolia is also richly endowed with renewable wind and solar energy resources that could be captured and utilized. Hence, the current rural electrification strategy

is consisted primarily of adopting renewable energy technologies such as renewable-diesel hybrid systems (wind or solar power complemented by diesel) for the soum centers and portable photovoltaic solar home systems (SHS) for the nomadic herders.

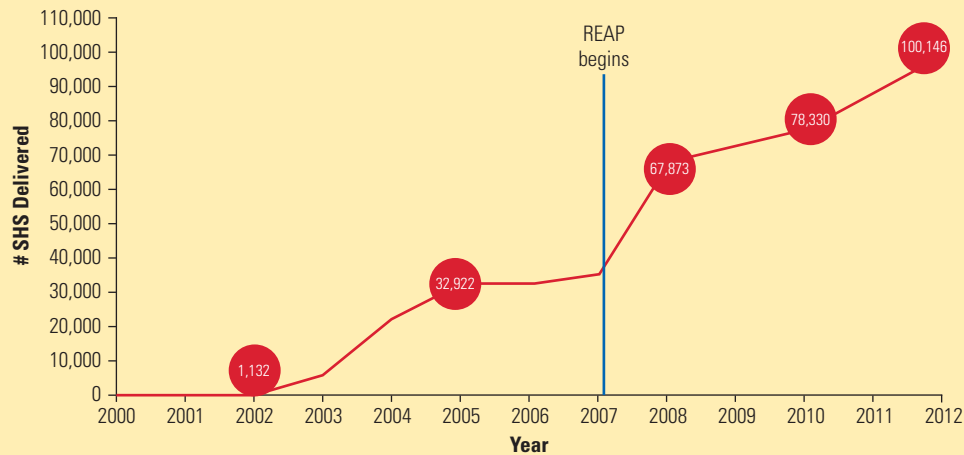
Project Background

In accordance with its new rural electrification strategy, the Government of Mongolia launched the National 100,000 Solar Ger Electrification Program (100k Program) in 1999. It was an ambitious initiative aimed to improve the lives of about half a million herders by providing them with SHSs that were adaptable to their nomadic lifestyle and complementary to their traditional way of life. The program gained substantial internal and external attention and support, initially establishing three targets for SHS dissemination: 5,000 units by 2005, 45,000 for 2001–2005, and 50,000 for 2006–2010. Through grants from several donor countries, the Government managed to provide over 30,000 herder households with SHSs by 2005. Unfortunately, when external funding dwindled the 100k Program began to stagnate.

The World Bank-assisted Renewable Energy and Rural Electricity Access Project (REAP) was conceived to help the Government revitalize the 100k Program and remove other barriers to rural electrification. The ultimate objective of the project was to increase electricity access and improve the reliability of services in off-grid soum centers and amongst the herder population. The project was designed as an integrated program of physical investments and technical assistance. It was funded with contributions from four partners, namely: the Government of Mongolia, the International Development Association (IDA), the Global Environmental Facility (GEF), and the Government of the Netherlands. Bringing together the public and private sector in a vast geographical area, the Project also benefitted from the support funding of the Asia Sustainable and Alternative Energy Program (ASTAE) in the early phases of implementation.

REAP was launched in 2007 and implementation was completed in 2012. The project was comprised of three components: (1) the Herders' Electricity Access Component (about US\$12 million) which included, inter alia, smart subsidies to facilitate the acquisition of 50,000 SHSs by herder households and help the government achieve the 100k Program target; (2) the Soum Center Electricity Service Component (about US\$10 million) to support the rehabilitation and installation of renewable energy technology systems in SC mini-grids; and (3) the Institutional Capacity Building Component (about US\$1



FIGURE 1.1 IMPLEMENTATION OF THE NATIONAL 100,000 SOLAR GER ELECTRIFICATION PROGRAM

Source: Ministry of Mineral Resources and Energy, Mongolia.

million) to strengthen national renewable energy policy development and to support project management.

The successful completion of the Herders Electricity Access Component under REAP was considered a great achievement by the GOM. The result was a significant scale-up in the number of SHSs sold and delivered to the herder households, as illustrated in the following Figure 1.1. Specifically, the Government's target of electrifying 100,000 gers was fully met and surpassed. In all, over 67,000 SHSs provided under the 100k Program (or about two thirds of the total) were attributable to this project component. In terms of distribution, delivery reached nomadic herders in 342 soums spread across every one of the 21 provinces (known as "aimags") in Mongolia. As envisioned, the total number of beneficiaries of the 100k Program was estimated to be about half a million people. This represented coverage of more than two thirds of the country's herder population.

Survey and Impact Study Background

Upon completion of REAP, with financial support from the Asia Sustainable and Alternative Energy Program (ASTAE), two beneficiary surveys were conducted to assess the impact of the distribution of SHSs. They are: (1) a sample survey of about 800 herder households in ten soums; and (2) in-depth interviews of twelve herder households in four soums. The data collection and analyses entailed both qualitative and quantitative assessment

of SHS utilization, user satisfaction and socio-economic impacts attributable to the installation and use of SHSs.

After the conclusion of project implementation, the Bank was able to disseminate information on the preliminary results of the Project and lessons learned with funding provided by ASTAE. Titled "Capturing the Sun in the Land of the Blue Sky—Providing Portable Solar Power to Nomadic Herders in Mongolia", the product includes an information poster, a documentary video, a paper, a web article and a PowerPoint presentation. These materials, along with the Implementation Completion and Results Report of the project (World Bank Report Number ICR00002151) should be referenced for a more comprehensive understanding of the background of the Project and this impact study.

The main portion of this report is divided into two chapters (Chapters 2–3). Chapter 2 is a brief description of the two beneficiary surveys carried out after REAP was completed. It includes the methodologies used, the survey processes, and the surveys' areas of focus. Chapter 3 presents the main results and findings of the surveys based on qualitative and quantitative information and data collected. They include three main aspects: use and sustainability of REAP portable photovoltaic solar home systems; immediate impacts of the resulting changes in energy use patterns; and where the availability and use of electricity have the most impact on the nomadic herder community's quality of life and development.

The Beneficiary Surveys

As noted in the project background section, the World Bank assisted Renewable Energy and Rural Electrification Project (REAP) has provided over 67,000 portable photovoltaic solar home systems (SHS) to the herder community in Mongolia. The objective of the surveys was to gain some measure of the project's impact on the beneficiaries through face-to-face interviews with selected adult household members. The first survey (Sample Survey) involved close to eight hundred households (defined as family or extended family members living in the same ger). The second survey (In-depth Interviews) covered twelve households. An extensive questionnaire was used in both cases. Due to the design of the surveys, most results are qualitative in nature. The households selected for both surveys were all registered REAP SHS purchasers.

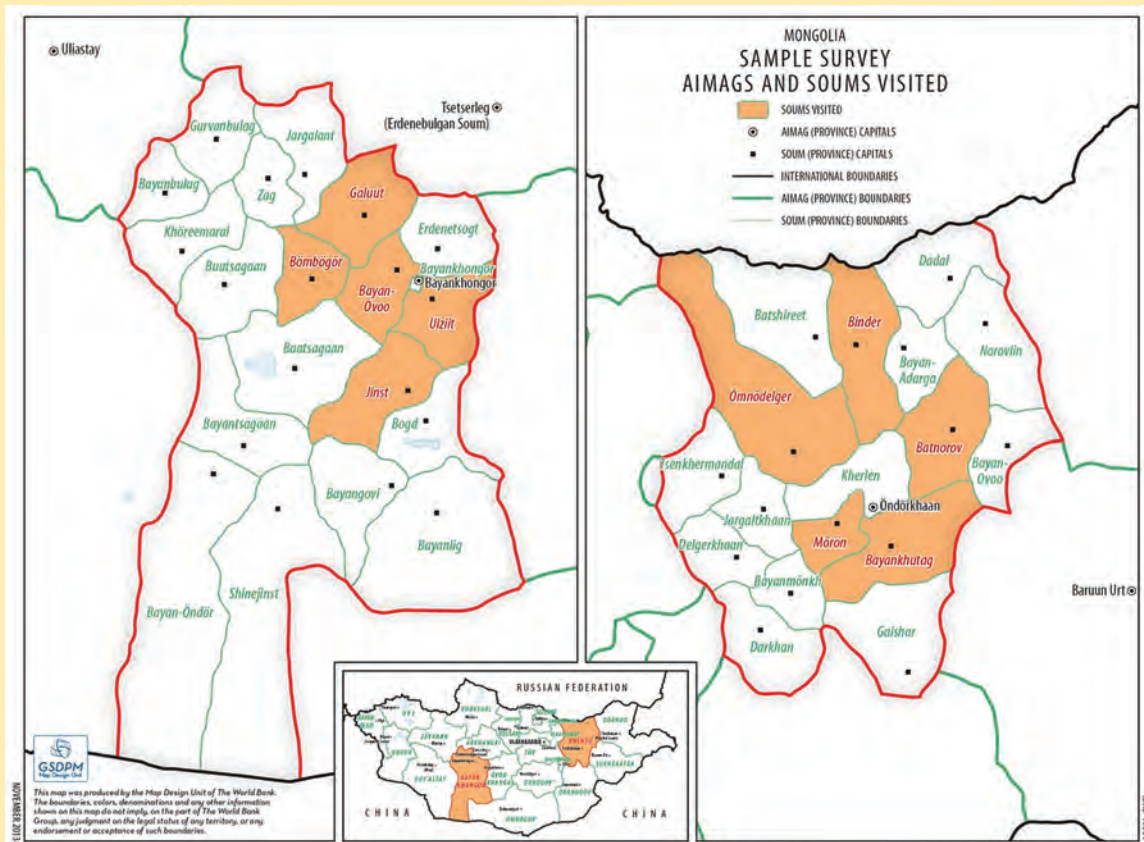
Survey 1: Sample Survey

The sample survey was conducted in 2012 in the Khentii and Bayankhongor aimags (there are a total of 21 aimags in Mongolia). Within each aimag, the soums were stratified according to their total number of herder households owning SHSs. Five soums were then randomly selected from each aimag. Thereafter a sample of 800 herder households was randomly selected from a pool of 1,490 households that were registered as SHS purchasers under REAP. Actual face-to-face interviews were conducted with 789 households. Salient demographic features of the survey population are summarized in Annex A. A map of the selected aimags and soums is presented in Map 2.1.

A draft version of the survey questionnaire was pretested among ten herder households and revised to its final form based on the experience and feedback received. The final survey questionnaire used for the interviews included 13 sections focusing on the household and its members. They are, in the order of the questions asked: (1) basic household information—composition, roles of members, and their ages and education levels; (2) main sources of income; (3) incomes and expenditures; (4) information on the acquisition, use and maintenance of SHS unit(s); (5) REAP SHS consumer satisfaction; (6) use of energy for lighting and other electrical appliances; (7) alternative sources of energy used before and after the installation of the SHS unit(s); (8) time allocation during daylight; (9) time allocation after dark; (10) communication methods; (11) information access; (12) healthcare; and (13) attitude towards the use of electricity.



MAP 2.1 SAMPLE SURVEY—AIMAGS AND SOUMS VISITED



Source: World Bank.

Data collection was carried out by seven field teams which were provided with a survey manual and a full-day training prior to conducting the interviews. Data entry, verification and quality control were performed at various stages; by the interviewers themselves, their supervisors, and the data editing group in the home office and during data processing. The software program used for data entry, verification and database development was CPro-5.0. The final product was a report on the survey results, accompanied by a copy of the final dataset.

Survey 2: In-depth Interviews

A total of twelve in-depth interviews were conducted in the Khentii aimag by a World Bank team over the course of four days in June 2013. Khentii was chosen because it was covered in the October 2012 market survey conducted under REAP and it also overlaps with one of the

aimags covered in the sample survey. Four soums within Khentii aimag were selected as the sites for the interviews, they were: Undurkhaan, Bayankhutag, Murun and Umnudelger. Specific locations were chosen after consultation with stakeholders in the REAP Project Implementation Unit. A selection of aimag and soums is presented in Map 2.2.

At each of the sites the team interviewed individual heads of household, their spouses and, occasionally, their neighbors and friends. Interviews were semi-structured, following an outline of questions similar to the sample survey, and adjusted from interview to interview depending on circumstances and relevance to the interviewee. The follow-up questions asked during these in-depth interviews were more open ended as compared to the strictly structured sample survey. The purpose was to encourage the interviewees to elaborate their views and tell their stories.

MAP 2.2 IN-DEPTH INTERVIEWS—SOUMS VISITED



Source: World Bank.

From the in-depth interviews, the team sought to gather a combination of qualitative and quantitative data. Due to the small sample size and the nature of the in-depth interviews, quantitative data can only be considered as indicative in nature. However, the findings do serve as a useful means to validate and elaborate on the findings of the larger sample survey.

Survey Findings

Use and Sustainability of SHSs

Before SHS became available, only 69 percent of the surveyed households had access to some form of electricity. The main sources of alternative energy were candles, kerosene lamp or dry cell battery powered flashlights for lighting; and dry cell battery powered radios for news, information and entertainment. The concern herders had regarding the use of candles was the fire hazards they created. The majority also believed the burning of kerosene and oil in closed quarters was harmful to their health.

One common source of portable electricity was from motorcycle or car batteries, which allowed the herders to power small tools and appliances. However, they were not renewable resources, and safe disposal of used batteries had often been problematic.

Only the lucky few who owned diesel or wind powered generators were able to use electrical appliances routinely, which often include a light bulb and, in some cases, a black and white television set and cell phones. However, the diesel generators became very costly to operate once the long-standing fuel subsidies were removed. It was also seen as unreliable as fuel supply and delivery were often interrupted. The wind-powered generators, while not expensive to operate, were also considered an unstable source of supply as production was subject to seasonal fluctuations. During the summer and autumn, there tends to be little wind, whereas during the spring and winter the equipment often broke down under the strong Mongolian wind and created maintenance issues for their owners. Also during those seasons

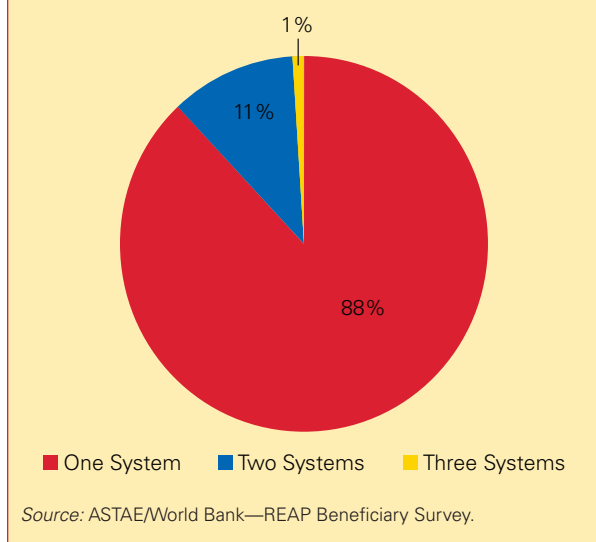


herders often set up their gers in areas that shelter them from strong gusts, rendering their wind-powered generators useless.

SHS Ownership and Capacity

All households included in the surveys were registered SHS purchasers. In terms of ownership, the majority of the herders own one SHS. Far less are the households with two or more system units. Similar to most other major purchases, the acquisition of a SHS is generally a family decision. A summary of the number of SHSs owned among the sample households is presented in Figure 3.1.

Under REAP, virtually all households purchased a 50-watt peak load system, and paid a subsidized price of a little under US\$200 for it. The prevailing full price was about \$330 per unit based on bulk purchase and before transportation and storage. By comparison, the market retail

FIGURE 3.1 NUMBER OF SHSs OWNED PER HOUSEHOLD

price for a similar unit is about US\$400 in 2013. Appliances powered through a 50 watt SHS typically include a 14 to 17 inch color or black and white television set; a satellite dish and receiver; a 7–11 watt compact fluorescent light (CFL) lamp; and a charger for one or more mobile phones.

The respondents express satisfaction with the capacity of the SHSs they own. About 89 percent report that the electricity generated is generally adequate to power their appliances. However, many also feel it is not sufficient to power all the appliances simultaneously and continuously throughout the day, particularly during the winter months when there are fewer hours of sunlight. That said, according to the vast majority of those interviewed (95 percent), the solar PV systems are still considered a reliable source of electricity.

The herders' coping mechanisms during power shortages include using the SHS without the base so they can turn the unit to catch the sun in early mornings and late afternoons; operating the television set for fewer hours or switching to a black and white set during the winter. Some more affluent herders opted to install additional SHSs to enhance reliability and also to accommodate larger television sets and other major electrical appliances such as a freezer.

The survey reveals that even when the interviewees agree that the output from their systems is sufficient to power the basic appliances they own, roughly half also expressed plans or desire

to upgrade so they can add on other appliances. The most popular item on the herder households' wish list is a freezer for preserving meat. Usually, after a slaughter herders would try to consume the meat as quickly as possible to avoid spoilage. They believe a freezer would allow them to spread out meat consumption more evenly, and that in turn would enable them to eat a more balanced diet over time. Many feel that adding variety to their meals would make them more nutritious as well as more enjoyable. The second most popular item on most respondent's list is a washing machine.

While many herders seem to be interested in SHS upgrades and the purchase of several major appliances, it is observed that only a few actually have plans to do so in the near future. Fewer still actually have a clear idea as to where to make such purchases and how they would impact their household budget. The sometimes conflicting signals the survey reveals suggest that moving forward it would be necessary to better understand the evolution of the herders' electricity needs, and their willingness to pay and affordability if the demand of the Mongolian nomadic community is to be adequately met.

Maintenance and Servicing of SHSs

The design of REAP included several innovative features. First, the SHSs supplied were of high quality and conformed with International Electrotechnical Commission (IEC) standards. They were easy to install and dismantle, and the battery life was expected to be longer than those available prior to the project. Indeed, the majority of herders interviewed note that they have experienced few maintenance issues. More than six years after their initial installation, about 90 percent report that the SHS they purchased under REAP are still in use.



The main components of a SHS include CFL bulbs, a charge controller, a battery and a power box including plugs. According to the survey data, inverters and charge controllers were less likely than light bulbs and batteries to be replaced. Specifically, while the majority of people are still using the original inverters and charge controllers, about 75 percent report that they have already replaced their light bulb(s) at least once, and 35 percent of the survey population has their SHS batteries replaced.

One common complaint herders have is the fact that when the original CFL bulbs go out they are not able to replace them with bulbs of the same high quality. Based on anecdotal evidence, herders tend to buy cheaper replacement bulbs that are commonly available in local convenience shops for 2,000 Mongolian Tugrik a bulb (or less than two dollars). Good quality replacement CFL bulbs are about five times more expensive as compared to these lower-priced alternatives, and are only available in specialized stores. The use of lower quality bulbs might negatively impact the perceived quality of the service provided by SHSs. However, it does not seem to affect the overall customer satisfaction, which is high among herders.

In 2006, a study on SHSs showed general user dissatisfaction with the one-year warranties that were offered with the systems sold. In response to the needs voiced by the SHS users, the units sold under REAP were offered with a two-year manufacturer's warranty. The

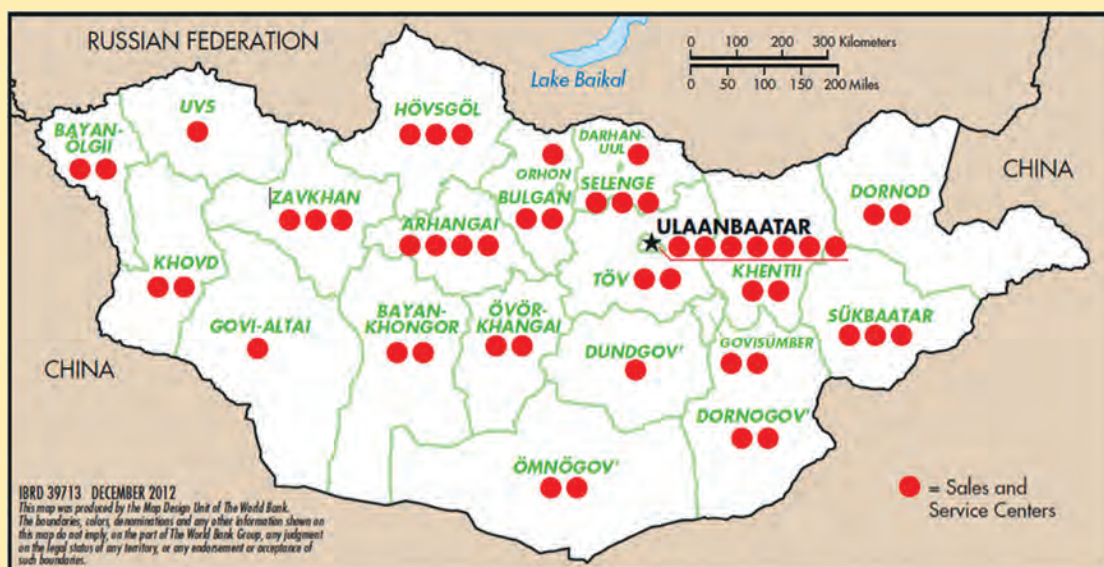
project also introduced best practices such as after-sale service. A network of trained and certified sale and service centers (SSC) was established to buy, distribute, sell and service SHSs and meet the scattered herder population's electrification needs. Map 3.1 shows the network of SSCs established under REAP.

That said, however, what happens on the ground appears to fall short of expectation for a few of the herders interviewed. The survey reveals that maintenance and repair services are potentially problematic because the network of service centers is only established at the aimag level (at the time of this report, there were between one to four centers in each aimag). This implies that many herders would still need to travel long distances if and when they need to have their broken SHS repaired. In fact, about five percent of those interviewed reports that they stopped using the units because they were broken (albeit it is not clear from the survey answers whether the herders chose to replace or abandon those SHSs because they have better alternatives, or they simply were not able to have the units repaired).

Overall Consumer Satisfaction and SHS Sustainability

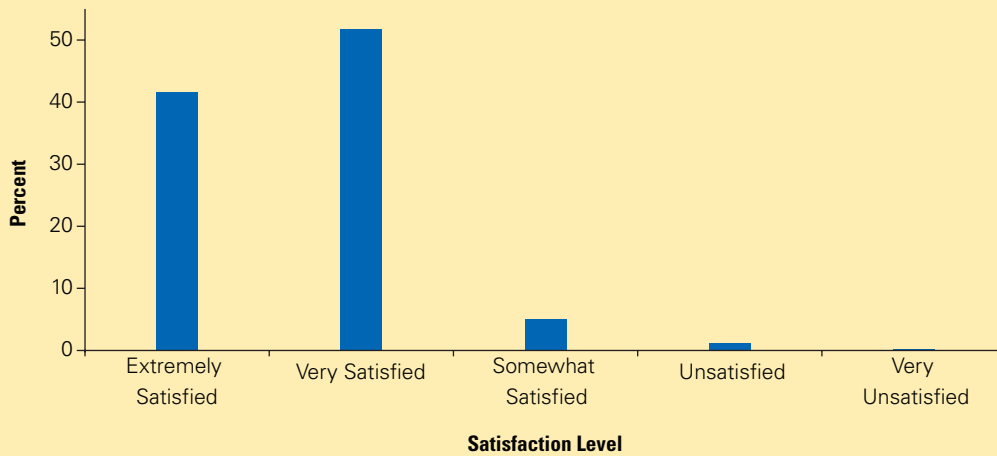
The survey results indicate that the overall consumer satisfaction with the solar home systems the households acquired under REAP is high. Among the interviewees, 41.7 percent are reported to be "extremely satisfied"

MAP 3.1 NETWORK OF REAP SALES AND SERVICE CENTERS



Source: Ministry of Mineral Resources and Energy, Mongolia.

FIGURE 3.2 OVERALL CONSUMER SATISFACTION

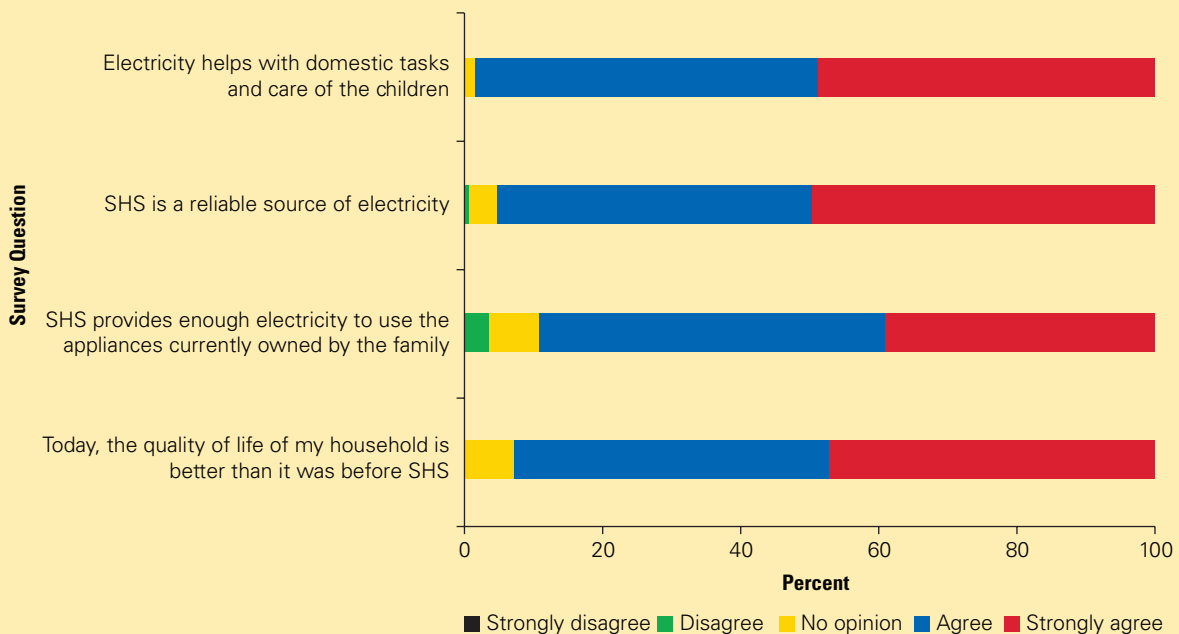


Source: ASTAE/World Bank—REAP Beneficiary Survey.

and 51.7 percent are “very satisfied” with their systems. The interviewees indicate that the systems they own are very useful in their lives as well as in the lives of the other household members. They are particularly appreciative of the fact that the SHSs reach them well below market price (after a subsidy of about 50 percent). The level of consumer satisfaction is captured in Figure 3.2.

In terms of the reasons why herders find the installation of SHSs helpful, out of the 777 persons who responded, 70.5 percent cite “increased productivity for work” as the key benefit, followed by a distant second “more time for leisure activities” (15.2 percent), and a third “more time for household chores” (9.5 percent). These top three answers account for over 95 percent of the responses. Figure 3.3 captures the herder households’ general positive response to four groups of survey questions.

FIGURE 3.3 ATTITUDE TOWARDS SOLAR HOME SYSTEMS



Source: ASTAE/World Bank—REAP Beneficiary Survey.

Out of the 789 household interviewed, eleven households express some dissatisfaction with the SHSs they own, which are mainly related to the decreasing efficiency of the SHS batteries over time as the systems age.

As the surveys were carried out several years after the distribution of the majority of the SHS units, the high customer satisfaction reported could be seen as an indication of the herders' preference and a positive sign regarding the sustainability of the devices. The survey further shows that the vast majority of herders are either likely (52 percent) or very likely (44 percent) to use SHSs in the future and 99.6 percent of them would recommend them to others. This also suggests a strong buy-in to this form of renewable energy supply and ownership.

Immediate Impacts of Changing Energy Patterns

The portable solar home system sold under REAP were equipped with a compact florescent lamp. For those households that did not own a television set and a mobile phone prior to the SHSs, these electronic devices became the most sought after gaining access to stable electricity. The impact of having a lamp, a television set, and a mobile phone (or phones) on the herders' daily lives was immediate and obvious. The following summarizes such impacts in the areas of lighting, access to information, communications, and time allocation after dark.

Lighting

Prior to the installation of SHSs, more than 90 percent of the nomadic herders interviewed relied upon candles for lighting. The costs amounted to about 9,000 Mongolian Tugrik (or about US\$5.50 equivalent) a month for one candle a day, which lasts for about two and a half hours. After SHSs were popularized, the percentage of people still using candles dropped to six. Accordingly, the average number of candles used by the households also fell sharply. Most only resort to their use in emergency situations when power is interrupted or insufficient.

The capacity of SHSs makes it possible for households to increase the use of more advanced lighting devices such as 2x8 compact fluorescent light bulbs which can be used both inside and outside the ger. In comparison with candles, they provide significantly higher intensity (lumens) and quantity (hours) of lighting as measured in lumen hours.

Of those interviewed, 95 percent are satisfied with their current lighting system (37 percent agreed and 58 percent strongly agreed). They feel electric lighting is superior to the kerosene or oil alternatives as almost 80 percent believe oil burning is harmful to their health; they also consider candle burning a fire hazard.

Access to Information

Mongolia has extremely harsh climatic conditions that significantly affect the lives of the population. Natural disasters in Mongolia are frequent and are caused inter-alia by: (i) severe snow falls, resulting in deep burying of forage, with consequent livestock death from starvation, (ii) severe rain storms, resulting in flooding which can wipe out "ger district" dwellings on hills in urban area; and (iii) sand and dust storms, resulting in sand from the Gobi Desert and dust from the grasslands blowing across settlements in both urban and rural areas, with consequent eye diseases and respiratory diseases. Table 3.1 gives an indication of the severe weather pattern that exists in the various aimags in Mongolia.

Consistent with the lifestyle of the nomads and the climate of Mongolia, news and weather reports and alerts are considered the most important type of information the households seek (about 84 percent).

Prior to the installation of SHSs, herders largely relied on trips to the soum centers, listening to radio broadcasts and talking to neighbors to gather the information they need. With improved electricity access, television quickly overtook them as the most popular and widely used source of news and information. About 87 percent report such a switch, and about 96 percent find it easier to gather information the new way. The shift of practice was captured in five groups of survey responses on commodity prices, weather report, and school information as depicted in Figure 3.4.

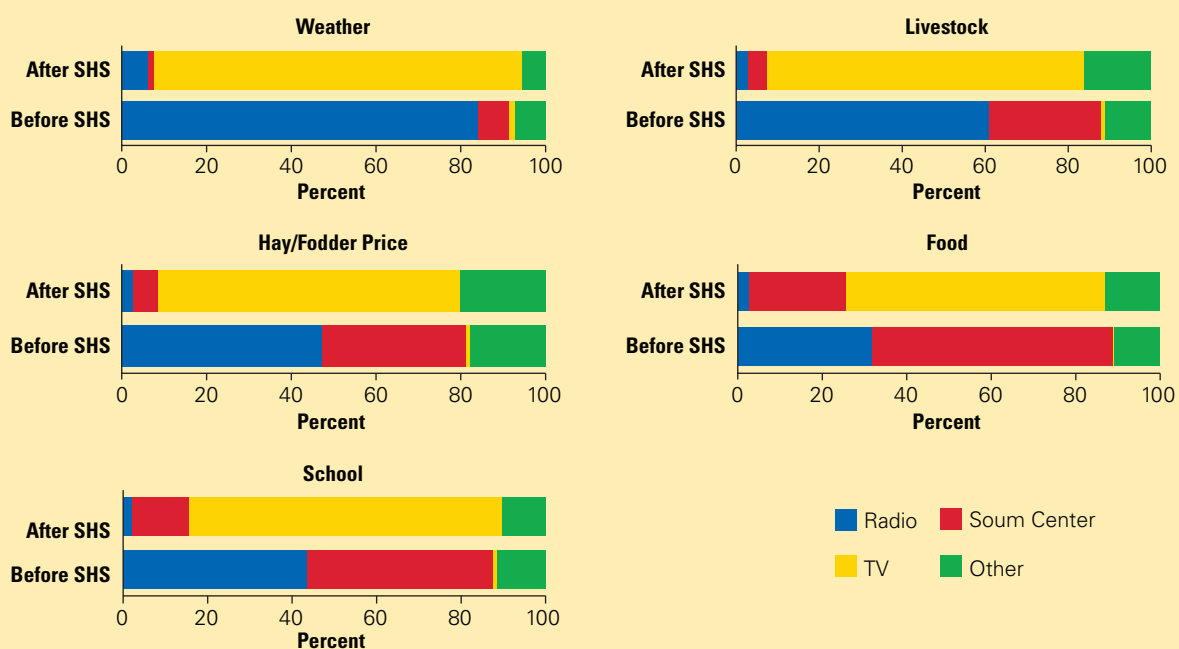
Herders also greatly value information on healthcare. Over 93 percent of respondents either agree (61 percent) or strongly agree (32 percent) that access to healthcare information has become easier after they installed SHSs. Prior to REAP, about 72 percent of the households surveyed relied on visits to the soum centers as the main means of collecting of healthcare information (followed by listening to the radio 13 percent, talking to neighbors 6 percent and reading the newspaper 4 percent). Figure 3.5 shows how having a television set (with channels that air various healthcare programs) enables herders to access more comprehensive information without having to leave home.

TABLE 3.1 SEVERE WEATHER PATTERN IN MONGOLIA

Aimags	Average number of heavy snow storms	Average number of heavy rain storms	Average number of sand storms
Arkhangai	30	50	24
Bayan-Ölgii	106	65	43
Bayankhongor	8	30	25
Bulgan	4.3	65	18.3
Darkhan-Uul	5.5	65	15.5
Dornod	7.8	50	19.7
Dornogovi	5.8	30	30.4
Dundgovi	6	30	20
Govi-Altai	11	30	18
Govisumber	5.8	30	30.4
Khentii	4.3	50	20.1
Khovd	10	30	15
Khövsgöl	14	70	25
Ömnögovi	5	30	99
Orkhon	5.3	65	19.3
Övörkhngai	6.1	30	10.3
Selenge	7	65	15
Sühbaatar	3.5	30	35
Töv	4.5	50	30
Uvs	0.7	65	4.6
Zavkhan	6.5	65	20
Ulan Bator	4.5	50	30

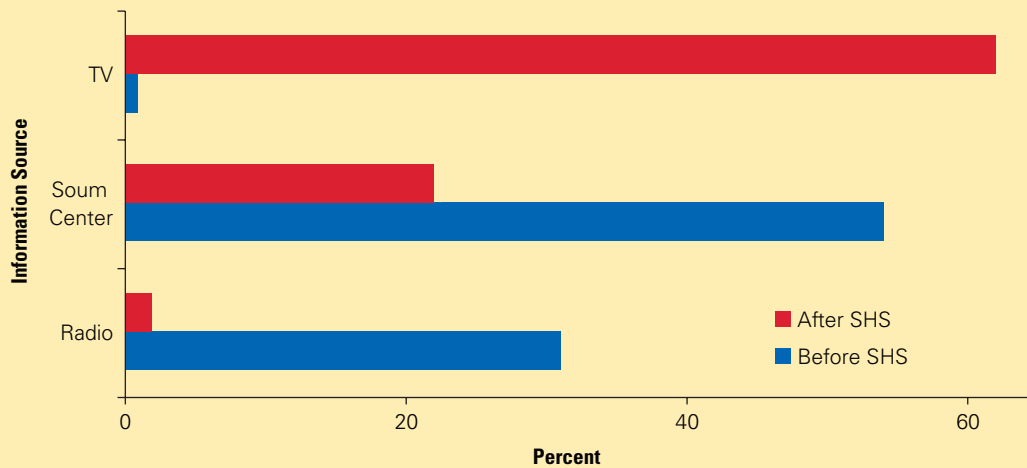
Source: Authors.

FIGURE 3.4 INFORMATION ACCESS PRACTICES



Source: ASTAE/World Bank—REAP Beneficiary Survey.

FIGURE 3.5 HEALTH CARE INFORMATION SOURCE



Source: ASTAE/World Bank—REAP Beneficiary Survey.

Communications

The widespread use of mobile phone in recent years has greatly facilitated communication in Mongolia. According to the survey, more than 97 percent of the herders use mobile phones as their main means of communication (compared to a pre-REAP level of near zero). The growth is mainly attributable to improvements in electricity access and cell phone technology and services. For example, a couple of telecom companies offer unlimited in-network calls for a monthly fee of 10,000 to 15,000 Mongolian Tugrik (about US\$6 to US\$9 equivalent). These plans are very popular among herders and are considered affordable by most households.

According to the majority of the herders interviewed, cell phone coverage is generally good. The four main service providers claim to have established base stations (each covering a radius between 30 km to 60 km) in almost every town and rural center throughout the country



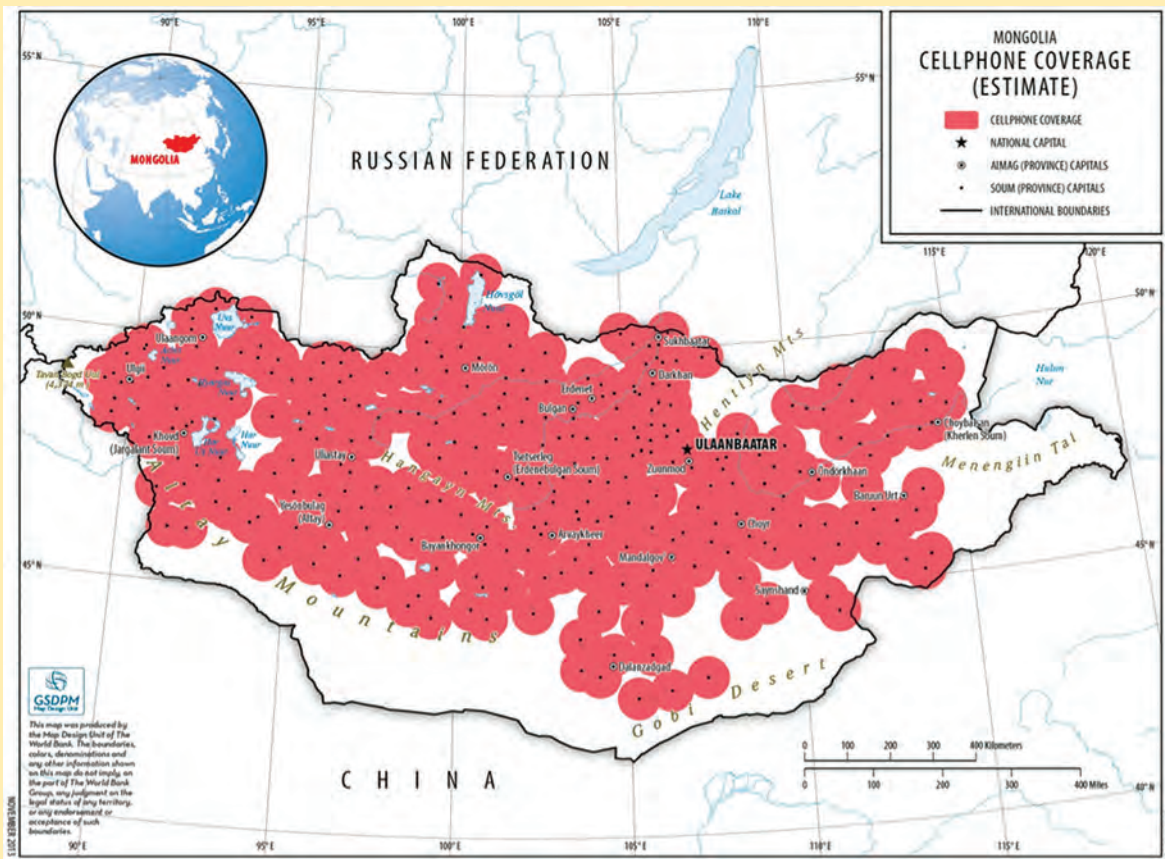
among them. Map 3.2 shows a projected cell phone coverage area based on the above assumptions. Despite an extensive coverage, however, due to the remoteness of some dwellings, reception quality is uneven and for distances beyond 20–30 km from the nearest soum or aimag center the reception could be poor. To cope, some herders acquired antenna to amplify the signal; in some instances herders would travel up a hill in order to improve the reception.

Time Allocation after Dark

Compared with pre-SHS days, the herders interviewed find themselves staying up between one to two hours later (from 10 to 11 in the evening to around midnight) and spending more time working and relaxing in the evenings. The interviewees report that brighter and on demand lighting, particularly during winter when the sun set early (before 5:00pm in December), makes it possible for men to finish their day's work and women to finish cooking and cleaning without rushing, postponement or trying to make do in semi-darkness. They also find more time to relax with their family after the evening meal. Besides watching television together for news, educational programs and entertainment, some common activities include playing games, reading, or simply chatting with each other.

Responses such as these are common among the interviewees: "We can stay up after dark and do more work or watch TV if we are done working for the day. We spend more time together." In terms of television watching habits, children seem to spend more time in front of

MAP 3.2 PROJECTED MOBILE PHONE COVERAGE AREA



Source: World Bank.

the sets than women, and women more than men. This is consistent with their lifestyle as most men work outside of the gers and children generally have more free time than adults. According to parents, watching educational programs available on the various television channels is a great way for children to learn. Examples of their responses are: "Education programs help prepare young children for kindergarten"; "Children learn to sing and dance from the entertainment programs"; and "Health related programs boost our children's knowledge and help them develop good habits such as, the practice of hand washing."

Impacts on Quality of Life and Development

Socio-cultural issues are critical factors in the Mongolian society. New social values and beliefs have emerged during the transition from the socialist economy to the new system based on democracy and socio-economic

openness. The Mongolian people have developed new attitudes towards work, education, health, marriage, and parenting. For the Mongolian herders, this change process has been further exacerbated by the advent of SHSs and improved access to reliable electricity services, which brought about modern forms of doing business, education, health care management, and social interactions.

More than 90 percent of those interviewed indicate that SHSs have improved the quality of their lives. It should be noted that while television and the use of mobile phones existed within the herder communities long before REAP, the availability of affordable SHSs enabled the rapid buildup of a critical mass. The result is that in just a few years the tipping point was reached in terms of their community-wide adoption. The following is a summary of what the surveys reveals in terms of impact in areas such as productivity and income; household expenses and spending patterns; communication and social interaction; health care and emergency care; vulnerability and sense of security; and attitude and cultural preservation.

Productivity and Income

As previously discussed, on-demand, continuous and more intense lighting available after dark has enabled the ger dwellers to extend their evening activities by at least one to two hours a day. This likely contributed to the increase in productivity and efficiency among the herder households. In fact, over 70 percent of those interviewed cite “increased productivity” as the key benefit linked to the installation of SHSs. Both men and women appreciate the convenience and quality of CFL lamps. Men feel that good lighting allow them to complete the tasks on hand and also get a head start on preparing their tools for the following day. Women mostly like the fact that they can take their time to prepare the evening meal and then clean their cookware and dishes properly afterwards. They also appreciate the opportunity to perform some detail-oriented tasks such as sewing after dinner.

The following is a typical response to the survey questions on lighting: *“Yes, I spend more time herding at night, my wife also spends more time taking care of the house, cooking and sewing. Before SHS, it was not possible do it properly. We used to go to bed early.”* Another example of response goes like this: *“Perhaps we spend more time working at night, but the real impact is that we now carry out our work in a relaxed manner. We don’t have to rush to get things done before it is dark any more. This is true for my work outside the ger, but also for my wife’s working inside the ger like preparing meals.”*

Many heads of household indicate that easier and timely access to reliable market information on livestock and food prices gives them an edge in marketing and pricing their products, and in making purchases. The added



transparency gives them the sense that they are making transactions at “fair” price levels. Being up-to-date on weather conditions and alerts also helps the nomads prepare themselves against natural disasters and minimize hardship and property losses resulting from them.

Even though it is hard to quantify income and productivity changes, the general feeling amongst the households surveyed is that it has increased since they have gained access to CFL lighting, cell phones and televisions. The following response to an income-related question touches upon many themes and seems quite typical: *“We would not be able to quantify the increase, but now we save on candles; we can finish our daily tasks without having to postpone them; and we sell our meat at a higher price because we have better access to information thanks to our TV and phone. If somebody shows up at the ger, we can check the market price now. Before SHS, we used to accept whatever figure the other person would suggest.”*

Household Expenses and Spending Patterns

Based on the survey results, it is estimated that the total costs of the new lighting scenario is marginally higher than the previous candle dependent scenario (increasing from about US\$80 to about US\$90 a month). The increase in cost, however, is likely to be more than offset by the increase in productivity.

While the use of candles has diminished significantly since the use of CFL lamps became commonplace, interestingly the use of dry cell batteries has remained a constant in the herders’ lives. However, battery consumption patterns have seen a notable shift since the en-masse switch from radio to television (with remote controls) and the decreased use of flashlights. One possible side effect of this was the quadrupling in the price of the smaller “AA” and “AAA” batteries while those for larger “C” and “D” batteries have remained largely unchanged. How this phenomenon impacts the household budget is not known, but it is not expected to be significant.

Having access to electricity has boosted the herder households’ demand for consumer goods such as television sets, satellite dishes, cell phones and other electrical appliances, tools and equipment. Following are examples of prevailing retail prices of “typical” products generally available on the market: small portable color television set about US\$150, satellite receiver about US\$140, and freezer about US\$400. As for SHSs, the price for 50W, 80W and 100W peak capacity units are about US\$400, US\$640 and US\$800 respectively.

Communication and Social Interaction

Since the popularization of the SHSs, one of the more significant social changes in the nomad community is in the way the herders communicate within the families, between herder households, and with the outside world. Herders used to have to go to the soum or aimag center's post office to make calls, and this was often described as a very tedious process. In addition to time spent on travel, a herder had to wait in line for the use of a public telephone. If the person he/she was trying to reach did not have a private phone, the caller's post office would have to try to contact the post office of the other party and then get him to go there to take the call or return the phone call. The whole process could take up to two or more days.

In the case a herder wanted to talk with his/her "next door neighbor" (often a few kilometers away) simply to inquire about the whereabouts of their animals; to discuss prices of their slaughters; or to socialize and exchange greetings, the process used to be time consuming as well. At times it could even be challenging, especially when the weather condition was bad or when it was after dark. The near universal adoption of mobile phones has revamped the mode of communication amongst herders completely. Many tasks that once required travel can now be accomplished by a simple phone call. Despite fewer visits in person, herders feel they actually communicate with each other more often now because cell phone use is low cost and very convenient.

While most herders cite the greatest benefit of having cell phones is in the way they facilitate their business dealings (mostly by way of timely exchange of information, and more convenient means to seek information), many also note how communication has improved among family members and friends. Many households own multiple mobile phones. Couples can now keep each other informed and that is particularly useful when



the men are herding away from home. Parents are now in frequent contact with their children who are in school and living away from the gers during the school year. In the past, inviting friends and relatives over was a rare occasion as it made little sense to visit somebody and then invite them to walk back home for a get together. Planning gatherings ahead of time has become a new feature of herders' social life, and it appears both men and women take part in extending the invitations.

Healthcare and Emergency Care

According to the survey data, about 85 percent of the surveyed households have at least one member who has been admitted to a hospital or treated at a clinic at least once in their lifetime. Soum/aimag center clinics or hospitals, however, could be hours away and travelling could be time consuming and expensive for many herders. This is particularly so for those who are more vulnerable and do not have their own means of transportation (usually by way of road vehicle, motorcycle or horse). Unfortunately, in the days of limited information and communication, rushing the patient to the clinic or hospital was deemed the only sensible option available.

Following are some common responses when the interviewees were asked to comment on how access to health services had changed: *"No need to walk to the soum center anymore, which is great. It saves us time and energy, especially when we are not feeling well. In emergency situation it's even more important for us to being able to call somebody. If we think that something is wrong, we can call a doctor and get an immediate feedback."*

Table 3.2 shows the number of public and private clinics at the aimag level and how the average distance between a ger and the closest aimag level facilities is often over 100 km.

With more open access to health care information, it appears that herders are learning to take better care of themselves and their families, thus reducing the incidence and severity of certain medical conditions. Direct consultation with doctors and nurses over the phone when problem arises also helps to decrease the number of visits to clinics and hospitals.

In cases of true medical emergencies herders note that they can now call for ambulance and at the same time get immediate advice over the phone while they wait for help to arrive. This significantly cuts down the time spent on seeking help and waiting for help to be arranged. Prompt medical attention reduces suffering and presumably saves lives in the instances of serious injuries and illnesses.

TABLE 3.2 AIMAG CLINICS AND AVERAGE DISTANCE FROM GERS

Aimag	Number of Public Clinics	Number of Private Clinics	Average Herder Household Distance from Aimag clinic (km)
Arkhangai	1	8	152
Bayan-Ölgii	1	1	114.4
Bayankhongor	1	6	183
Bulgan	1	4	141.9
Darkhan-Uul	1	9	40
Dornod	1 ^a	8	171
Dornogovi	1	15	160.7
Dundgovi	1	2	120.6
Govi-Altai	1	4	176.6
Govisumber	1	1	35
Khentii	1	2	155.2
Khovd	1 ^b	12	169.9
Khövsgöl	1	7	159.7
Ömnögovi	1 ^c	10	171.6
Orkhon	1 ^d	46	30
Övörkhangai	1 ^e	4	128.3
Selenge	1	8	146.1
Sükhbaatar	1	2	146.1
Töv	1	2	157
Uvs	1	4	160.5
Zavkhan	1	7	193.9

Source: Authors.

a. Including Centralized Laboratory for Eastern Region.

b. Including Centralized Laboratory for Western Region.

c. Including Centralized Laboratory for Southern Region.

d. Including Centralized Laboratory for Northern Region.

e. Including Centralized Laboratory for Central Region.

In terms of maternal and child care, women reflect that access to information and services has improved a lot since consultation with doctors and nurses can now be conducted over phone and information could be gathered from the various public programs. Customarily, a pregnant nomad woman is escorted to the nearest clinic by an ambulance two weeks prior to her expected delivery date. The home pickup service can now be arranged over the phone, and this is considered very convenient and often cuts down on the time a woman has to spend away from home for childbirth. Not unlike emergency care, the phone reduces waiting time and knowing that help is only a phone call away provides much peace of mind.

Mothers also find it easier to coordinate with soum or aimag nurses for their children's checkup and immunization, which have long been a mainstay of the country's children healthcare program. A less cumbersome process is usually conducive to better compliance with good healthcare practices.

Similarly, herders reported that the use of the cell phone has helped them to take better care of their animals. They can now call veterinarians to ask questions, schedule the next round of vaccinations, and seek help in case of emergencies. Knowing when to expect the veterinarians in advance is also appreciated by the herders as they could better pinpoint the time to round up their animals and keep them close by in order for them to receive the services and treatments.

Health Education and Preventive Care

According to the interviews, it appears that the most popular and effective means of health education is often delivered via regularly scheduled television programs (some also available on the radio). They usually come in the form of tips on preventive care. For example, a bi-weekly program called “Healing YoYo” prompted its viewers to say: “*We learned that it’s better not to use too much salt, fat and sugar*” and “*we watch the show all the time.*” Another example is a program that discusses certain common diseases (such as flu) that herders could contract, their symptoms, ways to prevent them, and the drugs that are used to treat them. An example of a rather common response goes as follows: “*Now that we have a TV, we can learn about health-related issues from some programs and discuss with the doctor our symptoms. From the prevention perspective, TV is very helpful.*”

Also very popular are the various television shows on cooking. They discuss nutritional values of different types of foods, demonstrate various methods of cooking, and introduce healthy ingredients and recipes. As a result of the newly gained knowledge, herders appear to be more aware of food choices and consequences. They also feel more confident and empowered; some even observed that now they could “talk to doctors as equals.” Table 3.3 shows a typical educational television program that was available around the time of the surveys.

Vulnerability and Sense of Security

The Mongolian herder population is vulnerable to many elements because they live in remote areas and often in isolation. While their lifestyle is to live simply and to respect and blend in with nature, inclement weather for a greater part of the year often makes it very tough and dangerous to cope on their own. During the winter when the hours of natural daylight are short and the air is very cold productivity is also curtailed.

Being able to maintain a constant link with the outside world where support resources could be sought mitigates a lot of the nomads’ vulnerability and enhances their sense of security. With easier access to timely and reliable news, market information and weather reports and alerts; coupled with brighter lights for longer hours each day, the generally low-income herders believe are able to earn a fairer living, sustain fewer losses, and increase their productivity and efficiency. Knowing that support is only a phone call away and there is good lighting to complete the day’s chores seems to provide the herders peace of mind and thus reduced their stress level.



With a CFL lamp and a mobile phone, herders overwhelmingly agree that they feel safer, particularly at night because they can see who is approaching their gers, their animals are calmer when it is not pitch dark, and the threat of fire hazards are reduced because the need for candles or oil lamps has largely been eliminated. Improved access to health education, medical services, as well as emergency care further enhance the herder households’ sense of wellbeing as they feel more prepared to deal with illnesses and injuries as well as pregnancies and childbirth. Moving towards a more balanced diet not only impacts the herders’ health, but also makes their meals more enjoyable. Closer ties with family and friends also contribute to a general sense of contentment.

Gender Impact of Solar Home Systems

Literature review finds access to energy to be gendered: it is determined by intra-household decision-making, social position and the value attached to labor.¹ As stated in a 2011 World Bank report, while both poor women and poor men suffer from energy poverty, women are disproportionately affected, as their access to energy resources and benefits is further curtailed by unequal power relations.²

Moreover, there is evidence from all over the developing world that women’s needs, views, and participation have persistently been excluded from energy policy and practice. When women experience energy poverty and their energy needs are not met, the consequences are severe. As a result of time-consuming and physically draining tasks, women’s health conditions are poor, their options to earn additional income are minimal, the opportunities to improve their labor productivity are low, and

1. Danielsen (2012).

2. Köhlin, G. et al. (2011).

TABLE 3.3 TYPICAL EDUCATIONAL TELEVISION PROGRAMS

Name	Description	Weekly number of times aired	Duration (Minutes)
Healing Yo-Yo, MN25 TV	Medicine and drug application, what can do for illness and sickness	2	30
Health training, Education TV	Distance learning	3	30
English language, Education TV	Distance learning	5	50
Korean language distance learning, Education TV	Distance learning	5	115
Women hour, Mongol TV	Famous Women participate and share their experiences and lessons learned	5	30
How to make it? Education TV	Distance learning	5	55
Modern healing and TV doctor programs, NTV	Distance learning	1	20
Health program, MNB-2	Training program on health and women	7	60
Cooking's cool, Education TV	Chef Tengis teaches how to cook	1	55
EAT-Tengis's hour, C1 TV	Chef Tengis teaches how to cook	1	60
"Bon Appetit" Cook Show, MN25 TV	Chef T. Bat-Orgil teaches how to cook	1	70
Your Health, TM	Medicine usage, health warning, healthy food	1	20

Source: Authors.

the options for social and political interaction outside the household are restrained.³

Within this context, the wide adoption of SHSs and the subsequent improvements in access to electricity services have positively impacted intra-household dynamics, partially addressing some of the above-mentioned concerns. With improved electricity access, rural women seem to have become experts at multitasking and very efficient at managing their time. The majority of the women interviewed indicate that the newly-gained access to stable electricity has translated into significant time-savings, which in turn, allow for increased time spent on personal care, parenting, learning and work diversification. One of the responses collected from a herder woman is as follows: *"We are freer than ever before to help our children, assist our husbands and take better care of ourselves."* Along the same lines, a herder man reports: *"Women do more and do it better, both for themselves and the household as a whole."*

The information collected indicates that, following the installation of SHSs, women's household-related decision making enjoys a higher degree of freedom. Similarly,

male herders seem to put higher value on a woman's work contributions towards the overall level of household income. All in all, improved energy access at the herder household level is contributing, albeit indirectly, to gender equality, which has been experiencing a negative trend over the past two decades. In the future, there is merit in reviewing the impact of reduced energy poverty on the overall theme of gender inequality. Additional information on the subject matter is available in Annex 2.

Changes in Attitude and Cultural Preservation

Under the Government's 100k Program, herders initially received their solar home systems for free as most were financed from grants provided by the international donor community. For those who did not obtain free systems the majority was reluctant to spend their own resources to buy them even though the SHS were publicized as affordable, cost effective and the users could derive a lot of benefits from having a reliable source of electricity. With widespread awareness of the benefits and general acceptance of a substantial copayment (about 50 percent cost sharing under REAP) it appears the former misconception and market failure has been addressed. Positive feedbacks based on on-the-ground experience will likely promote the growth of the household renewable energy market.

3. Cecelski, E. (2004); Clancy J. S., Skutsch M. M. and Batchelor S. (2003); Cecelski, Elizabeth and CRGGE (2006); and Balmer, M. (2007).



That said, while there exists a small percentage of households that have augmented their electricity supplies by installing additional SHS units to accommodate other major appliances (such as freezers and washing machines), whether the majority of households would be prepared to pay full retail price for them remains to be seen. In fact many of them express mixed feelings about purchasing without subsidies even though they realize that higher SHS capacity is a prerequisite for acquiring appliances they consider highly useful and desirable.

For centuries, the availability of water and pasture land had been the two main factors herders took into account when they considered a move. It is interesting to note that with the sea change in the way herders communicate nowadays, mobile phone coverage and signal strength have become a third common criterion that herder households take into account when they determine their relocation needs.

Many herders interviewed express their general sense of satisfaction with the introduction of solar home systems and the improvements and development it brings about. Some even hold the opinion that their SHS power supply was more reliable than that provided by the main power grid because cities still experience outages periodically. They also consider their SHSs superior to the wind power generators, which often break down when the wind is strong or underperform because of the lack of wind. Others also see their units as more affordable and environmentally friendly than the historic diesel alternative.

The in-depth interviews revealed that two of the families are former soum center residents. They decided to become herders after they observed the improvements in herders' living conditions brought about by SHSs and saw potential for higher income. As herders begin to enjoy better quality of life, stories like these provide anecdotal evidence that the trend of migration into peri-urban areas at the soum level might be slowing or even reversing.

As noted in the survey result section, about ten percent of the heads of household and their spouses have had some level of tertiary education. It is observed that despite their potential to find jobs and integrate into urban society, these adults choose to live and bring up their families the traditional way. With the country experiencing its current economic boom, rural electrification and the positive impact felt by the beneficiaries would help ensure that the nomad community, with strongest connection to the country's rich history and culture, would be able to maintain its long-established way of life without being left further behind.

Salient Demographic Features of the Sample Survey Population

Household Composition and Age Distribution

The total number of residents in the 789 households covered in the sample survey was 3,014 persons. The size of households in the sample ranged from one to nine members, with an average of about four persons living in each ger. In terms of distribution of family size, about 84 percent of the households surveyed were comprised of two to five members (at 14 percent, 21 percent, 29 percent and 19 percent respectively).

A typical family is comprised of a married or cohabiting couple (83 percent), i.e. a head of household, a spouse, and their children; and occasionally an extended family member. A little more than a third of the population is in the age range between 23–45 years. The age distribution of the surveyed households is presented in Table A.1.

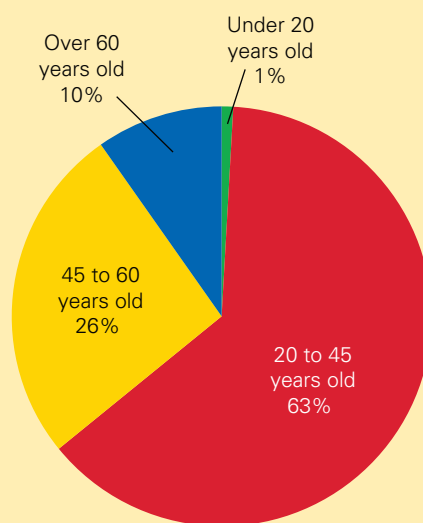
The Survey Interviewees

The survey included interviews with heads of household (60 percent, between the ages of 18 and 82), their spouses (33 percent, between the ages of 20 and 80) and other members of the family (7 percent). In order to adequately capture the perspectives of both genders, the interviewers were mindful in balancing the number

of male and female interviewees. The resulting male to female ratio was around 56:44.

The majority of interviewees (63 percent) were between the ages of 20 and 45 years, and the average age was about 42 years. The age profile of the interviewees is summarized in Figure A.1.

FIGURE A.1 AGE DISTRIBUTION OF INTERVIEWEES



Source: ASTAE/World Bank—REAP Beneficiary Survey.

TABLE A.1 AGE DISTRIBUTION OF MEMBERS OF THE SURVEYED HOUSEHOLDS

	0–5	6–12	13–18	19–22	23–45	46–60	61 and Above	Total
Number	397	340	430	255	1055	441	127	3,045
% of Total	13%	11%	14%	8%	35%	14%	4%	100%

Source: ASTAE/World Bank—REAP Beneficiary Survey

TABLE A.2 AGE DISTRIBUTION OF HEADS OF HOUSEHOLD

	Under 20	21–30	31–40	41–50	51–60	61 and Above	Total
Number	7	147	261	175	122	77	789
% of Total	1%	19%	33%	22%	15%	10%	100%

Source: ASTAE/World Bank—REAP Beneficiary Survey.

Heads of Households

In line with the Mongolian tradition, the survey confirmed that the vast majority of herder households was headed by men. In this particular sample, about 90 percent were male (of which 83 percent were married or cohabiting with a woman). The age distribution of the heads of household is provided in Table A.2.

Education of Adult Household Members

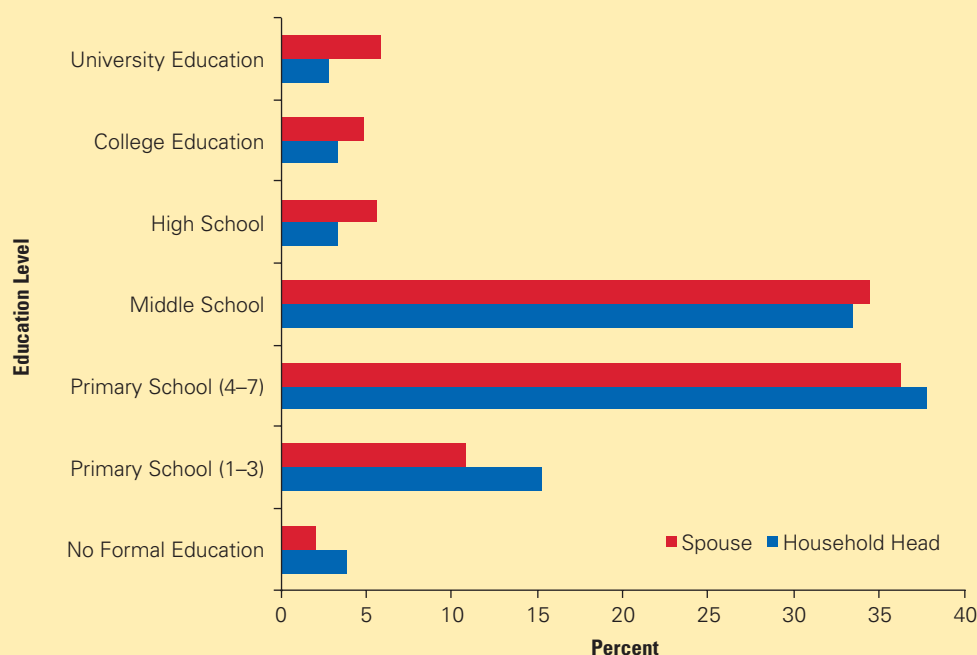
The majority of adult household members were made up of the heads of household and their spouses. In terms of their education attainment, the survey revealed that most of them only completed primary or middle school

(53 percent and 33 percent respectively). Consistently with the country's trend on higher education¹, more spouses (about 98 percent were women in this sample) than their husbands had earned a college or university degree (71 women as opposed to 49 men). A distribution of the education attainment of the heads of household and their spouses is provided in Figure A.2.

Household Income

About 90 percent of the interviewees indicated that their main source of income was livestock based including products such as meat, wool and cashmere; and their

1. http://www.unicef.org/infobycountry/mongolia_statistics.html.

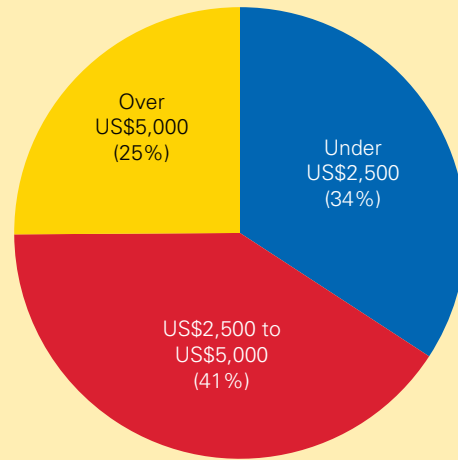
FIGURE A.2 EDUCATION OF HEADS OF HOUSEHOLD AND THEIR SPOUSES

Source: ASTAE/World Bank—REAP Beneficiary Survey.

livelihood was mostly associated with herding sheep and goats. About 75 percent of the respondents regarded men as in charge of the household's business related affairs.

Income of herders was low as compared to the national average of about US\$3,000 per capita in 2012. In the sample households (with an average size of four persons), about a third made less than US\$2,500 in 2012, and only about a quarter managed to earn more than US\$5,000 for the year. The average annual income of households in the sample survey was about US\$3,900. The group's income distribution is presented in Figure A.3.

FIGURE A.3 INCOME DISTRIBUTION OF HERDER HOUSEHOLDS IN THE SAMPLE SURVEY



Source: ASTAE/World Bank—REAP Beneficiary Survey.

Gender Aspects in Mongolia

Trends of Gender Inequality

The topic of gender inequality has received much attention in literature over the years. One of the most common measures to assess gender inequality is the Gender Inequality Index (GII), which is a composite measure that reflects the loss of human development resulting from gender inequality. The GII combines indicators of reproductive health, political empowerment and labor market participation. The lower the GII, the less gender inequality impacts on development.

In Mongolia, data on gender inequality indicate that it has increased over the past two decades. As shown in Figure

B.1, the country's Gender Inequality Index (GII) has been rising from 0.315 in 1995 to 0.411 in 2011.

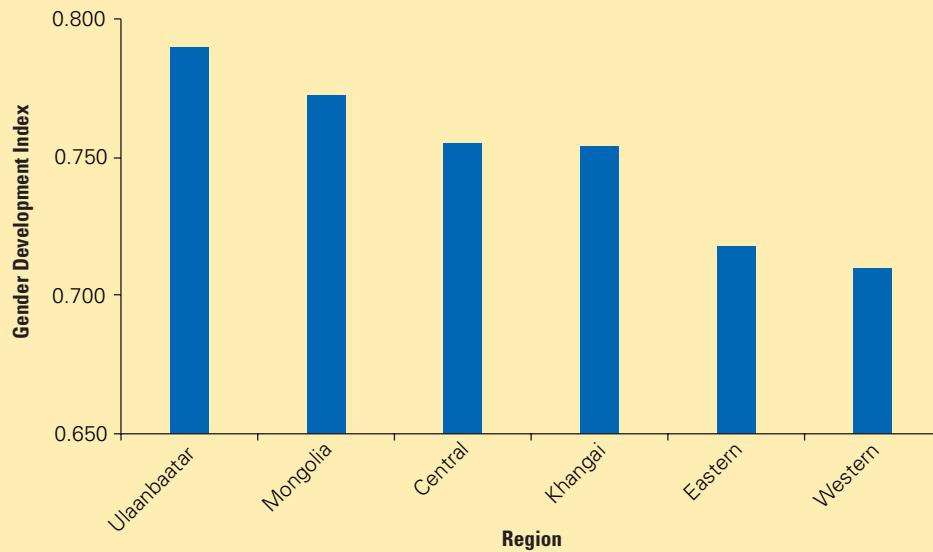
While GII-level data are not available for region-specific analyses, a similar index called Gender Development Index (GDI), which is defined as a "distribution-sensitive measure that accounts for the human development impact of existing gender gaps in the three components of the Human Development Index (HDI)", provides an approximation of the fact that rural Mongolia has a higher level of gender inequality than the capital. As it can be concluded by looking at Figure B.2, the higher the GDI score, the lower the gender inequality.

FIGURE B.1 TREND IN GENDER INEQUALITY INDEX (GII)



Source: UNDP.

FIGURE B.2 GENDER DEVELOPMENT INDEX (GDI)—REGIONAL COMPARISON



Source: National Statistical Office.

As it can be gathered from the figure above, improving Mongolia's gender indicators chiefly implies reducing inequality at the rural level, with particular attention to the country's Eastern and Western aimags.

Corrective Actions

According to the United Nations Population Fund (UNPFA), actions for reducing gender inequality should be focused on: (i) improving reproductive health, including improving knowledge of how to prevent sexually transmitted infections; (ii) reducing maternal mortality rates (MMRs), which have declined by 65 percent since the late 1990s and are on track to achieve the Millennium Development Goals (MDG) target by 2015; and (iii) making progress on equal pay for the same work and greater political participation for women.

Despite the good progress made in the past twenty years, there is ample room for improving Mongolia's population's reproductive health. Sexually Transmitted Infections (STIs) are about 35 percent of the total infectious disease burden in the country. The presence of STIs augments the risk of Human immunodeficiency virus (HIV) transmission. The number of confirmed HIV cases increased dramatically between 2005 and 2010. Youth aged 15-24 are five times more likely to be infected with HIV than adults in general.

The country also lags behind many of its neighboring countries in terms of MMRs, which are high by regional standards. Specifically, Mongolia's MMRs are about six times higher than Singapore's and five times New Zealand's. Intra-regional differences are also starkly marked with the Western aimags more than doubling the MMRs of the Eastern aimag.

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