Gham Power

Finding a replicable model for mobile-enabled micro-grids with Ncell in Nepal

OCTOBER 2017

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The **Mobile for Development Utilities Programme** improves access to basic energy, water and sanitation services in underserved communities using mobile technology and infrastructure. Our work encompasses any energy, water and sanitation service provided to a community, which includes a mobile component, whether it is voice, SMS, USSD, Machine-to-Machine, NFC, a mobile operator's agent network or tower infrastructure. We aim to seize the opportunity, leveraging mobile technology and infrastructure to enhance access to affordable and reliable energy, clean and safe water and sanitation services in underserved communities. The GSMA Mobile for Development Utilities Programme receives support from the UK Government.

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ghampower.com

Gham Power develops, installs and maintains solar micro-grids and commercial off-grid systems in Nepal. Founded in 2010 they have completed over 1,500 energy installations to date, with a total installed capacity of over 2 MW. Their clients include large industries, small businesses, individual households and productive end use services for small farmers.

www.ncell.axiata.com

Ncell is a privately owned mobile network operator in Nepal. It is part of the Axiata Group. Ncell is expanding coverage beyond the national electricity grid by installing solar powered towers. Presently 5.77 percent[1] of all Ncell sites are fully solar powered and another 8.5 percent use solar power as a backup.

1. https://www.ncell.axiata.com/About-Us/Details?rAm+dYL/LOPGPQrUws5AoGvYa3Ca5NGkjtPP177dZ4o=

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Gham Power

GSMA Mobile for Development Utilities Seed Grant 2015-16

Finding a replicable model for mobile-enabled micro-grids with Ncell in Nepal

USE OF MOBILE

Mobile payments
Mobile Money

M2M Connectivity

USE OF MNO'S ASSETS

Mobile Infrastructure

Two micro-grids with combined capacity of **37.6 kW** improved energy access for two rural villages and provided energy to two telecom towers, improving access to mobile network for **31 VDCs** (Village Development Committees) in Nepal. Mobile money was used for bill payment and smart meters were deployed to monitor individual consumption.

900 people benefitted from clean, reliable energy and improved connectivity.

PROJECT OUTCOMES

32% increase in mobile internet usage reported.

32% increase in fridge ownership reported. This was predominately driven by small hotels, which saw positive impact on business after adding an appliance.

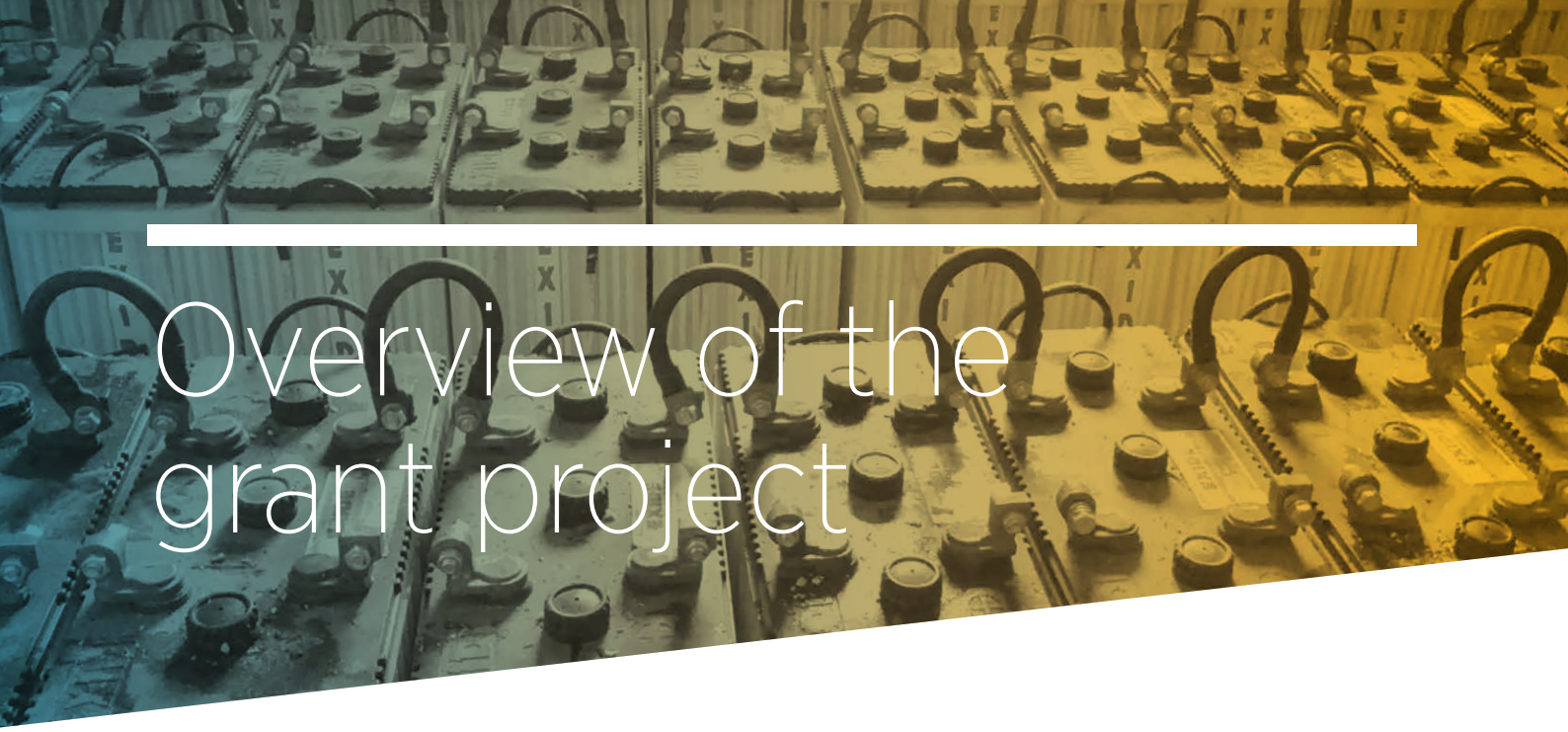
44% increase in smartphone ownership reported.

KEY PROJECT LESSONS

Reliable service can help drive consumption of energy and telecom

Having a telecom tower as an anchor load is valuable for the micro-grid business model, but local businesses have the greatest impact on micro-grid capacity utilisation and profitability.

Use of technology, such as M2M connectivity and mobile money, can help to improve the operational efficiency of micro-grids.



Overview of the grant project

The GSMA Mobile for Development (M4D) Utilities programme, with support from UK Aid, awarded Gham Power a grant in May 2015 to expand the capacity of two micro-grids. These micro-grids were part of the Halesi micro-grid pilot,[2] which included three micro-grids with total capacity of 72.6 kW (post expansion funded by GSMA), originally funded by Asian Development Bank and the Doen Foundation. The GSMA-funded phase began production in March 2016 and included two independent installations in the villages of Harkapur in Okhaldhunga and Chyasmitar in the Khotang district of eastern Nepal. The two micro-grids each powered an Ncell telecom tower in addition to households and local businesses.

In 2014, Ncell worked with GSMA M4D Utilities to conduct a feasibility study[3] to understand how it could leverage its assets and presence across the country to improve energy access. To trial the recommendations of the study, Ncell supported Gham Power in the grant-funded pilot by investing in the installation of new telecom towers with 2G connectivity near the micro-grid installations in Harkapur and Chyasmitar.

Service design and use of mobile channels

Micro-grid installations at both sites were functionally independent, but bundled together as one legal entity. Each site had a powerhouse with batteries, a local gateway for the smart meters installed on a laptop, a backup diesel generator, and other monitoring equipment. Gham Power also employed an agent at each site to maintain the system.

In addition to having a telecom tower as an anchor load, Gham Power used smart metering (SparkMeter's[4] equipment and dashboard) and mobile payments (in partnership with eSewa[5]). The plan was to integrate the smart meter and mobile money platform for real-time consumption readings and billing.

- Each customer, including the telecom tower, connected to the hybrid (solar and diesel) micro-grid through smart meters from SparkMeter.
- Gham Power introduced monthly plans based on energy consumption levels ranging from NPR 250 (USD 2.50) to NPR 5,000 (USD 50) to cater to the different energy requirements of household and business customers. Advance payments were collected from the community at the end of the previous month.
- The smart meters connected in a series and communicated with each other using a built-in wireless mesh network. The smart meter closest to the powerhouse communicated with the local gateway located in the powerhouse.
- The local gateway connected with SparkMeter's cloud server through the internet to upload consumption information.

2. https://thehimalayantimes.com/nepal/khotang-receiving-247-power-supply-solar-grid/
3. Rahul Shah, October 2015, "Assessing the opportunity to improve energy access: Ncell in Nepal", https://www.gsma.com/mobilefordevelopment/programme/m4dutilities/assessing-the-opportunity-to-improve-energy-access-ncell-in-nepal-2
4. http://www.sparkmeter.io/en/solution/
5. https://esewa.com.np/home

- 2G connectivity provided by the telecom tower was not sufficient for the local gateway to update the SparkMeter cloud server. Gham Power installed four radio antennae to bring internet connection to the site from an Internet Service Provider (ISP) at the nearby district headquarters.

- SparkMeter's cloud server integrated with the mobile payment provider eSewa's server to facilitate real-time notification of customer payments for Gham Power. This would enable customers to:

  - Make mobile payments through their eSewa wallet or any eSewa agent; and

  - Check their energy usage against the monthly maximum using SMS.

Due to technical and regulatory challenges, the actual performance of the system deviated from the plan described above (Figure 1).

- Stable internet connectivity, required for SparkMeter's local and cloud server to synchronise, was a challenge throughout the pilot. Even if one of the four antennae providing internet connection to the site were misaligned, internet connectivity would be disrupted.

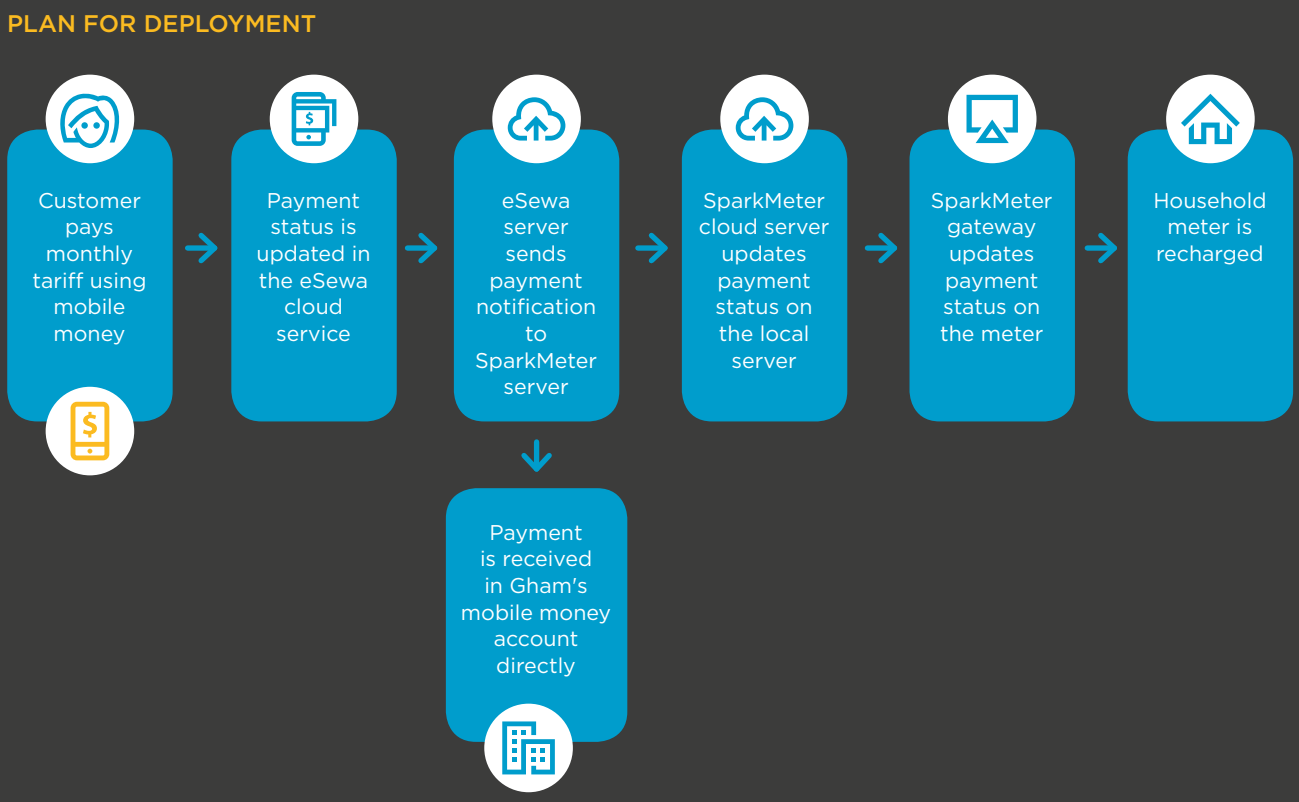
- In the absence of real-time synchronisation, there could be delays or errors in processing payments and tracking consumption. This would result in a poor customer experience since energy access may be delayed even after payment had been made. Due to these considerations, payments were only processed manually.

- Gham Power developed a manual intervention to ensure customers received uninterrupted service. Gham Power agents (who were also eSewa agents) would receive cash payments directly from customers and manually update the payment status in the local SparkMeter gateway set up on the laptop. The agent then transferred the funds to Gham's eSewa account.

Other than making payments to Gham Power, mobile money was still primarily used as over-the-counter (OTC) payments, since regulation in Nepal at the time of the pilot only allowed for cash-in through a bank account. Due to limited banking penetration, wallet use did not expand beyond a few customers.

FIGURE 1

The actual payment process deviated from the plan due to technical challenges with real-time synchronisation of the local gateway and cloud server



Lessons from the pilot

1 Having a telecom tower as an anchor load is valuable for the micro-grid business model, but local businesses have the greatest impact on micro-grid utilisation and profitability

Ncell signed a Power Purchase Agreement (PPA) with Gham Power for the micro-grid to supply energy to two telecom towers in Harkapur and Chyasmitar. This PPA between an off-grid energy service provider and telecom operator was the first of its kind in Nepal.

Finding a commercially sustainable model for micro-grids

Gham Power wanted to measure the impact of integrating a telecom tower as an anchor load on the profitability of the micro-grid. During the planning phase, the telecom towers helped Gham Power assure NMB Bank, a debt funder, to extend a loan for the project. Having a stable anchor load for the micro-grid would help to ensure it was not underutilised and provide a steady cash flow to support loan repayment. However, consumption and revenue data from the pilot show that, while the tower was helpful in reducing cash-flow risk, the tower alone is not a guarantee of profitability or higher utilisation rate.

The expected Internal Rate of Return (IRR) was around 15 percent over 10 years assuming an utilisation rate of 70 to 80 percent. However, based on current revenues, Gham Power estimates it will achieve an IRR of 11 percent for Harkapur and four percent for Chyasmitar. Therefore, together, the micro-grids are expected to deliver 8 percent over 10 years. Delay in installation due to political unrest and lower than expected energy consumption at Chyasmitar resulted in a lower return than originally expected.

The sites at Chyasmitar and Harkapur had a different mix of household and business customers (Figure 2), that help understand the importance of having sufficient customer demand in addition to a tower.

Harkapur

Since launch, the micro-grid in Harkapur has maintained a higher utilisation rate than the one in Chyasmitar (Figure 3). Existing businesses in Harkapur, mostly tourism-related enterprises such as small restaurants and hotels, have been quick to change their source of power. By transitioning from diesel generators or upgrading from solar home systems, local businesses have become the micro-grid's main source of revenue. To maintain more than 80 percent usage, especially during peak evening hours, Gham Power is running the backup diesel generator for three to four hours a day.

Chyasmitar

In Chyasmitar, there were few existing businesses to drive utilisation. Businesses that have opened since the micro-grid was installed have been slow to start operations, resulting in a low utilisation rate and subsequently low return on investment. The tower is the main consumer of power and contributed the lion's share of the revenue.

Based on the consumption trends in both locations, it is evident that a tower alone cannot drive energy utilisation or provide sufficient revenue. It is helpful during the planning and initial deployment phase to have steady consumption and revenue. To build a sustainable long-term solution, local businesses will need to receive support, such as funding, capacity building and links to market, to help them grow into primary consumers of power. Higher consumption by a business is also more likely to have a spillover effect in terms of economic activity in the community.

'Before connecting to the micro-grid, we could only work for six hours. The solar panel was not sufficient for printing and lamination purposes; we had to use the diesel generator, which was very expensive.

Now we are able to operate for longer hours and have introduced computer classes. There is sufficient power to run several computers and connect to the internet. Access to reliable energy helped expand the business; our income has almost doubled since.'

CASE STUDY: TIKA RAI, 22-YEAR-OLD FEMALE BUSINESS OWNER, CHYASMITAR

Consider telecom operators a long-term partner, not just an another customer: Ncell's experience

In this pilot, by outsourcing power for a new tower to an energy service company (ESCO) such as Gham Power, rather than setting up an in-house solar power generation system, allowed Ncell to cut its upfront capital expenditure by about half. Although it still had to invest in basic infrastructure upfront. Ncell expects it may not have been able to realise these savings over the long term (Figure 4). According to Ncell, the total cost over 10 years (based on present value of money) will be higher for the outsourced model than managing a solar-powered site in-house. This is because of the continued need for management by Ncell and annual increases in the price of energy.

A mobile network operator (MNO) is likely to calculate the long-term benefit of outsourcing and not just lower upfront costs. Since the pilot ended, Ncell and Gham Power have been discussing how the value proposition for the MNO can go beyond initial CAPEX savings and include other aspects, such as:

- What is the long-term opportunity in this partnership for the MNO?
- How can the contract be structured to ensure the MNO is compensated for taking the initial risk of outsourcing a critical component of its operations to a third party that may not have previous experience in providing power to telecom towers?
- How can the micro-grid influence the consumption of telecom services?
- Will associating with the micro-grid enhance the MNO's brand?
- Will the partnership deliver any social impact?

Innovation for scale

The project received the 'Most Innovative Telecom Project in Asia Pacific' award at Telecom Asia Awards 2017, giving credibility to this approach as a more replicable model for expanding network coverage. Moreover, by simultaneously bringing energy and telecom network coverage to communities, this model has a multiplier effect on social impact.

Since the pilot ended, Ncell has been working with Gham to refine the economics of the model to scale it up.

Ncell bags Telecom Asia Awards 2017

Himalayan News Service

Kathmandu, May 4

Ncell has received the prestigious Telecom Asia Awards 2017 for implementing the 'Most Innovative Telecom Project in Asia Pacific'.

Ncell was declared winner and conferred the awards after an independent panel of jury judged Ncell's initiative with Gham Power Nepal Pvt Ltd to connect the unconnected off-grid communities with telecom as well as energy by promoting off-grid clean power solutions as the most innovative project implemented by telecom service providers in Asia Pacific, as per a media release.

Other projects short-listed for the Most Innovative Telecom Project were Google's Project Loon, China Unicom's IoT-based smart parking and SK Telecom of South Korea's first virtual assistant service 'Nugu'. Ncell's project was declared the best based on criteria of innovation, financial performance, technology, market leadership and corporate governance.

Ncell's Corporate Communications Director Sanju Koirala received the award amid a gala event of 20th Telecom Asia Awards on Wednesday.

"The win is a testament to Ncell's exemplary works and commitment towards socio-economic advancement of the country," Simon Perkins, managing director of Ncell, has been quoted as saying.

Telecom Asia Awards, organised by Telecom Asia — Asia's largest regional telecom publishing group — every year, rewards innovative and outstanding performance by Asian service providers and industry executives.

Under the initiative, Ncell has collaborated with local micro-grid operator, Gham Power, to support each other to connect unconnected off-grid communities of Khotang and Udaypur districts to mobile and energy services, opening new opportunities for them. People in 31 VDCs now have access to Ncell mobile network.

Surplus capacity of the micro grid has contributed in electrification of communities and created new economic opportunities.

FIGURE 2

Both installations had a different mix of customers, with predominantly business customers in Harkapur

HARKAPUR

38 Households

80 Local Business

01 Telecom Towers

CHYASMITAR

15 Households

06 Local Business

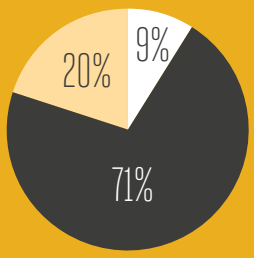
01 Telecom Towers

FIGURE 3

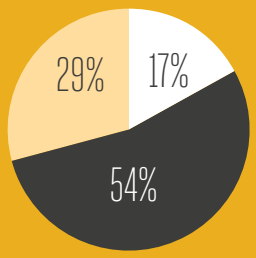
Revenue contribution and energy consumption of different customers over the duration of the pilot

HARKAPUR

ENERGY CONSUMPTION



REVENUE CONTRIBUTION



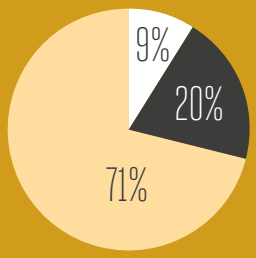
Households Business Tower

94% Maximum capacity utilisation

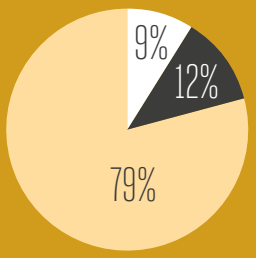
68% Average capacity utilisation

CHYASMITAR

ENERGY CONSUMPTION



REVENUE CONTRIBUTION



Households Business Tower

33% Maximum capacity utilisation

23% Average capacity utilisation

FIGURE 4

Cost analysis by Ncell based on present value

CAPITAL EXPENDITURE

↓ 1/2x

COST OVER 10 YEARS
(Including CAPEX+OPEX)

↑ 1.3x

2 Reliable service can help drive consumption of energy and telecom services

The Gham Power deployments provide important insights on the impact of access to grid-quality electricity and a reliable mobile communication network on a community's standard of living.

Consumers increase their energy consumption; it is not just about saving money on energy

During the planning phase, Gham Power anticipated that cost savings for local businesses running diesel would be the main motivation to connect to the micro-grid. Since about 84 percent of respondents to the September 2015 baseline survey owned a solar home system, their basic need for lighting was already fulfilled. However, within four months of first connecting to the micro-grid, about 17 percent of customers changed their package to gain access to additional power for appliances—a visible impact of the micro-grid on energy consumption.

Customers reported an across-the-board increase in appliance ownership (Figure 5) 10 months after connecting to the micro-grid. The only exception was a drop in radio ownership, although given the reported increase in TV ownership and new products such as sound systems and cassette players; this change probably indicates an upgrade. A key lesson for Gham Power has been consumer interest in investing in 'luxury' products such as TVs and fridges rather than just saving money on energy.

About 22.5 percent of business customers reported a positive change in profit, with most attributing the change to the addition of new appliances. Several of the business customers are small hotels or roadside eateries that added refrigerators or cold storage to improve business.

A reliable telecom network can help increase mobile ownership and usage

Respondents reported about a 10 percent increase in mobile phone ownership. Smartphone ownership increased from 11 percent in September 2015 to about 55 percent at the time of the post-launch survey in December 2016. According to GSMA Intelligence, the national average for smartphone ownership in Nepal was 38.23 percent during Q4 2016. An increase in airtime expenditure was also reported, with 17 percent more respondents spending NPR 500 (USD 5) or more in a month between baseline and post-launch (Figure 6).

The increase in smartphone ownership, mobile internet usage and spending appear to be inter-related. Only four percent of respondents to the original baseline survey listed the internet as a source of information, but this had increased to 25 percent by the time of the post-launch survey.

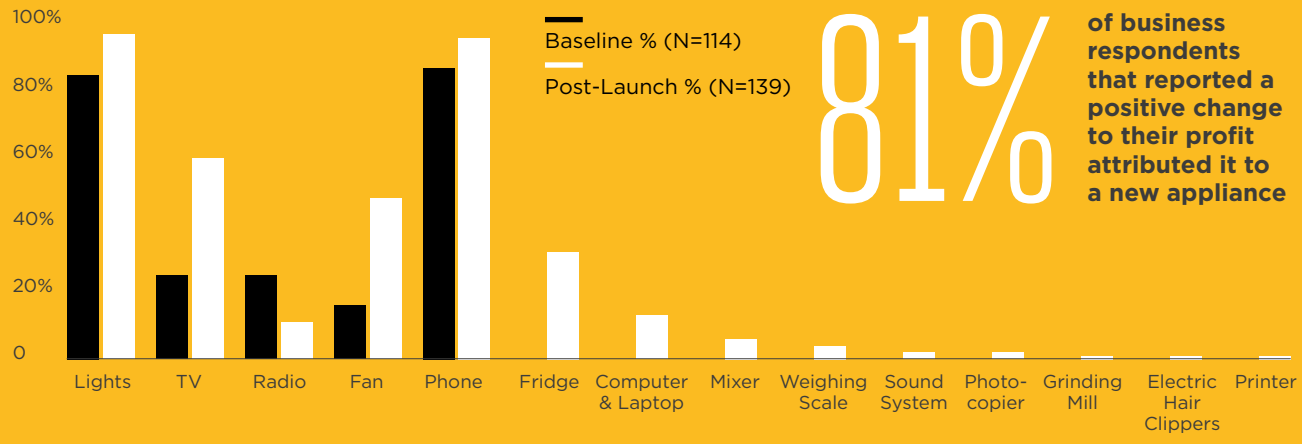
Improvement in the quality of telecom service was reported as the main reason for increased mobile usage (Figure 7), although business expansion and access to energy were also reported as reasons. The weak connection between access to energy and use of telecom services needs to be understood in context. Most respondents already had access to power to charge their phones through solar home systems before the micro-grid was installed. Improved energy access therefore did not reduce of cost of charging or make it more convenient. Additionally, the mobile towers provided coverage to a much larger region beyond the customers connected by the micro-grid. As a result, the number of unique mobile subscribers for the towers was much higher than the number of micro-grid users, making it difficult to isolate the impact of energy access on mobile usage. However, initial data indicates demand for telecom services such as internet in remote communities that may not be perceived as having sufficient demand.

'The earlier Ncell network was not stable in the village, but now the network is stable. Because of this, it is easier for people to use internet. Ncell also offers cheap international call rates and this helps homemakers connect with their husbands and family working abroad. Girls in my neighborhood are also using Facebook.'

CASE STUDY: MAYA SHARI RAI,35-YEAR-OLD FEMALE BUSINESS OWNER, CHYSAMITAR

FIGURE 5

Increase in the number and diversity of appliance ownership

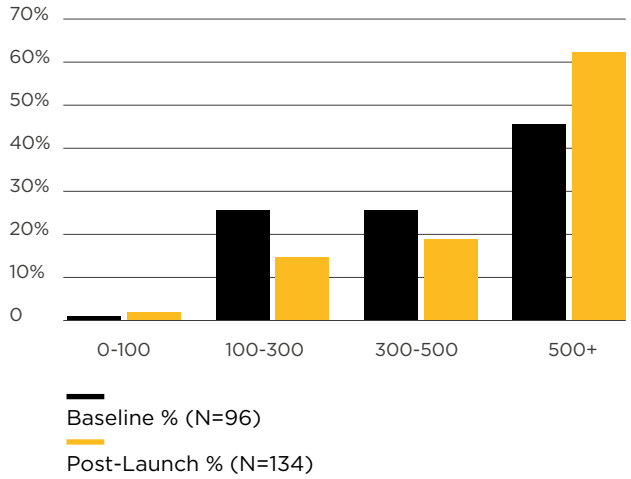


81% **of business respondents that reported a positive change to their profit attributed it to a new appliance**

FIGURE 6

Change in consumption and usage of telecom services

CHANGE IN AIRTIME EXPENDITURE



USE OF MOBILE SERVICES

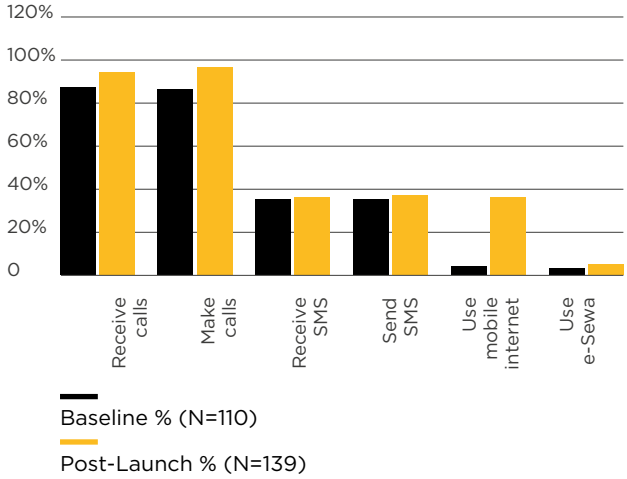
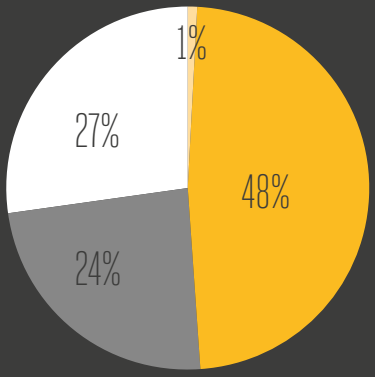


FIGURE 7

Reasons for increased mobile usage



Improved NCell coverage

Friends and family moved elsewhere

Increased business

Electricity available for charging a handset

3 Use of technology, such as M2M connectivity and mobile money, can help to improve the operational efficiency of micro-grids

Even though there were hurdles to deploying smart meters and mobile money, Gham Power found they made operations considerably more efficient.

Smart meters: An essential solution for micro-grids but they need to be affordable

Pre-paid smart meters were essential to collecting operational data, such as energy consumption patterns for individual accounts, uptime and downtime for the grid, and payment discipline. Gham Power has been able to access and analyse the operational data, available through the cloud server, to refine payment plans. In future, it would like to develop peak and off-peak load tariffs to improve utilisation rates and smooth load demand. Having remote access to data through internet connectivity also allows Gham Power to monitor the operations of distant sites from its office in Kathmandu.

Benefits of metered billing versus a flat fee for a micro-grid model include:

- **Payment discipline:** The use of smart meters and pre-payments allows the service provider to ensure regular payments. During an intermediate phase, when not all customers had meters, payment collection was a challenge for Gham Power.
- **Payment plans:** Consumption information provided by smart meters allowed Gham Power to tailor various monthly payment plans based on consumption. In the absence of metering, it is not possible to manage the load or customise tariff plans.

Although GSM connectivity was not used for machine-to-machine connectivity in this case, the benefits would have been similar.

Even though metering provides many benefits, the cost of metering technology will need to drop significantly for scale-up commercially in micro-grids. For the pilot, a smart meter was approximately USD 60 per unit, including the cost of the local gateway. A household consumer was paying Gham Power a monthly tariff of NPR 250 (USD 2.50), which made it difficult to justify the investment in metering technology. Various smart meter manufacturers are experimenting with technology and connectivity options, features, and use cases to reduce the cost of hardware. Further investment and support in this area will have a significant impact on the growth of micro-grids.

Mobile money: Enabling the local ecosystem

In these villages, mobile money has facilitated access to other services, such as mobile phone top-up and satellite TV subscription payments. For the two mobile money agents set up for this pilot, 55 percent of non-Gham Power transactions (by value) were peer-to-peer transfers, with the remaining 45 percent spread across mobile phone top-up (30 percent) and satellite TV subscriptions (15 percent).

Even though the two agents were new, the volume of merchant transactions during the pilot (excluding Gham Power transactions) was comparable to the regional and national average for eSewa agents. It is interesting to note that if the value of Gham Power transactions is added to their merchant transaction value, the total far exceeds regional and national averages (Figure 8). This suggests that utility payments can provide stable revenue for agents, allowing mobile money companies to extend and maintain their agent network in rural areas.

Although not an issue for this pilot, high transaction values concentrated in a short period could create float issues for mobile money agents, who may not have sufficient funds to remit customer payments to the merchant immediately. Float could perhaps be managed by spreading the amount across several agents, although this would require establishing and training more agents.

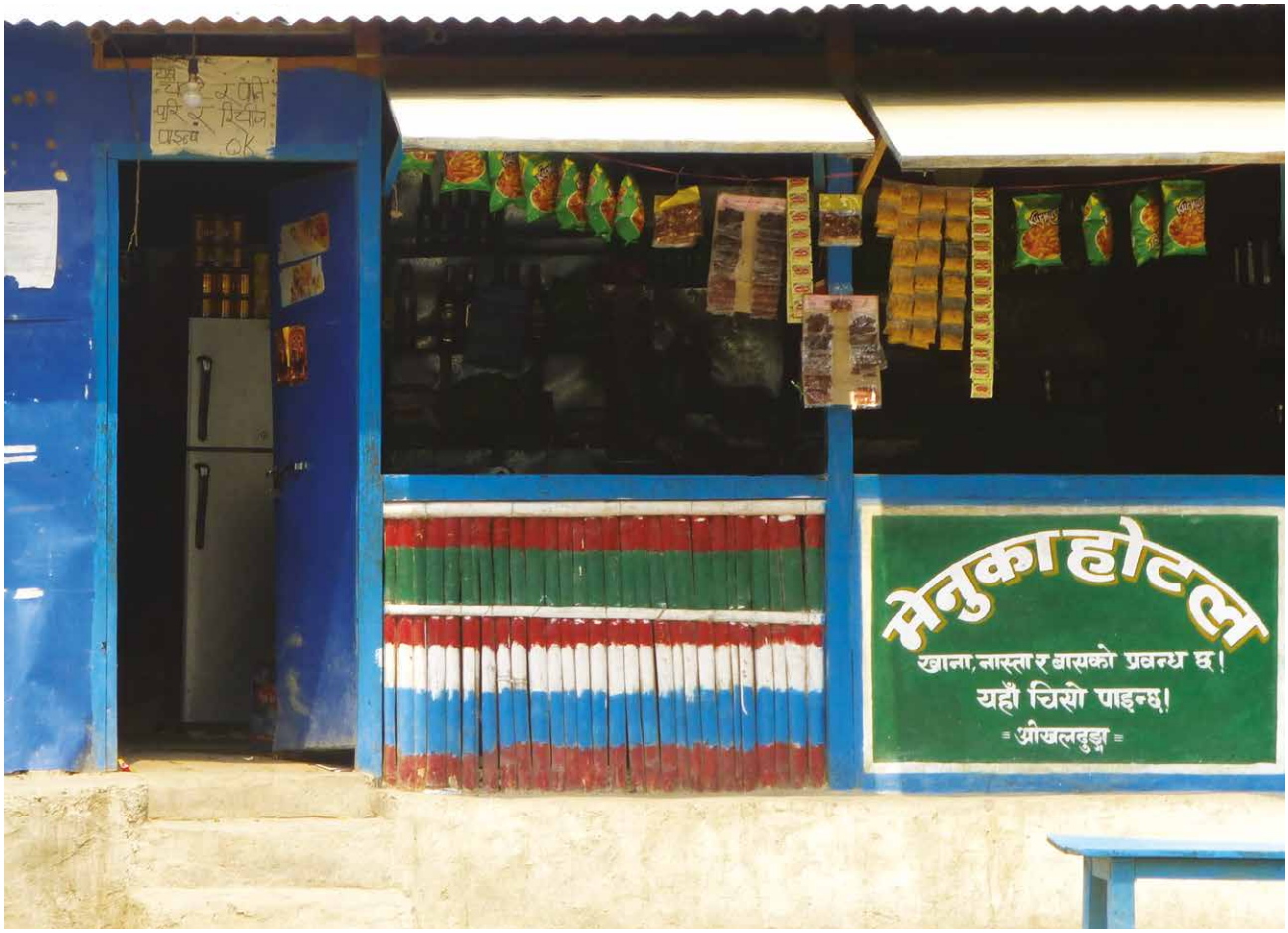
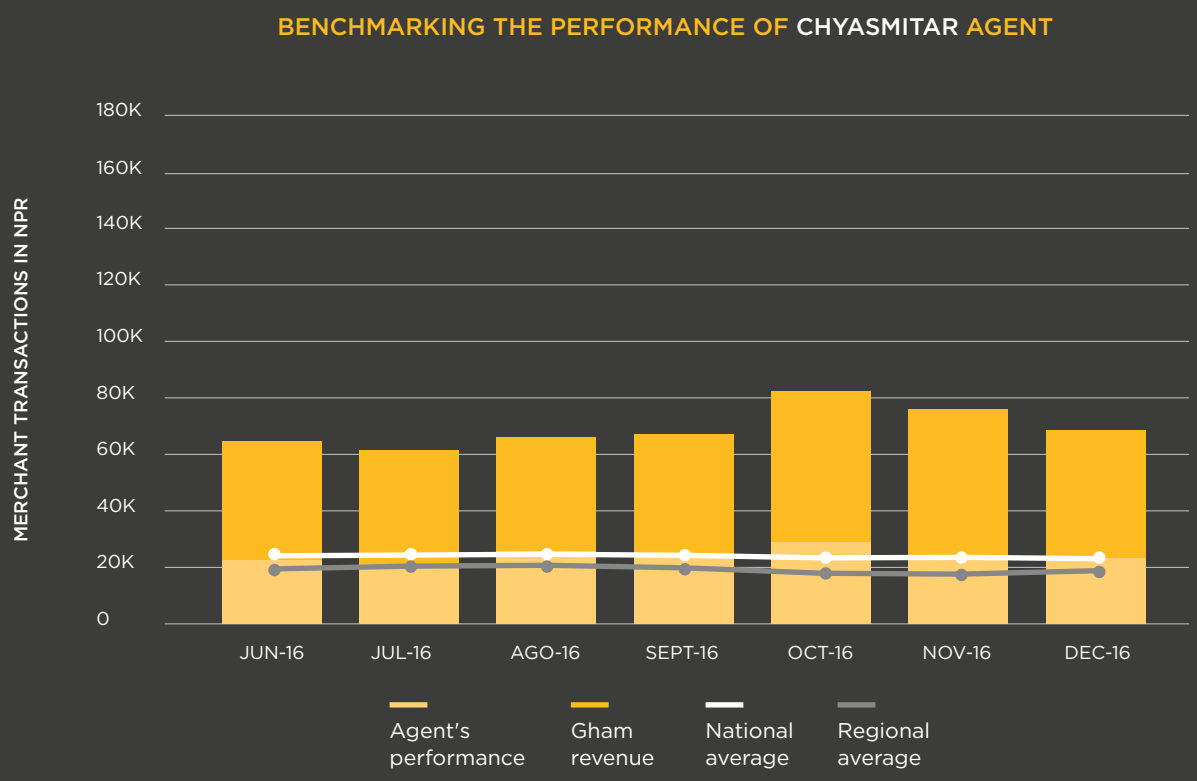
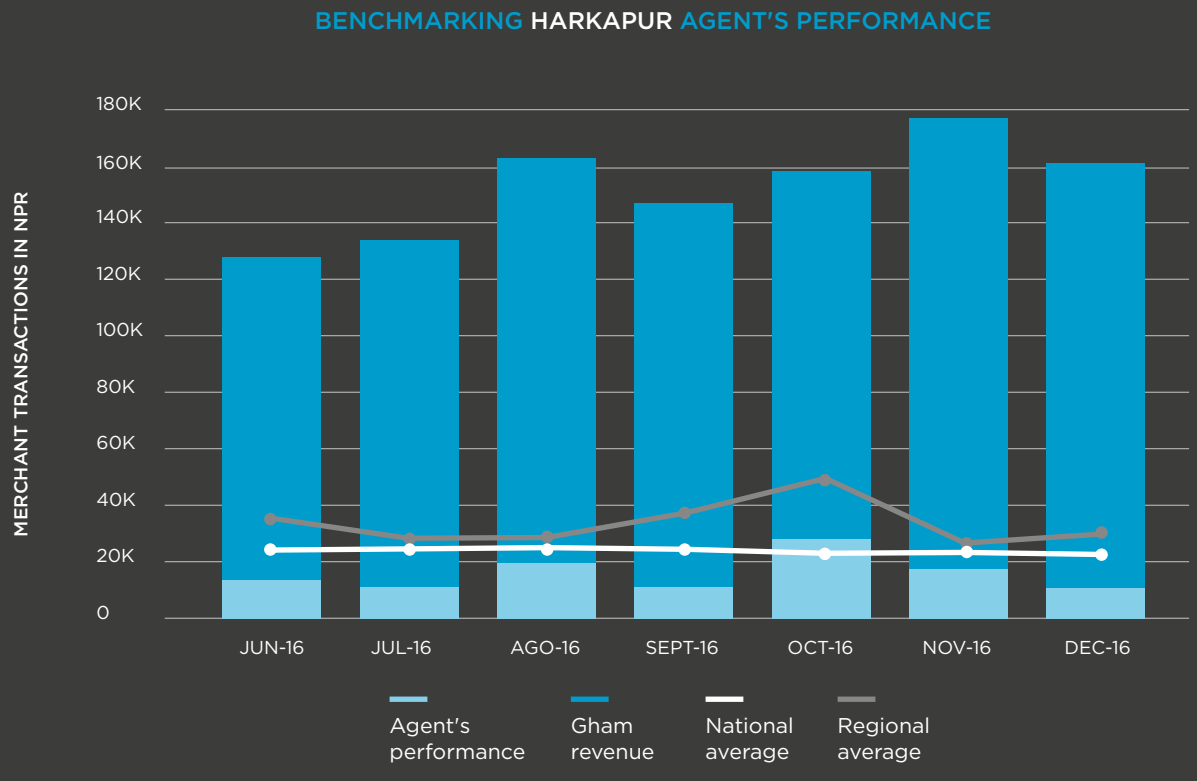


FIGURE 8

Utility payments can create predictable revenue from transaction fees for mobile money agents (1USD = 101.615 NPR)





Recommendations

FOR MOBILE NETWORK OPERATORS

Outsourcing power solutions to reduce capital expenditure can speed network expansion.
By outsourcing power production to an ESCO, MNOs can save on upfront costs. This model provides an alternative to capital expenditure for expanding infrastructure, which may be perceived as a barrier to expansion in rural areas. However, it is important to identify an ESCO with a strong record of accomplishment that can deliver the quality of service an MNO requires.

Partnerships with ESCOs can improve brand perception.
Qualitative feedback indicated that even though Gham Power and Ncell did not explicitly communicate their partnership, consumers did associate them. Several respondents mentioned that the quality of telecom services from Ncell had improved since the installation of the micro-grid. However, they were not aware of the telecom operator's financial contribution to enabling improved access to off-grid energy. If the role of the MNO in delivering energy services was made explicit to consumers, the brand perception of telecom operators could receive a boost.

FOR OFF-GRID ENERGY SERVICE PROVIDERS

Long-term profitability is driven by local businesses.
Relying only on the anchor load is not sufficient to drive utilisation and profitability. Local businesses need to be supported so they can increase their consumption and provide additional revenue. As the Gham Power pilot illustrates, local businesses also have a considerable socio-economic impact on the community.

Having a mobile tower as an anchor load helps during the initial development phase of a micro-grid.
A tower adds value by giving investors and funders confidence there is a reliable source of revenue. It can also provide cash flow for operations while consumption in the community is taking off.

Consider MNOs a partner.
An ESCO should work with the MNO to develop models that leverage both reliable access to energy and telecom services. MNOs can also offer value-added services across health, agriculture, news, and information that may be relevant to communities. Promoting these activities will have a positive social impact while also generating economic value for the telecom operator and ESCO. This approach, therefore, focuses on increasing revenue, not just on saving costs.

Appendix A – About the Innovation Fund

Methodology

Monitoring & evaluation methodology and design was provided by Alexandra Tyers of Tyers Consulting.[6]

All data used in this case study is primary data. Data sources include:

- An in-person quantitative baseline survey conducted in September 2015 in two villages with a sample size of 114 households, shops, and businesses
- An in-person quantitative post-launch survey conducted in December 2016 in the same two villages and with the same respondents as the baseline
- The sample size for the post-launch survey was 139 households, shops and businesses, since there were new clients that had not registered for the service during the time of the baseline survey.
- Operational monitoring data from the micro-grid from February to December 2016
- Mobile and mobile money usage data from Ncell and eSewa
- An independent third-party qualitative evaluation, conducted by Solutions Consultant,[7] a research agency based in Kathmandu, consisted of nine in-depth interviews with residential and commercial users of the micro-grid.

The research methods and data gathered are as robust as possible, but are not intended to form part of an exhaustive, academic study. Rather, we have taken a pragmatic approach to recording the impact of the mobile service on the beneficiaries, capturing early-stage data and insights to help GSMA grantees improve their business performance, and generating knowledge for GSMA and the wider mobile ecosystem on the business case for using mobile innovations for energy, water, and sanitation services.

We recognise some limitations of the data: capacity and budget restraints meant that most quantitative field data was collected and analysed in-house by the grantee (not research professionals) and relies primarily on self-reported responses by users/beneficiaries. Also, the sample sizes were statistically significant where possible, but statistical analysis has not been applied. Finally, some commercial data was difficult to obtain from mobile operator systems.

6. http://www.alexandratyers.com/
7. http://solutions.com.np/site/

For more information on the Mobile for Development Utilities programme visit:
www.gsma.com/mobilefordevelopment/programmes/m4dutilities

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