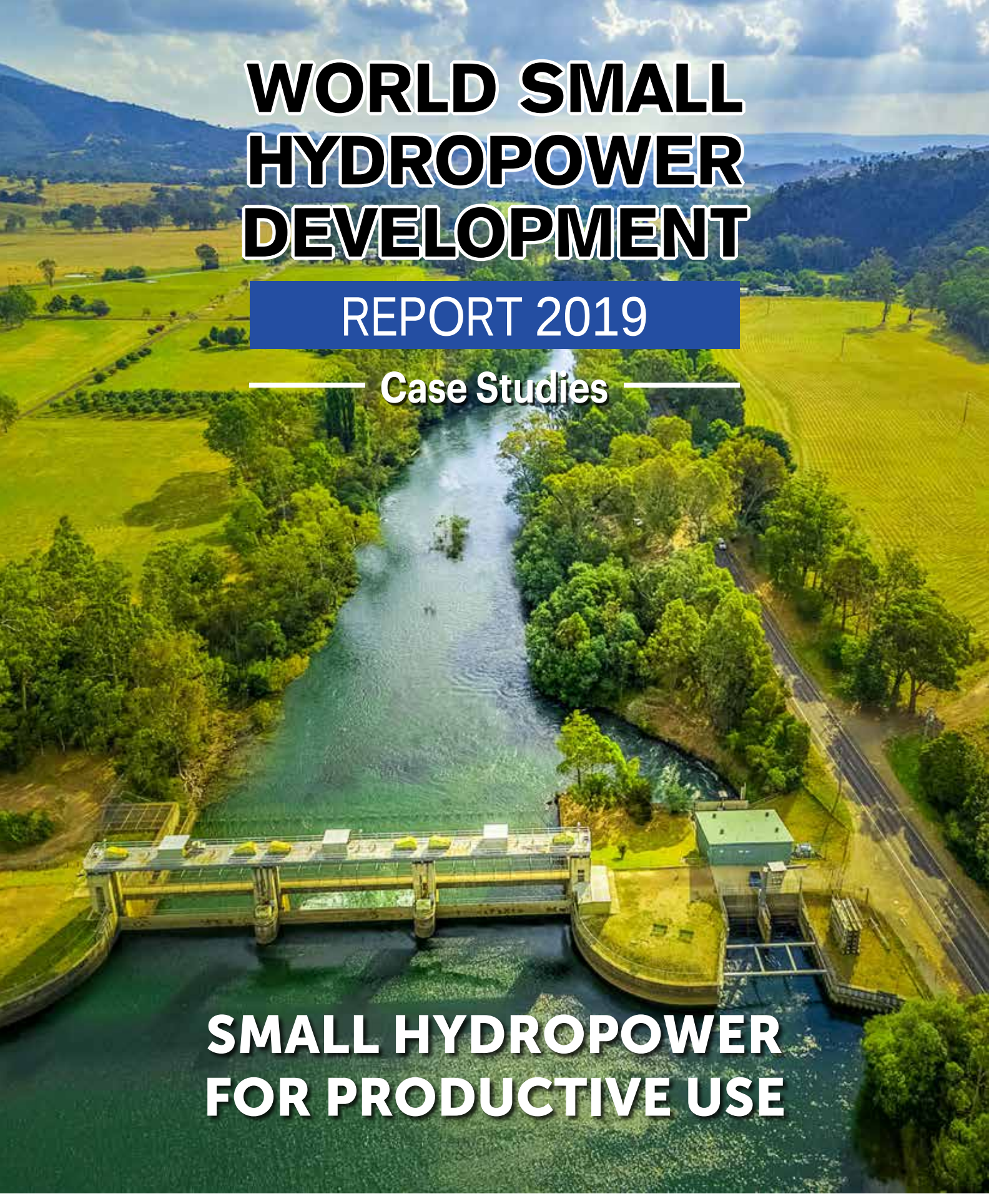
WORLD SMALL HYDROPOWER DEVELOPMENT

REPORT 2019

Case Studies



SMALL HYDROPOWER FOR PRODUCTIVE USE

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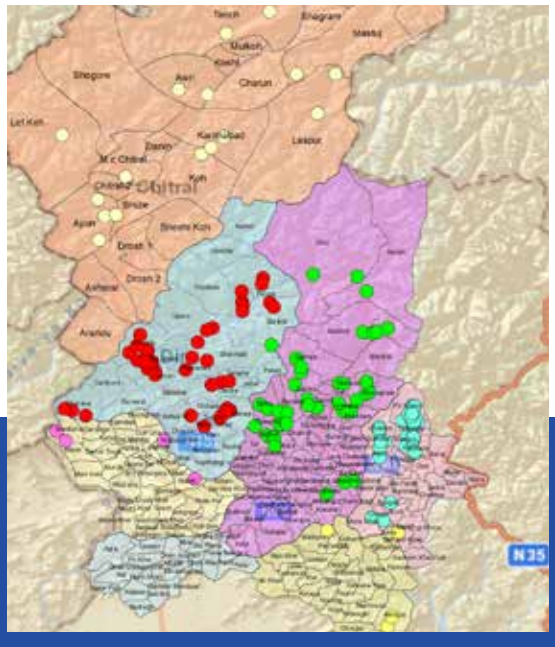
1. SARHAD RURAL SUPPORT PROGRAMME: SMALL HYDROPOWER IN PAKISTAN



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Atif Zeeshan Rauf, Sarhad Rural Support Programme

Seven years ago the non-governmental organization Sarhad Rural Support Programme (SRSP) started developing small hydropower (SHP) projects in Malakand Division, Khyber Pakhtunkhwa, Pakistan with funding from the European Union under the Programme for Economic Advancement and Community Empowerment (EU/SRSP-PEACE). A key goal was to produce clean and renewable energy while promoting small hydropower (SHP) for productive use and rural development. Today, the expanded programme benefits a population of well over half a million people (mostly off-grid) – and helps improve economic prospects and life quality for marginalized groups in one of Pakistan's harshest environments.

In 2012, SRSP (Box 1) decided to develop village-level SHP schemes in six districts of Malakand Division, a remote and inaccessible part of Khyber Pakhtunkhwa Province of Pakistan, in partnership with the European Union under the Programme for Economic Advancement and Community Empowerment (EU-PEACE). The area is home to an estimated 2.2 million people, many of whom live in isolated villages. Around a quarter of the population have no connection to main grid electricity, as the state never extended power infrastructure in these localities in part due to poor governance, bad access roads, harsh winters and the ever-present risk of natural disasters.

Active across Malakand Division for many years under the wider EU-funded regional support programme, SRSP recognized the large technical potential for hydropower given plentiful water resources including glacial-melt water streams and rivers. Working at the community level, SRSP also saw how the lack of access to electricity had the effect of holding back the region's economic and social development. From an early stage, SRSP put these two factors together, strengthening its commitment to SHP for productive use and considering the transformative potential of SHP technology in terms of poverty mitigation for marginalized groups.

Developing and managing SHP projects in six districts of Malakand Division

SRSP's SHP projects were developed under the umbrella of the EU-funded PEACE (Box 2). The SHP initiative comprises about 165 SHP projects across six separate Malakand districts – Buner, Chitral, Dir Lower, Dir Upper, Shangla and Swat. Collectively, the SHP projects have an installed capacity of 21.3 MW generating renewable and sustainable electricity for

the benefit of an estimated 625,000 people from largely off-grid and marginalized communities.

With experience on wider development issues in the region, SRSP understood that for the hydropower schemes to succeed, it was essential to involve and engage the local communities. Throughout each project development, SRSP works closely with community-based institutions, including village organizations, or apex-level support organizations at Union Council level, along with support from programme technical teams to identify potential sites for establishing the local SHP projects.

Box 1. Sarhad Rural Support Programme's overall SHP portfolio

In the early 2000s, SRSP, based on learning from local and regional experiences, initiated two SHP projects in Chitral District, Khyber Pakhtunkhwa, Pakistan. These SHPs used locally manufactured technology to produce 80 kW of clean and renewable energy to benefit at least 1,000 rural poor. Initiation of these two prototype SHPs as a starting step was indeed a 'giant leap' into the future. Being a learning organization, SRSP, in the following years, through available resources improved technical and technological aspects to enhance the efficiency of SHPs developed in its programme areas. As of October 2019, SRSP initiated 353 SHP projects producing 33 MW of electricity to benefit 928,000 people in selected districts of Khyber Pakhtunkhwa and newly merged Tribal Districts.

Following site identification, SRSP programme officers undertake detailed socio-economic and technical feasibility studies. These studies consider a range of issues and factors including productive use, water rights, demand and ability to pay for electricity, community impact, the community's role in project management, plant operation and maintenance – as well as its role in identifying new business opportunities that access to electricity could potentially bring in. From the technical perspective, appropriate turbines are selected based on the requirements of the specific site (Box 3).

In terms of the management at the local level, the community-based institution guided by programme staff form a Power Committee. This committee is comprised of community members, oversees the construction of the scheme, and once operational, manages and maintains the plant. This includes appointing paid operational staff, setting tariffs and managing income from the scheme.

Box 2. Sarhad Rural Support Programme

The Sarhad Rural Support Programme (SRSP) is a non-profit non-government organization working in Khyber Pakhtunkhwa and parts of Federally Administered Tribal Areas (FATA) in north-western Pakistan. Established in 1989 by members of civil society and individual members of the Government of Pakistan, it is an intermediary organization based on the rural support programme approach to community empowerment and economic and livelihood development. This essentially is a belief in bottom-up, flexible, community-driven development and the idea that marginalized communities have within them the capacity for self-support. In recent years, renewable energy has become one of the SRSP's largest portfolios with SHP, in particular, attracting significant funding under the six-years EU PEACE Programme (Programme for Economic Advancement and Community Empowerment). SRSP has a strong commitment to developing community ownership, which it sees as critical to long-term sustainability of projects. Its SHP initiatives supply cheap, stable, environmentally friendly and sustainable electricity across Malakand Division.

Box 3. Using different turbines to generate hydropower

Based on the requirement of the specific sites, different turbines are used to generate renewable energy at the local level. These include cross flow, Pelton, Kaplan or pump as turbine. To maximize efficiency, direct coupling of locally manufactured turbines with alternators and a gear box system are introduced. Programme logic control (PLC)-based panels are used for the first time in SHPs at this level. For controlling fluctuation in voltage, electrical load controllers (ELC) are used in these units. High standard brushless alternators are part of the system depending on site requirements such as altitude, temperature and ELC factor. In most units, cylindrical steel poles are used to avoid wooden poles thus avoiding deforestation. For controlling line losses, properly designed and tested conductors are also used along with transformers.

Usually one to two operators and seven to eight members of respective Power Committees handle operation and routine maintenance of smaller units, while periodic maintenance of the larger plants usually requires help from outside service providers. Initially, SRSP oversees operation and

maintenance of SHPs, but depending on the size of the plant, legal ownership is usually transferred to respective community-based institutions, and the Power Committee remains responsible for the SHP system management and maintenance.

The benefits of SHP: transforming local communities and creating employment

For 90 per cent of the households in the project area, the 165 SHPs implemented by SRSP provide the first ever access to electricity – with huge practical implications for the lives of the estimated 625,000 beneficiaries. The overall quality of life is significantly improved. An obvious and immediate change in many homes is that the electric light replaced the dim and dirty kerosene lamp or pine-torch, allowing women to work from home. Children study better at night, which in turn improves their attendance and performance at school. Meanwhile labour-saving electric appliances, such as washing machines, cut the drudgery of housework (Figure 1), while wood-burning stoves are replaced with cleaner and quicker electric versions. Communications are improved too, with power for phone-charging at home, families are able to keep in touch, and access to infotainment provides a window on a wider world, reducing the isolation of remote villages.

From an employment perspective, the SHP schemes have provided direct employment and income to 500 operators at SHP project sites. Furthermore, in terms of SHP for productive use, reliable access to electricity in Malakand has helped local businesses, such as bakers, tailors and flour mills, to expand to meet local market demand, and new business opportunities have also been created. For example, local companies can now dry fruits such as red persimmon using electric driers to produce a better quality product with a higher market demand, and some businesses are now able to process and sell wild olives.

Local businesses have also been able to bring in much needed income from outside of Malakand. For example, local hotels are attracting more tourists from other parts of Pakistan now that they have reliable electricity for lighting and services. Meanwhile, access to electricity has helped more women earn income in small businesses such as fruit drying, embroidery, washing, beauty parlours and baking. Their priority is usually to invest in their children through schooling and the extra money means that daughters, as well as sons, have opportunities for advancement.

Hydropower projects have also helped to develop local community institutions in Malakand Division. For example, electricity has boosted the capacity of local health centres and hospitals, which now having good lighting for examinations and procedures, can run pathology tests, and are able to refrigerate vaccines and other medications. From an educational perspective, local schools have improved lighting (Figure 2) allowing students to study even during an overcast day and giving students access to computers and improving teaching capacity; while in some Malakand villages, IT centres have been set up, providing both computer and Internet access and training courses

‘In terms of SHP for productive use, reliable access to electricity in Malakand has helped local businesses, such as bakers, tailors and flour mills, to expand to meet local market demand, and new business opportunities have also been created.’

Figure 1. Following the establishment of SHPs in remote communities, marginalized people like these Kalaash girls have more opportunities to use electrical appliances. This contributes to a reduction in domestic workload for many women and girls, freeing up time for educational or economic activities. It also contributes to productive use, as some Kalaash women set up small businesses of washing clothes from home.

(Figure 3) for marginalized groups such as the Kalaash community in Chitral District. With further service provision and development, locals report that there is now less pressure to leave their villages.

Environmentally, the SHPs have made a remarkable contribution in providing renewable, clean and sustainable energy to the local population in the programme areas, which in turn has reduced the usage of fossil fuels and the pressure on precious forests. The current portfolio of 165 units with a combined capacity of 21.3 MW has been a major contributor in the reduction of CO_2 emissions by 66,000 tons/year. Similarly, these 165 units have reduced the amount annually spent on kerosene oil from EUR 3 million to EUR 0.3 million, which is a huge economic benefit to the local population.

Box 4. Malakand SHPs: from the stream to the home

These SHP projects use falling water diverted from a stream or small river, to turn a turbine located in a seismic-resistant powerhouse. The turbine rotates a shaft, which drives an electrical generator. Electricity is distributed through overhead lines with connections to individual customers. Customers have circuit breakers to set the maximum amount of power that can be drawn and a digital kilowatt hour meter to measure their total electricity consumption. The SHP runs continuously except during maintenance periods. Local operators supported by respective community-based institutions have a regular (daily and monthly) operation and maintenance schedule to follow, which includes greasing bearings, keeping channels free from debris and removing snow from power lines. The total cost of installing a hydropower scheme, including cabling, has averaged EUR 1,000 per kW. However, this amount varies considerably depending on the location and the complexity of the site. Each customer has an electricity contract with the Power Committee and pays a connection fee of approximately EUR 15 and a monthly fee for the kilowatt hour of electricity used. The local Power Committee sets the tariff. A typical domestic rate is around EUR 0.035 per kWh, with an allocation of around 60 kWh each month.

Lessons for future SHP development

Lesson 1: SHP can have a transformative effect on economic and social development

SRSP's initiative demonstrates that developing a power infrastructure and providing 24/7 electricity to an off-grid, rural population can have a transformative effect in terms of economic and social development. These SHP projects have revolutionized daily life for Malakand's rural low-income population – creating direct employment, generating economic growth via new opportunities and business start-ups, strengthening the capacity of existing infrastructure and local institutions, and improving the quality of life in the home. SRSP's projects show that it is possible to bring the huge benefits of electricity to remote and challenging parts of Khyber Pakhtunkhwa Province. Given that these projects have been successfully implemented in Malakand, it is likely that SHP for productive use can be replicated in other remote, off-grid communities across Pakistan and in other countries.

Lesson 2: The importance of active engagement with local community institutions

The project promotes active engagement with local community institutions at all the stages of project development, from identifying potential sites to setting up legitimate community structures to keep the SHPs operational and share the benefits of the plants widely. SRSP views local capacity building as an integral part of the project design. In just a few years, many of the units start to produce

Figure 2. Like many other children in Khyber Pakhtunkhwa province, Ashlina Gul is happy to have electricity in her classroom, which makes it easier for her to practice her reading and writing skills. The environmentally friendly electricity is generated locally at an SHP plant in Shangla District.

Figure 3. Girls and boys from the Kalaash community, the Dardic Indo-Aryan indigenous people from Chitral District, are gradually improving their technical skills boosting their employment chances. Thanks to locally generated electricity from SHP, the children are able to undertake computer training and go online, giving them access to information and offering a window on the outside world. Local businesses also benefit from Internet access including local hotels, which can now more easily attract tourists from outside of the region.

a surplus of electricity, which is a definitive indicator of local capacity development. This proven success has encouraged further funding from the Government of Khyber Pakhtunkhwa for a significant expansion of the programme to benefit an additional 150,000 people.

Lesson 3: The power of ensuring continuous technical improvements to electricity supply

SRSP recommends making continuous technical and technological improvements with a view to improving and enhancing electricity production and ensuring that there are no major delays or fluctuations in the electricity supply. This in turn increases confidence in the supply among communities who become increasingly willing to pay for services. Regular payments against the services provided ensure the availability of a surplus income, which can be reinvested in local communities and social enterprises. This encourages long-term sustainability of SHP projects and ensures that project benefits are multiplied.

2. GENERATION OF ELECTRICITY TO INCREASE ENERGY ACCESS IN TEA-GROWING AREAS BY KENYA TEA DEVELOPMENT AGENCY: 5.8 MW GURA SMALL HYDROPOWER PROJECT IN CENTRAL KENYA

Source: Google Maps

Sarah Kwach, Kenya Industrial Research and Development Institute (KIRDI); Eric Nguchitta Njoroge, Kenya Tea Development Agency (KTDA)

Located near the Aberdare National Park, high up in Kenya's Gura Valley, KTDA's 5.8 MW Gura SHP plant generates clean and reliable electricity for four tea factories, increasing productivity and reducing the factories' carbon footprint. It also helps bridge the rural infrastructure gap by selling surplus electricity to the state utility, increasing income for tea farmers and improving local electricity supply and access.

Kenya's tea sector accounts for most of Kenya's exports and provides livelihoods for more than 500,000 tea farmers. However, energy access in tea growing areas, including access to electricity, remains limited and unreliable, contributing to the escalating costs of tea production. Further, according to recent World Bank figures, 4 million households in Kenya are still without power, predominantly those located in rural areas.[1]

Part of the problem is the inability of the national utility, Kenya Power and Lighting Company (KPLC), to fund national grid expansion, coupled with limited government financial resources to develop large-scale projects which require a long gestation period. Nonetheless, the Kenyan Government's Vision 2030 development plan has set the ambitious target of universal access to electricity by 2030 – and to achieve this, the Government is retreating from its traditional role in power provision and enabling the private sector to play a more active part in filling the substantial infrastructure gap.

Increasingly, private sector actors are coming around to the idea that they can play a significant role in the Kenyan power market by helping to tackle the challenges associated with optimizing electricity access in rural areas. A good example of this is the recent experience of the Kenya Tea Development Agency (KTDA), which is gradually moving its plants from the national grid to use its own captive, renewable energy for its processing needs. Through its subsidiary KTDA Power Company (KTPC) and in conjunction with KTDA-managed tea factories and regional power companies, it has made investments in several small hydropower (SHP) projects, the main focus being the development of SHPs for productive use, income generation and the empowerment of local community.

[1] World Bank (2017). Mini grids in Kenya : a case study of a market at a turning point (English). Energy Sector Management Assistance Program (ESMAP). Washington, D.C.: World Bank Group.

Specifically, the development by KTPC of the 5.8 MW Gura SHP in Nyeri County clearly illustrates the potential for SHP for productive use in the Kenyan context. Located high up in the Gura Valley, this SHP generates clean and reliable electricity for four tea factories. Besides increasing productivity, the project has created an additional revenue stream for tea farmers by selling excess electricity to the national utility under a feed-in tariff (FIT). This in turn has improved local electricity supply for rural communities. The successful implementation of this mini-grid project may well serve as a model for private investors interested in SHP for productive use in Kenya (Box 1).

Box 1. KTDA's Power Company energizing Kenya's tea-growing areas

Set up in 2010, the KTDA Power Company (KTPC) invests in the energy sector and manages SHP projects owned by tea factory companies. A wholly owned subsidiary of KTDA, it was established to manage the implementation of SHP schemes, coordinate and manage SHP power plants.

KTDA is the single largest tea producer in the world and accounts for 61 per cent of tea produced in Kenya. It is owned by about 570,000 small-scale tea farmers through their 69 privately owned tea factory companies, which cultivate tea across the 16 tea-growing counties of Kenya. In the KTDA model, smallholders manage their own business, with farmers receiving between 60 and 70 per cent of the final auction price of tea, the remaining 30–40 per cent used to cover processing and operational costs.

With rising energy costs, KTPC on behalf of KTDA, has been exploring ways to reduce energy production costs while increasing power supply reliability and reducing greenhouse gas emissions. In the initial plans, KTPC developed a portfolio of SHPs with an aggregate generation capacity of 28.6 MW across 10 sites on rivers close to the tea factories in central Kenya. The first phase of the hydropower roll-out programme is based on the development of three hydropower plants – the 5.8 MW Gura SHP (Nyeri), the 5.6 MW North Mathioya SHP (Muranga County) and the 0.9 MW Chania SHP (Kiambu) located along the eastern side of the Aberdare Range. Each of these hydropower plants serves several tea factories in their geographical locations – and in the case of the Gura SHP plant, these include Iriaini, Chinga, Gathuthi and Gitugi.

The development of the Gura SHP

Named after the nearby Gura River, the 5.8 MW Gura SHP is located at the boundary of the Aberdare National Park, high up in the Gura Valley in Othaya Division, Nyeri County, and is approximately 220 km from Nairobi. This SHP project is run under the efficient management of Gura Regional Power Companies (RPCs) and KTPC. Successfully installed in 2016 by KTPC, it cost over US$ 9 million. It is one of the three hydropower projects funded by a credit line by the French Development Agency (AFD). Equity investment from the tea factories represented 35 per cent of the total project cost and 65 per cent was through a loan.

Overall, the Gura SHP project covers an area of about 5 ha and has a water canal about 6.4-km long, of which 2 km runs through a managed forest and the rest through tea farms. It is connected to the national grid through a dedicated 11 kV line and the power house is located close to Munyange Village.

The project has three main objectives. First, to generate captive electricity to enhance access to reliable electricity much needed by KTDA's four tea factories – Iriaini, Chinga, Gathuthi and Gitugi. Second, to supply surplus electricity to the state-owned utility company, KPLC, under a power purchase agreement (PPA). And third, to reduce the factories' carbon footprint while increasing productivity, incomes and other business opportunities.

Before the development of the Gura SHP in 2016, the waters of the Gura River had not been used in any major economic activity other than basic farming and for domestic use. Further, the four tea factories situated in the surrounding area received electricity only intermittently from the national grid and relied on a backup generator during electricity power outages. The escalation of power bills led to a reduction in tea farmers' earnings despite factories employing a mix of initiatives, including regular energy audits and replacement of standard machine parts (such as withering fans and motors) with high efficiency ones, to bring down the overall energy consumption. On an average, individual tea factories spent approximately US$ 290,000 to over US$ 600,000 each year on electricity, depending on the factory size. Additionally, the tea production process produced high levels of emissions.

The development of the Gura SHP has had direct impacts in terms of providing green electricity from SHP for productive use. Annually, the project delivers a total of 18 GWh of reliable, alternating current (AC) electricity to four factories (Box 3), freeing them from the national grid, thereby improving the efficiency of the tea factories and reducing the emissions that harm the environment.

Box 2. Technical features of the Gura SHP

The Gura SHP is a small-scale run-of-river hydropower plant, which is made up of components such as a weir, settling tanks, channel, forebay tanks, penstock pipe, turbine and generator. More specifically:

- Its installation involved the horizontal mounting of two 2,830 kW Francis turbines with the output power supplying the four tea factories.
- The weir is located upstream in the forest, approximately 2 km from its boundary (forest guard house). The level of the weir is 2,066 metres.
- The settling tank is laid down parallel and on the right bank of the river and upstream of the waterway. It has the following characteristics – size 34.6 x 5.55 metres, height between 5.0 and 5.3 m, storage volume 231 metres.
- Power house.
- Penstock with an approximate length of 400 metres.

Box 3. Monthly electricity supply by the 5.8 MW Gura SHP to the four tea factories

Name of factory	Amount of power supplied in (kWh/month)
Chinga	220,000
Gathuthi	200,00
Iriaini	180,000
Gitugi	140,000

Box 4. Multilateral support for SHP in Kenya

Multilateral donors including the World Bank, the African Development Bank (AfDB), the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP), support and fund SHP development in Kenya. One example is the "Greening the Tea Industry in East Africa" programme, funded by the United Nations Environment Programme (UNEP), GEF and AfDB and implemented by East African Tea Trade Association (EATTA). Through this programme, the Kenya Tea Development Agency (KTDA) in collaboration with a number of tea factories under its management are implementing a number of small-scale run-of-river hydropower projects across the various tea-growing regions of Kenya. An economic analysis has shown that SHP projects have a large and positive impact on agricultural production and productivity.

Figure 1. Gura SHP

Moreover, the Gura SHP is able to sell surplus power of approximately 1.5 MW per month to the national grid under a FIT. This provides the tea farmers with an additional revenue stream while stabilizing KPLC power supply to nearby villages in Nyeri, which were previously faced with poor power quality and frequent power outages.

The benefits of the Gura SHP initiative: Reliable energy, lower costs, power islands and job creation

The private sector-driven project enhances opportunities for public-private partnerships and provides major benefits to different groups, sectors and stakeholders. For example, the tea sector benefits from more reliable energy and lower energy costs, local communities benefit through access to electricity, and the grid benefits through access to low-cost surplus electricity and over time, through significantly increased investment in hydropower once the barriers are removed. The global environment also benefits with every kilowatt hour of hydroelectricity replacing emissions from burning fossil fuels to generate power on the grid or from backup diesel generators.

The four shareholding tea factories are the dominant users of the Gura SHP, primarily meeting their industrial power needs and reducing production costs. Reliable electricity from the Gura plant makes the factories more efficient by cutting dependence on the unreliable national grid, which reduces the cost of production. The savings from this reduced energy production cost has made the produced tea more competitive in the world market. Further, selling excess electricity to the national utility under a FIT creates a new revenue stream for tea farmers. The FIT policy allows private power producers, in this case KTPC, to sell and obligates the distributor (KPLC) to buy on a priority basis electricity generated from renewable energy sources at a pre-determined fixed tariff for 20 years. This FIT ensures the long-term viability of the SHP system.

Importantly, if there is a technical issue affecting the Gura SHP, the Gura regional company can still purchase power from KPLC until this technical issue has been resolved. From KPLC's perspective, the organization can purchase wholesale electricity, as needed, from the mini-grid instead of having to invest funds in developing new capacity. Further, the mini-grid can operate as a power island when the national grid is down, increasing the flexibility and reliability of electricity supply.

In addition to having direct access to reliable electricity, local communities benefit in several other ways. The project led to employment opportunities, especially during civil works for workers of various skill levels, thereby increasing the local income. The operation phase also created at least 10 new jobs as employees of the plant. Similarly, the project generated demand for various kinds of related services in parallel sectors such as transport and trade leading to increased economic activity and further employment in the local area. The availability of local employment encouraged the local population to remain in the local area, thereby reducing urbanization. Meanwhile, the income generated from selling excess electricity to KPLC has trickled down to tea farmers as dividends or bonuses contributing to poverty alleviation.

The project has wider environmental benefits through the provision of a clean source of electricity and, thus, contributing to the achievement of the UN Sustainable Development Goals. Moreover, the project is also consistent with the objectives of the Kenyan National Task Force on Accelerated Development of Green Energy to install SHPs.

Lessons for future SHP development

KTDA is replicating this model in other tea factories across the country to support their strategic goals of reducing their energy production costs while also protecting the environment. The successful implementation of the Gura hydropower mini-grid project may also serve as a useful model for private investors and other stakeholders interested in developing SHP for productive use in Kenya, specific lessons including:

Lesson 1: A practical and mature technology, SHP can contribute green electricity directly and effectively for productive use in Kenya

Although very few power plants in Kenya are under the private sector management, the Gura initiative demonstrates that SHP can be successfully used for productive use in Kenya. SHP should be considered a practical and mature technology for improving electricity supply and access. This development model has many advantages including short implementation times, low initial financial investment and environmental impact and the potential to serve the power demand of populations living in remote areas. It also involves community participation in construction.

Lesson 2: The importance of the integrated ownership model

The Gura SHP project was established on the basis of an integrated ownership model, which has been important to the successful development of the initiative. Specifically, KTDA has a wholly owned subsidiary, KTDA Power Company (KTPC), which is responsible for the coordination, the setup, the technical operation and maintenance of the plant. The four tea factories directly contributed funds for acquisition and formed a Gura SHP Company Board to supervise SHP construction. Gura SHP Company supplies captive power to the four KTDA tea factories, and sells any excess electricity to the majority state-owned utility company KPLC. Further, the tea farmers also have a role in organizing community contributions and making available the savings from the reduced costs of energy for the maintenance of the SHP system. It should also be noted that having a community committee or a cooperative responsible for tariff setting helps to ensure that the tariff system provides enough income to cover costs, maintenance and repairs, while offering reliable revenues for private investors.

Lesson 3: The benefits of building a local community

The project-driven approach provided technical training on the assessment, management, operation and maintenance to projects developers and the local population. This means qualified technicians will be available to provide maintenance and other services beyond the life of this project. Increased skills in and awareness of SHP, will allow for a sustainable replication in other tea-growing areas across the country.

Lesson 4: Using the private sector to fill in the infrastructure gap

Private sector actors can play a critical role in the power market to alleviate challenges associated with optimizing electricity access in rural areas, as they can offer more connection impact per investment dollar, improved reliability and customer service for end users (including demand stimulation interventions), and the ability to serve as a conduit for bringing "future-grid" technologies in the country's power system. For these reasons, the Kenyan Government is providing assistance to private investors with resource assessments and feasibility studies to increase the installed SHP capacity in the country.

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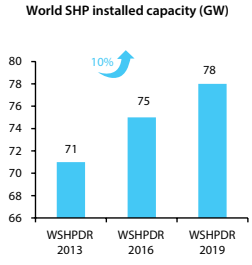
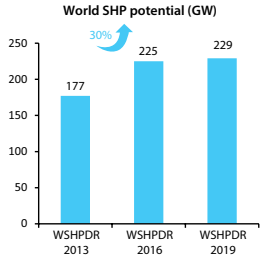
World Small Hydropower Development Report

The *World Small Hydropower Development Report (WSHPDR) 2019* is an update of the Report's first two editions in 2013 and 2016. The *WSHPDR 2019* contains **166** national reports and **20** regional reports, with 21 new countries added since its first edition.





A special report with **Case Studies** is added to the *WSHPDR 2019*, showing the different roles small hydropower can play in achieving the SDGs.

- SHP for productive use
- SHP for social and community development
- SHP financing
- Technology, innovation and smart SHP
- Incentive policies for SHP development
- Green SHP

- The Report is available on **www.smallhydroworld.org**;
- More than 230 experts and organizations have been involved;
- Every country report provides information on:
  a. Electricity sector;
  b. Small hydropower sector;
  c. Renewable energy policy and;
  d. Barriers to small hydropower development.

Small hydropower for a better world

Contributing organizations

European Bank for Reconstruction and Development

Energetyka Wodna

HRC Small Hydro

HYCON GmbH

Asociacion de Trabajadores de Desarrollo Rural – Benjamin Linder (ATDER-BL)

Der Wasserwirt

Ping An Bank

Smart Hydro Power

Sarhad Rural Support Programme

Turbulent

Virunga Power

Zhaoheng Hydropower Group

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