

Empowering Himalayan communities: Solar micro-grids for enhanced resilience in Ladakh, India

Key highlights

- Many remote mountainous communities in the Himalayas have limited access to electricity grids and rely on fossil fuel, including use of diesel generator sets for lighting and use of kerosene and firewood in winters for cooking and heating, which cause indoor air pollution and are detrimental to people's health.
- A social impact tourism enterprise in Ladakh, GHE is implementing solar-based electrification projects in the region, demonstrating how tourism can be leveraged as a driver for holistic socioeconomic development.
- Ladakh's experience shows how the initial capital investment required for installing solar micro-grids can be raised through various sources, from corporate social responsibility funds to travellers' expedition fees. Village households can contribute towards ongoing operations and maintenance of the infrastructure, fostering a sense of ownership and self-reliance.
- Decentralised, solar powered micro-grids are easy to install, operate and maintain, eliminating the need to use traditional fuels and providing access to electricity that can improve people's standard of living and provide alternative or additional livelihood options.
- Solar power provides opportunities for local women, who can be trained as solar technicians or learn new skills, such as pashmina weaving, promoting financial independence and gender equality.

Introduction

In regions such as Ladakh in India's Himalayas, remote mountain communities face significant challenges accessing the nearest electricity grid. It is not financially viable to invest in transmission lines that need to cross rugged mountain passes when population numbers in mountainous communities are relatively small¹. Communities rely on fossil fuel, including diesel based generator sets for lighting needs. Although significant progress is seen in Ladakhi villages with Liquefied Petroleum Gas (LPG) access, use of kerosene and firewood in winters for cooking and heating is still preferred. These traditional fuels emit greenhouse gases (GHGs), harmful fumes of carbon monoxide, particulate matter and sulphur dioxide, contributing to changes in climate and threatening people's health.

A lack of electricity confines communities' productive working hours to the daytime, limits their adoption of digital resources and education, and restricts their use of healthcare facilities. Installing solar micro-grids to provide electricity has enabled communities to better adapt to the region's climate risks and paved the way for holistic socioeconomic development in the area, primarily by extending the length of the working day⁴. It has also enabled the community to access digital education and make improvements to healthcare provision.

Approach

To address these challenges, a solar-based electrification project was launched in Ladakh in 2013, beginning with the villages of Sumda



Image source: GHE

Traditional pashmina weaving is an important source of livelihood for Ladakhi women.

Chenmo and Umlung, followed by Machu⁵, Lingshed, Skiing, Shade and Ralakung in Zaskar⁶.

The aim was to provide clean energy that could build climate resilience among these communities and improve livelihood opportunities in a sustainable manner. Decentralised solar micro-grids were installed in the villages, helping to power homes, schools and healthcare centres⁷. The project has since been scaled up to reach other villages in the Ladakh region.

GHE, a social impact tourism enterprise, provided the technical expertise and financial assistance to cover initial capital costs, engaging with stakeholders across the region, including regional government and village leadership. GHE manages trekking expeditions for international travellers to remote Himalayan villages, leveraging tourism as a driver of development, and mobilises funding through corporate social responsibility (CSR). It implements solar electrification projects in Ladakh using the following approach:

- 25-30%⁸ of the total expedition fee (US\$2,000-US\$3,000 per person⁹) is used to support local community projects, which are further supported by other funding sources, such as crowdfunding. CSR funding is also used as seed funding for the installation of solar direct current (DC) micro-grids (250-500 watts) and LED lamps in households, neighbourhoods, monasteries, schools, health centres and other public buildings.
- A range of stakeholders are consulted to identify community needs, generate awareness and ensure community buy-in. In Ladakh, these included the Ladakh Autonomous Hill Development Council, village panchayats (village councils) and representatives from the local villages.

- Initially, a joint village account is opened with two or three representatives, contributions are made by the community and GHE takes responsibility for operating and maintaining the micro-grids. After a year, the community takes full responsibility for managing the grids – the joint contribution is removed and payments are made directly to solar technicians for operations and maintenance.
- Men and women from the local communities are trained as solar technicians, who can provide technical assistance for operations and maintenance and help implement solar micro-grids in other villages. They are provided with technical and financial support, in addition to entrepreneurial training, facilitating the set-up of local service centres. For every 30-35 electrified villages, a local service centre¹⁰ is set up for providing operations and maintenance service.
- The local community is sensitised on the changing climate and its impacts, and how climate risks are exacerbated through human activities, such as cutting trees for firewood, which can cause increased soil erosion and landslides, and reduce the potential for carbon absorption.
- Women are considered critical stakeholders and are trained to operate homestays and revive traditional handicrafts as well as to become solar technicians¹¹. For example, women have been professionally trained in making pashmina products and provided with individual machines, adding to their earning potential. As a result, some women have established cooperatives to promote pashmina products.
- More than 50 homestays have been set up in Ladakh. In 2019, some of these are promoted to visiting tourists as astrostays. Local youth trained in astronomy and stargazing use their knowledge to generate interest. In 2022, the Cosmohub¹² was launched, offering visitors a home-cooked meal, an onsite retail space selling handicrafts and local organic products. CSR funding was used to upgrade the existing homestay with sustainable amenities and market linkages were created to enhance livelihood generation opportunities.
- Almost 75% of the income generated from these activities goes directly to the community for village level improvement. The remaining 25% is used by GHE to empower the communities through marketing, promotion, retraining and other operational costs.¹³

Results

The initiative to introduce solar micro-grids brings sustainable tourism and clean energy technology together, giving impetus for



Image source: GHE

Training of women in the meticulous craft of pashmina spinning, keeping heritage alive.

enhancing the environmental stewardship and socioeconomic opportunities of remote Himalayan communities. GHE has received several awards for this initiative, including the 2020 United Nations Global Climate Action Award¹⁴ from the United Nations Framework Convention on Climate Change, under the category of 'Financing for Climate Friendly Investment', for using the opportunity of tourism to electrify remote villages. Thus far, the results include:

- 94 villages have been electrified in Ladakh and over 100 villages electrified in North East India, directly impacting the lives of more than 70,000 villagers. 1.034 MW solar power has been installed, mitigating over 230,500 tonnes of CO₂ emissions per year.
- More than 200 women have been trained as entrepreneurs. These women operate 74 homestays and promote traditional handicrafts. Their annual income has increased by three to five times. Women trained as solar technicians have set up a service centre in Leh to support post-electrification maintenance.¹⁵
- Women's productivity has increased as access to electricity reduces time spent on household tasks and extends working hours into the evening. The initiative instilled confidence in local women, broadening their perspective to consider new socioeconomic opportunities. One of the female solar technicians was identified and acknowledged by Power for All as one of the global top 22 'Women at the forefront of scaling energy access'.¹⁶ Further, women-run homestays have been recognised by the Tourism Department of the Union Territory of Ladakh for fostering sustainable tourism.
- School-going students are able to harness the benefits of digital education. Today more than 17,000 students have access to digital content that has been made available through the 35 Innovation Centres set up across Ladakh and North East India.
- Women have been trained and upskilled by local experts at the Pashmina Weaving Centre – an enterprise that is managed by 20 women.
- More than 200 men and women have been trained as solar technicians and are engaging in the growing solar market in the region.
- The trend towards out-migration and cultural loss has been curbed, thanks to the new livelihood opportunities from tourism and solar electrification.

Learning

The success of the solar-based electrification initiatives in Ladakh has demonstrated how social impact tourism enterprises can be used to drive holistic socioeconomic development in remote communities. By enhancing access to renewable energy and directing funds towards women-led businesses, the initiatives implemented by GHE have closed gender gaps in economic independence, encouraged income diversification and built communities' adaptive capacity.

Significantly, externally sourced capital funding and its management by GHE at the preliminary stages created impetus for these grassroots initiatives without imposing an initial financial burden on the community. Yet, communities are at the heart of these initiatives and their buy-in is essential to any initiative's long-term sustainability. Extensive community mobilisation and engagement combined with financial contributions by village households for the ongoing operations and maintenance of the solar infrastructure, instilling a sense of ownership and self-reliance. Local administrators, such as Councillors from the Ladakh Autonomous Hill Development Council, emerged as a supporting force for the initiatives and actively pursued collaboration with GHE.

By virtue of their simple and decentralised design, with minimal wiring, the solar micro-grids can be considered 'climate smart'. They can withstand heavy snowfall and can be restored quickly after an extreme weather event because they require low-maintenance and minimal technical know-how.

Despite the success of the initiative, some more challenging impacts are being seen at a regional level. The growth in tourism results in higher numbers of visitors, thereby increasing water consumption, impacting groundwater levels and producing larger volumes of waste. While tourism is promoted through this initiative, the community as well as local government should plan and be trained to manage higher numbers of visitors sustainably.

Way forward

Many villages in the inhospitable Himalayan region still lack grid-based electricity¹⁷, which reflects **an opportunity to replicate and scale up the community-level solar micro-grids**. The model is simple enough to be reproduced by trained solar technicians and once the communities receive support in the form of initial capital, and skill in operations and maintenance, it can be self-sustaining. Based on the learnings in Ladakh, GHE has been able to replicate similar activities in Meghalaya, and within a short span of four years, more than 715kW of distributed solar energy has been set up with more than 130 local community villagers trained as solar technicians.

When **local women spearhead a solar micro-grid initiative, the results are even better**. The success of a woman-led model was demonstrated when Gurmet Angmo, the first woman trained as a solar technician in Ladakh by GHE, went to Meghalaya to support the initial operations in that region. Angmo's presence in the Garo communities of Meghalaya, accelerated the setting up of solar micro-grids, delivering a positive message to the Garo women, who were motivated to attend training and support the initiative's replication.

GHE has received several **requests from other mountainous communities** in the Hindukush Himalayan region and beyond - from Nepal, Myanmar, Bolivia, Peru, Colombia and Kyrgyzstan. Several villages in Nepal, Sumatra and Uganda are already being surveyed and identified for similar initiatives¹⁸. They have also expanded to include **the adoption of clean cooking solutions**.

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Image source: GHE

Women solar engineers trained by GHE bringing sustainable energy to Ladakh and empowering communities.

