

Sustainable Energy for all: Making a case for community-scale micro-hydro as the solution

International Rivers protects rivers and defends the rights of communities that depend on them. We seek a world where healthy rivers and the rights of local river communities are valued and protected. We envision a world where water and energy needs are met without degrading nature or increasing poverty, and where people have the right to participate in decisions that affect their lives.

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About this briefing

This briefing is intended for partners, supporters and funders of the Transboundary Rivers of South Asia (TROSAs) project, and policy stakeholders in South Asian governments. Its purpose is to provide evidence and examples in support of micro-hydropower (MHP) as an appropriate sustainable energy option. The briefing states the position of International Rivers and that of its networks in support of investment and policy that enables the upscale of micro-hydro. It further calls for disinvestment from large-scale hydro, which is poorly suited to deliver energy and other ecosystem services to the poor, or remote communities.

Hydropower generation has been widely promoted as a green and renewable energy source. In reality, the detrimental impacts of many hydropower projects have far overshadowed the intended benefits, especially for Indigenous Peoples who have borne disproportionate impacts of large dams.

In comparison to conventional hydropower projects, micro-hydropower (MHP) developments offer the benefits of hydropower to small communities, without the vast and long-term devastating impacts of large hydropower.

This briefing provides an overview of the evidence in favor of MHP as follows:

- Introduction to the global energy transition, the road to energy access for all, and the false promises made by large hydropower developers
- An overview of MHP as a decentralized energy solution and case studies of good practice
- Summary recommendations and principles for successful development of MHP for local and rural communities
- Suggestions and sources for further reading

Key Messages

- Top-down energy planning has often favored large-scale projects that feed the national grid. But for those living in remote, rural locations, extending the grid out to these areas is expensive, impractical, and in some cases impossible.
- Boosting the generation capacity of national grids through large-scale hydropower dams is a false climate solution that ultimately harms biodiversity, freshwater ecosystems, Indigenous Peoples, and local communities.
- Energy development plans must first emphasize investment in energy conservation and efficiency before considering new, large-scale projects that are typically favored by developers and officials.
- Decentralized renewable energy can accelerate progress to universal access to energy faster, more equitably, and with greater knock-on benefits to rural livelihoods including community ownership of electricity services.
- Meaningful public participation is key to realizing energy access that is sustainable and beneficial for local communities. Local communities, including women and Indigenous Peoples, must be directly included and involved during every stage of the energy planning process.
- If policymakers set their focus on decentralized and renewable solutions, it could be possible to meet SDG 7 by 2030 and provide affordable, accessible, and reliable renewable energy to the world's most vulnerable people that are without electricity access today.

1. Introduction

“Moving towards scaling up clean and sustainable energy is key to protect human health and to promote healthier populations, particularly in remote and rural areas. Far too many people, often the most vulnerable ones such as women and children, still lack access to clean cooking fuels and technologies, exposing them to dangerous levels of household air pollution. A healthy and green recovery from COVID-19 includes the importance of ensuring a quick transition to clean and sustainable energy” Dr. Maria Neira, Director of the Department of Environment, Climate Change and Health at the World Health Organization (WHO).

Energy access for all, and the global energy transition

According to the International Energy Association (IEA), energy access is when a household has reliable and affordable access to both clean cooking facilities and enough electricity to supply basic services initially, and an increasing level of electricity over time to reach a regional average. Many innovative startups and organizations are working towards this goal, collaboratively striving to reach the United Nations Sustainable Development Goal (SDG) 7 to “Ensure access to affordable, reliable, sustainable and modern energy for all.”

Globally, there is a movement to shift energy access to clean energy sources. This transition entails a shift from fossil fuels to renewable and sustainable electricity or energy forms. The transition is driven by the need to reduce CO₂ emissions to mitigate the impacts of climate change. The most comprehensive assessment (<https://www.ipcc.ch/report/ar6/wg1/>) of climate change was released by the Intergovernmental Panel on Climate Change (IPCC) in August 2021. The report confirms that human activities are increasing greenhouse gases in the atmosphere, mainly carbon dioxide (CO₂), along with methane and nitrous oxide. Human influence has led to increasing global land and ocean temperatures, resulting in increasing weather extremes globally, including drier dry spells, more frequent, longer, and more intense heatwaves, less frequent and less intense cold waves, stronger, wetter tropical systems, and increasingly severe fire seasons.

To stave off further disaster, the immediate decrease in emissions and the phasing out of fossil fuels have become vital. Increasingly, countries,

international-governmental bodies, and UN agencies have made commitments to reduce net carbon emissions to zero by 2050.

With the recognition of global warming and climate change, there has been a concurrent increase in greenwashing, and a proliferation of false climate solutions and promises that ultimately harm biodiversity, freshwater ecosystems, Indigenous Peoples, and local communities.

The hydropower industry, in particular, has falsely branded itself as a clean and green energy source for the future. The International Hydropower Association (IHA) (<https://www.hydropower.org>), whose members include PowerChina/Sinohydro, Sarawak Energy, Brookfield Renewable, and the Indian National Hydropower Association, has promoted the use of its own “sustainability tools” as a means to avoid the significant environmental, social, and governance risks that hydropower projects pose. However, these tools have been widely criticized by civil society for failing to ensure that community voices are reflected in decision making and that environmental and social issues are largely treated through a box-ticking exercise conducted by assessors that are accredited by the IHA itself, creating a significant conflict of interest.

Decentralized Renewable Energy

In comparison to large, centralized power projects and developments from which generation loads are transmitted across long transmission and distribution lines to consumers, decentralized energy systems provide promising opportunities for deploying renewable energy sources locally available, and for expanding access to clean and affordable energy services to remote communities.

A Decentralized Renewable Energy (DRE) system places the power source closer to the end-user or the communities. It allows for optimal use of renewable energy as well as combined heat and power, reduces fossil fuel use, and increases eco-efficiency.

The field is characterized by innovative technologies, including biomass gasifiers, pico- and micro-hydropower, solar photovoltaics (PV), and wind energy. These are particularly suitable for remote and rural areas.

Though a relatively new approach to the power industries in most countries, the cost of DRE systems is already decreasing as the technologies improve.

Costs for solar PV in autonomous systems and mini-grids, in particular, have lowered such that we are on track to affordable access to electricity for millions of people. If policymakers set their focus on DRE solutions, it could be possible to meet SDG 7 by 2030 and provide electricity to half of the people without electricity access today. The opportunities to provide affordable, accessible, and reliable renewable energy to the world's most vulnerable are substantial.

Micro-hydropower (MHP) is one DRE solution that has been proven to be economically viable.



2. Micro-hydro as decentralised renewable energy solution

Overview

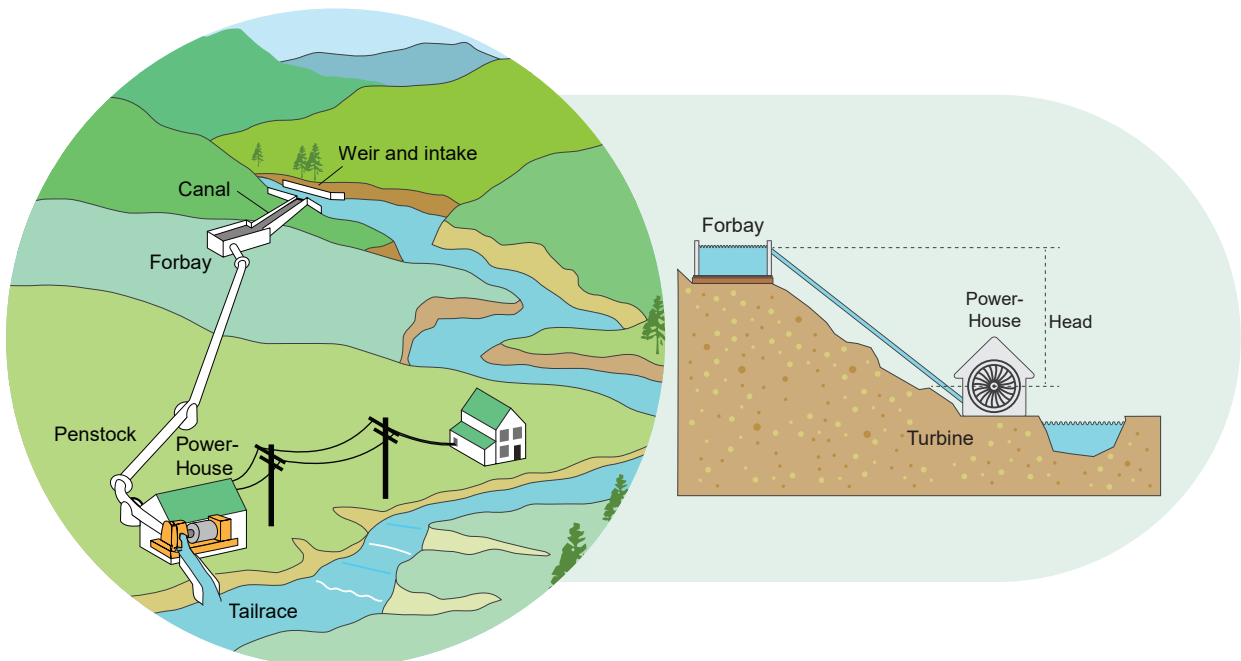
MHP is a renewable technology using a stream with enough head or flow to generate sufficient electricity for a specific community. MHP plants require no reservoir, which differentiates them from other small hydropower developments.

MHP is sometimes split into pico-hydro, which is smaller than 5kW; micro-hydro (smaller than 100kW); and, mini-hydro (smaller than 1000 kW). The Hydro Empowerment Network (<https://www.hpnet.org/>) defines MHP as “a small-is-beautiful, renewable energy technology for electrification that pays homage to the indigenous minds that build it, the empowered communities that use and care for it, and the vibrant watersheds that sustain it.”

Depending on how remote the site is, pico-hydro can be installed within three months, micro-hydro within nine months, and mini-hydro within two years. Components that require time for installation are those that require civil construction, such as weirs, channels, forebay tanks, penstocks, and powerhouses.

The technology is suitable for geographically isolated communities, as most of the system can be built by local communities and, with minimal training, taught how to maintain it. This allows for easier maintenance, while a sense of ownership is created.

The key to the MHP development process is to ensure that processes for scoping and assessing options are developed through a participatory



A typical micro-hydro plant



planning process, including both women and men from the end-user community, and that an environmental, social, and governance risk assessment is conducted.

As such, the technology is inclusive, sustainable and puts people in the center of the planning process. Micro-hydro systems are a bottom-up innovation in energy service design that puts the common people as part of the process and as owners of the system.

The core benefits of MHP:

- MHP contributes to water security for other uses. An uninterrupted flow of rivers ensures remote communities still have access to transportation, fishing, and means of livelihood offered by rivers.
- Nearly all components of the technology can be manufactured in a small town. Local manufacturing results in cost reduction, improved quality, innovation and reliability, local skills development, enhanced livelihoods, and job creation.

- With training, MHP can be maintained by the villagers themselves.
- Battery storage is not required for MHP.
- MHP creates an incentive for forest conservation, as efficient power generation depends on healthy watersheds and catchment areas.

Challenges to MHP development:

The technology's development has been hampered by a lack of investment, poor or non-existent government regulations and policy, and maintenance and scale-up challenges. Governments have favored investment in national grid expansion to the detriment of hard-to-reach areas where this expansion is impractical or impossible. Furthermore, micro-hydro expertise that was built up over decades has been lost in recent years with the shift to solar power generation. Furthermore:

- MHP plants are site-specific, and not suitable for every location;

- limited technical know-how might impede development;
- as the technology requires no reservoir, electricity generation is highly dependent on constant and sufficient streamflow, which might not be possible year-round, resulting in less power output; and,
- though minimal, any ecological impact of MHP still needs consideration before development starts.

MHP case studies

MHP has been successfully deployed at scale in Afghanistan, Indonesia, Myanmar, Nepal, and other locations with rural, hard-to-reach populations to supply off-grid or micro-grid power, thanks in large part to local entrepreneurs.

Case study: Installing pico-hydro plants for power supply in rural northeast India

The Nagaland Empowerment of People Through Energy Development (NEPeD) implements pico-hydro in the Nagaland region in northeast India, where many villages have access to small rivers and streams. These rivers have enough hydropower potential to meet the electricity demand of the entire state.

NEPeD manufactures and installs pico-hydro systems called Hydrogers (hydro and generator). Their Hydroger Systems are manufactured locally, making them available easily in the region. The low cost, lightweight, accessible operation, and versatile utility of the Hydroger systems have allowed widespread adoption. Besides Nagaland, over 50 units have been installed across northeast India, including Meghalaya, Sikkim, Manipur, Arunachal Pradesh, Maharashtra, and Jammu and Kashmir.



Community members installing the penstock (credit: NEPeD)

NEPeD has also trained more than 50 engineers to oversee and manage the sites' operations. Their skills include the capacity to up-scale the plants in the future. Employing rural engineers and technicians generate income and grow the rural economy. Furthermore, most of the NEPeD's Hydroger installations are owned and managed by the communities after a series of capacity-building exercises, in which the conservation of environmental ideas is deeply ingrained. Each project site is also capacitated and facilitated to evolve its own revenue model.

Read the full case study: [NEPeD Hydrogers in India](https://www.hpnet.org/blog/member-profile-neped-hydrogers-in-ne-india) <https://www.hpnet.org/blog/member-profile-neped-hydrogers-in-ne-india>

Case study: Mini-hydro improves lives at Sarujalik Village in Pakistan

The Sarujalik Village in the Bumburet Valley in northern Pakistan had always remained deprived of basic facilities. With no access to main-grid electricity, they mostly depended on diesel generators. In 2011, the Sarhad Rural Support Program (SRSP) designed and constructed a 200 kW mini-hydro system to be operated by the Sarujalik community. The system was later



A woman from Sarujalik village uses a micro-hydro-powered washing machine. Credit: SRSP

upgraded with the financial support of the EU. The system uses two locally manufactured cross-flow T-15 turbines and costs USD 72,559.70 (PKR 12.84 million).

The Sarujalik mini-hydro system has 592 domestic and 111 commercial connections, providing electricity to almost 6,000 individuals across the valley. The communities that were earlier using candles are now using telephones, refrigerators, and the Internet. One of the results is a considerably lighter workload on local women. Traditional wood-burning stoves have been replaced by more efficient electric cookstoves, and other electric appliances have reduced drudgery from laborious housework. The extra time has allowed women to invest their skills and energy in various other activities such as operating their own shops and designing traditional items for sale.

Read the full case study: <https://www.hpnet.org/blog/category/earth-voices>

Case study: Connecting micro-hydropower generation to the national grid



Syaurebhum community members. Credit: AEPC-RERL

In January of 2018, the Syaurebhum 23 kW micro-hydro system was connected to the national grid in Nuwakot, Nepal, making it the first grid interconnected MHP in the country, and opening the door for other MHP's to follow. This pilot project emerged from a government policy for grid interconnection of MHPs of less than 100kW capacity. The policy attempted to respond to the widespread abandonment of MHPs, which was occurring as the national grid expanded into previously off-grid service areas.

For Nepal, dotted with more than 3000 MHPs aggregating to about 35MW installed capacity, of which about 5MW is now unutilized due to the arrival of the national grid, this interconnection pilot is an important step towards revitalizing defunct MHPs.

Read the full case study: [Impact of practice-to-policy dialogue: Nepal's first grid interconnected micro-hydro project](https://www.hpnet.org/blog/impact-of-practice-to-policy-dialogue-nepals-first-grid-interconnected-micro-hydro-project) (HPNET) <https://www.hpnet.org/blog/impact-of-practice-to-policy-dialogue-nepals-first-grid-interconnected-micro-hydro-project>

Case study: Barpak Rural Electrification in Nepal

In 1991, Barpak Village in Nepal's mountainous Gorkha District was electrified with a 50 kW hydro plant owned and operated by a private developer, Barpak Rural Electrification Pvt. Ltd. Users included two agro-processing mills, a furniture mill, bakery, video parlor to show films and a ropeway for transport. The plant was upgraded to 130 kW in 2004, providing continuous and affordable electricity to well over 1,000 households as well as businesses in Barpak and adjoining villages. The plant now also powers a cybercafé, mobile tower, and cable television. The area (and power plant) suffered severe damages when a 7.8 magnitude earthquake hit in 2015. At the time, Jit Bahadur Ghale, owner of the village hardware store and local representative of the Nepali Congress Party, commented that four things were required for repairs: "people, power, roads, and bank." In 2018, the hydropower system was rehabilitated and upgraded to 500-kilowatt. Potential new developments with the upgrade included a cold storage plant for vegetables, a milk-chilling unit, a nettle powder-processing plant, a Lokta paper factory, and other tourism-related services, including a water purification plant.



Barpak Village, Nepal. Credit: Hydro Concern Pvt. Ltd.

Source: [Nepali Times, Builders of Barpak, Energypedia](https://www.google.com/url?q=https://archive.nepalitimes.com/article/nation/builders-of-Barpak,3185&sa=D&source=docs&ust=1639577189289000&usg=AOvVaw3-dwjzYP5pw_7LyE5umd0u), https://www.google.com/url?q=https://archive.nepalitimes.com/article/nation/builders-of-Barpak,3185&sa=D&source=docs&ust=1639577189289000&usg=AOvVaw3-dwjzYP5pw_7LyE5umd0u

For more information: [Resilient Enterprise in Nepal, Streamside Chats, HPNET](https://www.hpnet.org/blog/streamside-chats-edition-2-resilient-enterprise-in-nepal) <https://www.hpnet.org/blog/streamside-chats-edition-2-resilient-enterprise-in-nepal>

Benefits of good practice micro-hydro:

Environmental:

- Cleaner fuel for cooking, and concurrent reduction in deforestation, and increase in watershed protection.
- The conservation of free-flowing rivers, local waterways, and biodiversity.
- A construction process and electricity production with minimal impacts on the watercourse and riparian zone.



strong social and environmental license to develop, operate and maintain it.

Economic:

- Forms of investment/ownership that relate to women's empowerment/community development.
- A solution to energy poverty such as small decentralized systems can earn revenue for the village, bringing it out of poverty while generating renewable energy.



Within DRE solutions, micro-hydropower is a cost-effective solution for energy access that has been proven across the globe. Innate characteristics of sustainable MHPs allow for multiple socio-economic and environmental benefits. MHPs can produce economically viable, 24/7 reliable electricity at output capacities that are required for applications of productive end-use, reducing drudgery, and feeding electricity into the main grid. Several components can be built locally, creating local skills-building and jobs. MHPs provide an added incentive for communities to strengthen the watershed that fuels their MHP.

Social:

- Improved education opportunities due to lighting, and more time for school and studying since girls, for example, do not have to collect firewood.
- Entertainment and capacity to connect, due to access to the internet, mobile phones, and television.
- The participatory nature of the process means that that technology is understood and managed within the community (including women) and there is a



3. Recommendations and principles for MHP

3.1 Participation is key

The role of communities must be strengthened throughout the energy supply chain, from the design to installation and maintenance. The key principle in a successful development process is participation, to result in long-lasting, equitable, inclusive, and transformative change in the energy transition.

Communities including women and Indigenous Peoples must be directly included and involved during every stage of the energy planning process. The development of community-led micro-hydro projects has proven to be sustainable and reliable, including empowering women and youth.

Planning should be based on demand, driven by the consumers (communities).

3.2 Strengthen data and knowledge exchange

There is a need for a dynamic database that includes information on the performance of MHP. Data on performance are necessary to identify underlying reasons for possible sub-optimal performance. Data on the functionality of projects would help government stakeholders to improve policies.

Since project feasibility and generation capacity is informed by minimum water flows, datasets on water flows would help to assess the viability of future projects.



Data across community-scale hydro projects must be disaggregated, classified by size, grid and no-grid. Pico should not be grouped with mini-hydro, for example.

Integrated energy planning must be applied, during which data on all DRE options in an area is collected and mapped, and their trade-offs explained to the community, before deciding on the most appropriate technology. As most national energy planning efforts funded by donors focus on mapping solar, there must be a mandate to include an accurate analysis of MHP and other technologies.

3.3 Community-scale hydro must be integrated into national electrification planning

In most countries, DRE solutions are not integrated into national planning and instead are used as temporary solutions until the main grid can reach communities. The main grid is most commonly powered by fossil fuels or destructive hydropower. Without integration of all DRE solutions in national planning, the energy transition to renewables will not be completed.

Awareness must be built among

all stakeholders of all forms of DRE solutions, to enable them to assess which solution makes the most sense for their context. To integrate pico- and micro-hydro into national planning, community-based organizations and energy access practitioners must be equal partners in the decision-making process.

3.4 Productive end-use, business models, and financing

Standalone MHPs (especially pico-micro projects) that cater to small loads are not financially sustainable. Such projects are likely to shut down upon grid arrival unless these have productive end-use. Therefore, all these projects should have technological provisions/compatibility for grid connectivity. However, processes for grid connectivity are protracted and cumbersome which should be simplified and streamlined. As such:

Information on successful pico-micro projects with good productive end-use must be collated. This can be scaled up by documenting each state for country-wide advancement.

Successful case studies that are grid-connected that have a

profitable, productive end-user needs to be endorsed by the government as well as NGOs.

Sustainability invariably stems from viable business models that are executed by private players. These models will have to cater to productive end-use and accessible sources of viable finance such as rural banks.

3.5 Community-based hydro must be integrated with reforestation

Building resilient watersheds are key for communities to sustain and regulate stream flow, secure clean drinking and sanitation water, as well as forest resources that could support sustainable rural development. Healthy watersheds are the foundation to sustainable community-based hydropower that is also highly beneficial socio-economically. Maintaining and establishing mature forest cover alleviates the impacts of seasonal variability in flow, reduces landslide risks, and can help build resilience against the impacts of climate change. The potential for the communities to access stable sources of electricity provides communities with hydropower an added incentive to protect their watersheds.

Further information

- Status of SD7: <https://unstats.un.org/sdgs/report/2016/goal-07/>
- Why the SDG7 matters: <https://www.unep.org/explore-topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-7>
- The Global Energy Progress Report: <https://www.who.int/news/item/07-06-2021-global-launch-tracking-sdg7-the-energy-progress-report>
- Renewable Energy Development driven by Indigenous Peoples: <https://www.who.int/news/item/07-06-2021-global-launch-tracking-sdg7-the-energy-progress-report>
- On why protecting rivers is important (Rivers4Recovery): <https://www.internationalrivers.org/resources/reports-and-publications/rivers-for-recovery-protecting-rivers-and-rights-essential-for-a-just-and-green-recovery/>
- For more information on why community-based hydro must be integrated with reforestation: <https://www.hpnet.org/blog/why-watersheds-matter>

