Lighting up the Hills—Ballimusti

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Bringing electricity to the remote and difficult terrain of Ballimusti village by creating micro hydro projects using the available water resources in the area has transformed the darkness in the lives of the villagers and liberated them from depending on the meagre supply of kerosene to light their lamps.

Kandheri Mallika is in a hurry. She is rushing through her household chores to watch a new movie on the television with her friends. Life is not the same for Kandheri, who lives with her husband and children in a two-room house in Ballimusti, a small forest-fringe village, which is set amid the beautiful landscape of streams and trees. There was a time, not very long ago, when this scenic tranquillity would be enveloped in shadows when it started to get dark in the evenings. Life would come to a halt and the only light in the homes would be from the kerosene lamps, and that too for an hour or so while the children studied; then there would be complete darkness.

Kandheri talks about how her life was so dependent on kerosene, "I would walk 12 km to get a litre of kerosene from the market and that would take me the whole day. I had a BPL card, which entitled me to subsidized 5 litres of kerosene that lit up my home in the night. I used to spend Rs 150–200 per month only on kerosene. My children would study in the evening so they needed the light but then we would remain in darkness throughout the night to save oil and expenses.

"Now, we have electricity in the village. The scenario has changed. We can light up our houses the whole night almost for free and there is no need to buy kerosene. I can now use the money I save on my children—for their education and to buy them clothes. Recently, the school teacher in the village, Mrs. Priyatama Pradhan, started giving evening tuitions and my children go there to study.

"Having electricity in my house has also helped me do all my chores easily and quickly. After I complete my work and have my dinner, the other women in the village and I watch television. It is so joyous to watch television with everyone. Our village seems crowded even at night only because we have electricity. We hold important meetings in the night because everyone is free at that time to leave their homes. We no longer fear the night and move freely from one hamlet to another because the street lights are on through the night. These lights have not only lit up our village but have also lit up our lives."

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THE INITIATIVE

In 2011, the PRADAN team received an invitation from Odisha Tribal Empowerment and Livelihood Programme (OTELP) to initiate a hydro-water project in Balliguda block, where the team was already working. The proposal was to electrify remote villages in the operational area, where there was no electricity and also no chance of electrification in the near future, due to the remoteness of the villages and the difficult terrain.

A micro hydro project (Pico Hydro Water) for generating electricity was possible because there was perennial flow of water in the streams and rivers of the area. This was a new initiative for PRADAN and because OTELP was supporting it, the PRADAN team accepted the proposal.

OTELP then invited Practical Action, an international organization that works alongside communities to find practical solutions to the challenges they face by developing appropriate technologies in renewable energy, food production, agro-processing, sustainable transport, water, sanitation, small enterprise development, building and shelter, climate change adaptation and disaster risk reduction. Officials and engineers of the organization visited the field for a feasibility study. Engineers from Sri Lanka and Bhubaneshwar also came to Balliguda, to explore and discuss possibilities.

The terms and conditions for selecting the site were:

- A perennial source of water flow with a velocity of 100 litres per second
- A vertical drop of 100 m within a horizontal distance of 1,000 m
- There must be no electricity provision before the implementation of the Total Energy Access (TEA) and not even an opportunity for electricity supply from the government agencies in the near future.
- The community must agree to contribute their labour and locally available material so that they have a stake in the programme.
- The community must agree to implement and take care of the project for sustainability.

It was difficult to find a village that would meet all these requirements. Ballimusti, which is situated almost 30 km in the interior south-west of Balliguda, seemed to be the ideal spot. Looking at the terrain, the officials figured that they could install a small-scale Pico or Micro Hydro project as well as set up other energy saving or generating activities from renewable sources here, under the TEA programme.

Thus, PRADAN, Practical Action and OTELP agreed to collaborate on this venture.

PRADAN facilitated a meeting of the villagers, OTELP and Practical Action officials. Discussions were held about whether the villagers needed electricity for their village and for each home in the village;and would the villagers be willing to support such a project, in which power would be generated from the natural resources of their own village.

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The villagers spoke of the difficulties they faced due to the lack of power in their village and how it affected their lives. They shared how they lived in complete darkness at night when there was no power and no light. The availability of kerosene oil (from the PDS) was also very limited. The monthly entitlement was barely enough to light their rooms in the evening for an hour or so. Purchasing kerosene from the open market was very costly and, sometimes, it was not available. The village was surrounded by the forest and there was fear of wild animals attacking after dark. Sometimes, they used firewood to light their village and houses for security, but that was very dangerous because it could cause a fire. The community found the idea of generating electricity interesting and was eager to work on it.

What is Pico Hydro?

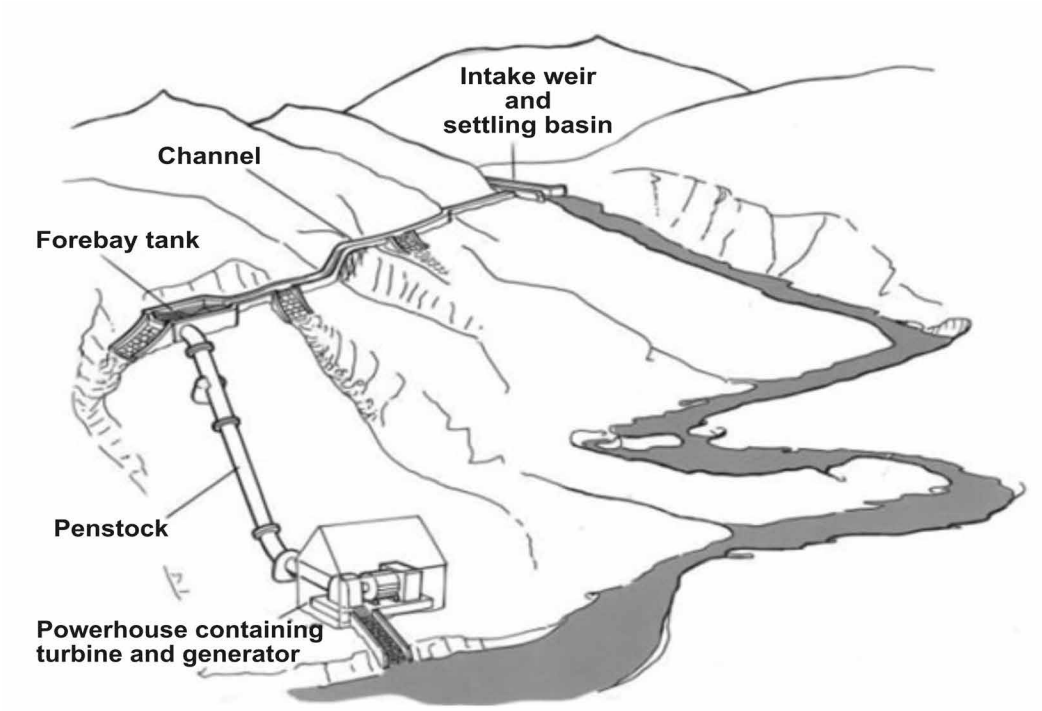
Pico Hydro is hydro power with a maximum electrical output of 5 KW. Hydro-power systems of this size benefit small communities because of the low cost and simplicity of installation. They are different in design, planning and installation than the larger hydro-power projects. Recent innovations in Pico Hydro technology have made it an economically viable source of power in some of the world's poorest and most inaccessible places. It is also a versatile power source. The AC electricity can be produced enabling standard electrical appliances to be used and the electricity can be distributed to a whole village. Common examples of devices that can be powered by Pico Hydro are light bulbs, radios, televisions, refrigerators and food processors. Mechanical power can be utilized with some changes to the design. This is useful for driving of machinery such as workshop tools, grain mills and other agro-processing equipment.

Principle of Pico Hydro

Pico Hydro works on the principle of generating electricity from the force of water flowing down a slope. The water from the source is diverted down a pipe, called the penstock, to fall through a vertical height, or head, in order to gather energy. The lower end of the penstock is attached to a turbine that is turned by the energy of the falling water. The diagram shows a typical hydro water scheme. The water from the stream or river is chanelled to a tank and then released downhill through a pipe, or penstock. The pressure of the flowing water on the turbine blades causes the shaft to rotate. The shaft is connected to a motor. As the turbine and the shaft rotate, the motor rotates automatically, resulting in the generation of power/electricity. The amount of energy available is directly related to the volume of water flowing down the penstock and the height from which it falls. The greater the volume of water the height, the more energy harnessed.

A Pico Hydro can be installed if there is a perennial water flow (with a minimum flow of 20 litres per second or more) in a gradient or slope with a minimum drop of 20 m and within a maximum distance of 500 m.

Figure 1: Pico Hydro Power System



THE SURVEY

When the PRADAN and Practical Action teams reached Ballimusti for the survey, the community showed us the *luddu* (the mountain stream/a small waterfall) with great excitement. We used GPS (Global Positioning System) navigation to survey the site and assess its suitability. GPS is a navigation tool by which we can find the longitude and latitude of a point on Earth and also its altitude to calculate the slope and elevation difference).

As per the findings from the survey, the vertical difference between the upper and the lower points of the water stream was 30 m. Also, the water flow was calculated at 50 litres per second (lps). The problem, however, was that to achieve a 30 m head difference, we needed to cover a distance of around 580 m. This increased the cost (pipes, fittings, plumber, labour, etc.), which the community was to contribute. When we shared this with the villagers, they at once agreed to contribute their labour and do the work. So the project was considered feasible with minimum allocation.

Calculating the Hydro Power

The amount of power that can be provided by the stream depends on two factors called the head and the flow.

1. The head, measured in metres, is the vertical drop/difference in height from the top of the penstock to the bottom. The greater this drop, the greater the power and the higher the speed of the turbine.
2. The flow measured is the amount of water flowing in litres per second (lps)

The power is calculated by multiplying the head and the flow by the force of gravity.

Hydro Power = Head x Flow x Gravity

As per the survey

Head = 30 m

Water flow = 50 lps

Hydro Power = 30 x 50 x 9.81

= 14,715 watt

= 14.7 KW

Considering the turbine efficiency (≈ 0.54), the available power may be

Power = 14.7 x 0.54 = 7.94 KW

After deducting the dissipation loss of 10 per cent, the net available power calculated was 6 KW.

Installing the Pico Hydro System

After the survey and feasibility report, the operational guidelines for the implementation were finalized.

PRADAN was to be the facilitating NGO (FNGO) with the major role of mobilizing the community and capacity building of the village-level institution—the Alok Path Jala Vidyut Committee.

Practical Action was to provide the technical assistance during the implementation and was to be one of the major funding agencies.

OTELP was a support institution that would bear a part of the project implementation cost and would provide the administrative support to FNGO.

For a better understanding of the work involved, we organized an exposure visit for the villagers to Karnibel in Kalahandi, where Practical Action, in association with Gram Vikas, had already implemented such a project, with the financial support from OTELP. The exposure visit was significant in terms of building confidence among the community. The villagers were convinced that such an initiative was possible and they also observed how the community in Kanibel had carried out the task.

After the exposure visit, a meeting was held in the village. Discussions and meetings were subsequently conducted on a regular basis for the quick and smooth implementation of the micro hydro project. The villagers agreed to form a new committee to monitor the project and maintain financial records. The committee was named Alok Path Jal Vidyut Committee (APJVC), Ballimusti. A bank account was opened in the name of the committee.

The committee comprised 13 Board Members, selected during the village meeting. The provision of the funds was to be from OTELP, Practical Action and some contribution from the community itself. The total project cost was estimated at Rs 13 lakhs, which included raw material for the construction of the super structures, the turbine, motor, pipes, electric fittings, wires, household-level electrical appliances, mason, plumber, mechanic cost, a part of the labour cost, transportation, etc. The community contributed Rs 2.85 lakhs in terms of labour and in supplying the locally available raw material for the construction. They collected sand and stone, and made bricks and metal chips in the village.

The committee took the responsibility for the timely completion of the project and for complying with day-to-day issues during the implementation of the project. The committee

also took charge of mobilizing and facilitating the community. It met fortnightly to take decisions regarding implementation, payment and other project-related issues. The programme was totally managed by the community and its members, wherein they took charge of the implementation, decision-making, future governance system and of the smooth distribution of power.

People took charge of their respective tasks. There were rocks in the springs, which were a hurdle and also affected the flow of water. The committee took the responsibility of cutting the rock, to allow the water to flow in a maintained slope from the forebay tank to the powerhouse through the penstock. Women, as usual, took the maximum responsibility, collecting sand from the river bed, breaking stones and metal into chips and placing these on the side of the fountain, luddu.

Gradually, the work began with the construction of a diversion check dam, fore-bay tank, penstock line, the laying of PVC pipes, construction of the power house, etc. The turbine was made at Bhawanipatna by a local designer, under the guidance of Practical Action professionals. The programme took almost 18 months to complete. However, every day brought a new challenge. There was no road to the village; the villagers carried the material from Baulimaha, a nearby hamlet, where the lorry would unload the material, to their village—a big task. All material such as cement, rods, pipes, electric fittings and appliances was carried by the villagers to the workplace, which was about 3–4 km from the unloading point.

All the hard work was worth it when the turbine started to rotate around the shaft by the force and pressure of the water

The villagers then decided to make a track from the village to the powerhouse so the material could be unloaded at the site itself. The length of the road constructed was approximately 1 km. The construction of the road was a big relief and reduced the distance of the dissipation line.

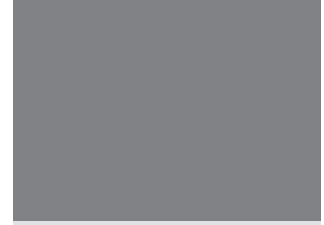
Along with the turbine, all other electrical fittings were purchased and installed by the community with support from the experts. To reduce the cost, wooden poles were made from the community managed forest.

All the hard work was worth it when the turbine started to rotate around the shaft by the force and pressure of the water, which rushed through the nozzle and caused the motor to run. It showed its signal strength with red, orange and green coloured lights. The village was illuminated. It was a joy to see the whole village dancing and playing drums. This was their victory over darkness and it was a well-deserved celebration.

Training on the construction of the structures, canals, pipe-line laying, electric wire-laying at the house-hold level and operating the turbine was conducted by Practical Action professionals and PRADAN jointly.

THE OPERATING SYSTEM

The community now manages the operating system. Two persons were identified during the implementation stage and trained in the basic operation of the hydro project. The task of the person involves opening the valve for water flow to the turbine and to close the valve to stop the motor form working. The system is managed by the APJVC.



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The committee decided to collect a monthly electricity charge from the community and keep the amount in the APJVC bank account. The corpus would be utilized for maintenance purposes.

The village has 27 households, and the nearby hamlet, Kadamahal has 25 households. All together now 52 households are electrified for 24 x 7 x 365 through the Pico Hydro project. For even distribution to each household, there is an individual and central control system that automatically cuts off the power if any one household consumes more than the desired load. The load per household has been calculated as per the net power availability after deduction of the dissipation losses.

Level of Power Consumption	Particulars	Approximate Load Required	Utility
Household level	2 lights x 14 Watts 1 light x 9 Watts 1 charging point	45 Watts per HH x 52 hh = 2,340 Watts or 2.3 KW	Lighting the houses, including the kitchen and the verandah in the evening. Charging of mobile phones and small charge torchlights.
Village level	7 street lights x 23 Watts	161 Watts per village	Lighting the village street
Community level (well-being and livelihood prospectus)	2 leaf plate pressing machines x 1,500 Watts 1 rice huller machine x 1,500 Watts	4,500 Watts or 4.5 KW	Production of value-added buffet plates made of siali leaves. De-husking of rice
Community level (well-being only)	1 television with DTH	200 Watts	For entertainment and information