# Chapter 5
# A Comprehensive Review on Projects Carried Out by RuTAG Centre IIT Roorkee

**R. P. Saini, S. K. Singal, Imtiyaz Ali and Ramesh Chandra Joshi**

## 1 Introduction

In order to develop the technological interventions using available human and natural resources for the critical needs of rural occupational groups, Rural Technology Action Group (RuTAG) at AHEC, IIT Roorkee is attempting to provide necessary synergy and technical support to nongovernment or voluntary organizations since its inception in January, 2010. Additionally, RuTAG established network with different centers of excellence, research institutes, and PSU's involved in creating sustainable rural technology. It also provides the facilities for testing and quality control, support in downsizing, strengthening, and upgrading the existing technologies for their nucleation into new initiatives [1]. A number of technological interventions have been carried out for the benefit of rural occupational groups (farmers, artisans landless poor and traders) of Uttarakhand, Himachal Pradesh and Jammu & Kashmir with the support of Government of India. RuTAG IIT Roorkee centre is trying to achieve its objectives through methodology which is given by flow chart as shown in Fig. 1.

A number of projects have been proposed by RuTAG, IIT Roorkee in consultation with participating NGO. Under the present study, an attempt has been made to review the progress on various projects being undertaken by the centre since its inception.

## 2 Identified Project Proposals

Following the methodology as shown earlier in Fig. 1, several projects proposals have been made to develop sustainable rural technology using available human and natural resources for the critical needs of rural occupational groups. The list of identified project proposals is given as follows:

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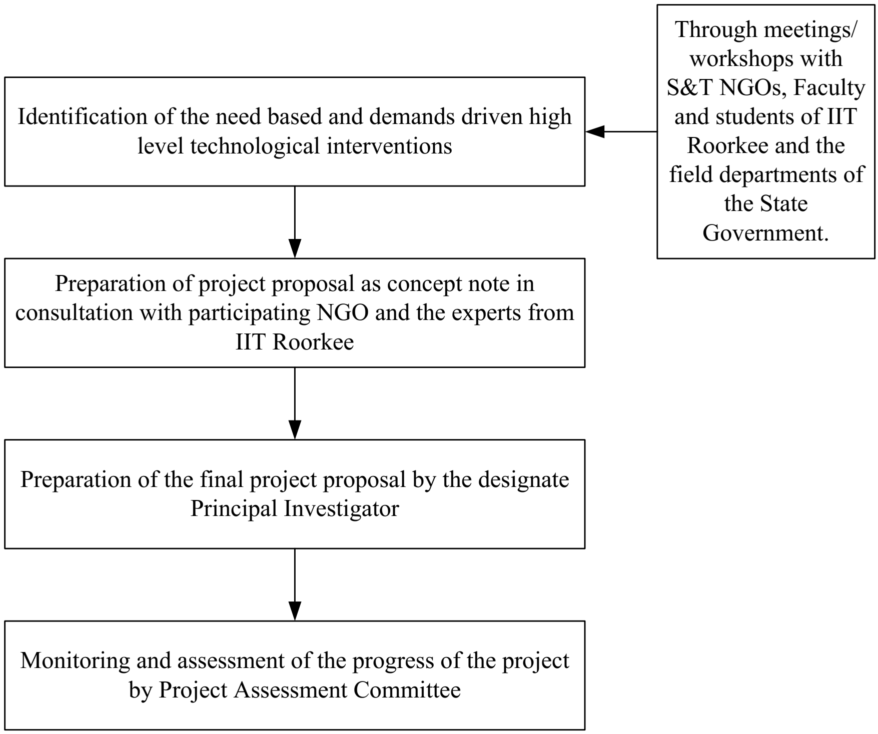


**Fig. 1** Flow chart of methodology adopted by RuTAG

i. Modified Bageshwari Wool Charkha
ii. Development of a Mechanized Roller for Felt Making
iii. Modified Pump used as Turbine for Pico Hydro
iv. Development of a Gravity-Based Ropeway
v. Development of Solar Energy Based Efficient Plant for Preparing Turpentine Oil and Rosin from Pine Resin
vi. Development of Cold Storage powered by Pico Hydro Power

A brief discussion on these projects is given in the following sections.

### *2.1 Modified Bageshwari Wool Charkha*

Spinning of locally grown wool using drop spindle and foot-operated charkha is a traditional occupation of people of Himalayas. This helps in utilizing wool for weaving fabric for local use and sale [2]. A traditional Bageshwari charkha was incapable to spin sufficient quantity of wool because of more physical work involved [3]. Various surveys were done by RuTAG IIT Roorkee team in various districts of Uttarakhand

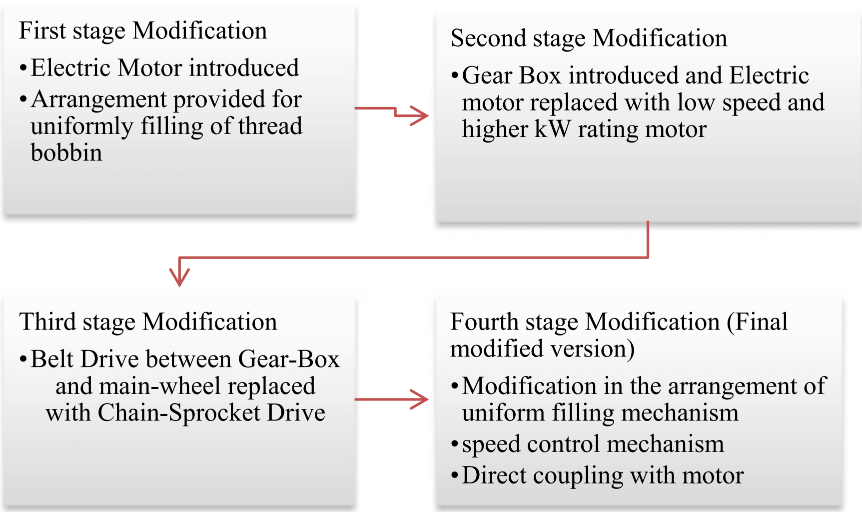


**Fig. 2** Different phases of modification for traditional Bageshwari charkha

during March 25–27, 2011. Based on the survey and interacted with people living in the adjoining villages, it was reported that more than 60000 families are involved in hand spinning and weaving in Uttarakhand state. All families were using traditional Bageshwari charkha which has several shortcomings such as nonuniform filling of bobbin, nonuniform thickness thread of yarn, manually operated and low productivity were identified on the basis of feedback given by the operators. In order to eliminate the shortcomings, a traditional Bageshwari charkha was modified in four phases. Modification in each phase is shown in Fig. 2. Traditional Bageshwari charkha was upgraded by introducing foot operated electrical motor, speed controller, modified flyer and a crank for lateral motion of bobbin. Moreover, wooden frame has been replaced by light weight steel pipe which facilitates in easy assembling and disassembling for easy carrying in remote area. Figure 3 shows the schematic of modified Bageshwari wool charkha.

In order to assess the performance of modified Bageshwari wool charkha, wool was spun by experienced spinners hailing from Uttarakhand, and their comments were also examined. During the test, various parameters were observed such as weight and length of yarn, time taken to spin different wool types, and performance of spinning wheel. Based on the measurements a comparison was made to assess the performance of improved Charkha with traditional charkha by spinning different types of wool (Local-Tibetan and Tibetan-56). Spun wool was also tested at Wool Research Association Textile (WRAT) Lab, Government of India. Based on the results of test conducted at RuTAG, IIT Roorkee and WRA (Wool Research Association) Lab, Thane (Maharashtra), it is concluded that the results of modified Charkha are promising.

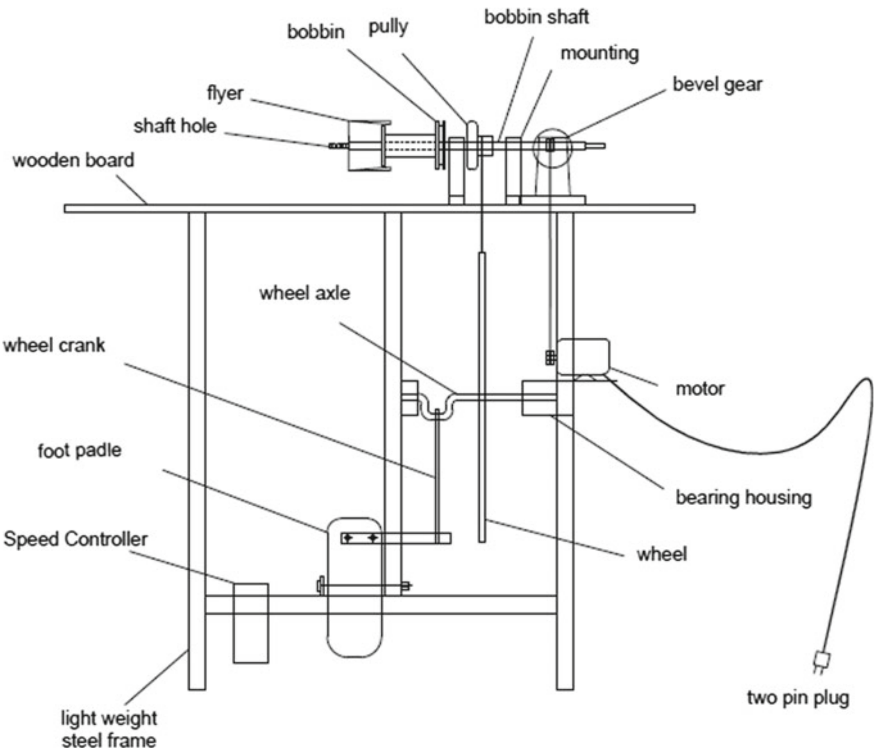


**Fig. 3** Schematic of modified Bageshwari wool charkha

In order to observe the performance of the modified Bageshwari Wool Charkha in field, five sets of Charkha were fabricated and distributed in the field. Photograph of modified Bageshwari Wool Charkha is shown in Fig. 4. A training program was also organized by RuTAG IIT Roorkee centre for the local users in association with various NGOs between May 24–30, 2016.

## *2.2 Development of a Mechanized Roller for Felt Making*

The felt is a nonwoven woolen fabric that is produced by hand matting, condensing, and pressing woolen fibers. It has wide range of applications such as bed and floor spreads, cushion covers, sofa covers, and yoga mats, meditation mats etc. [4]. Woolen felt is made in the states of J&K, Himachal Pradesh, Uttarakhand, and Rajasthan as a part of the household industry. It provides employment to a large number of people. Since there is no need to spin and weave, felting is easier in making and less time consuming. At present, felt is produced by rolling the roller by feet, as shown in Fig. 5. The hill areas have a ready market for woolen felt as winters are cold and

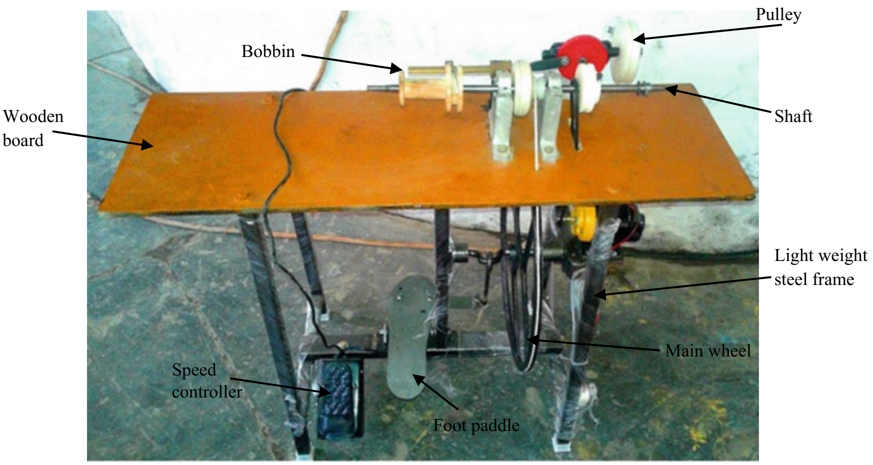


**Fig. 4** Photograph of modified Bageshwari wool charkha

**Fig. 5** Rolling the roller by feet during felt production [5]

woolen fabric is needed in each household. Felt is preferred over woven material as it is easy to make and does not require spinning and weaving. However, rolling of felt needs intensive labor while using feet and applying physical pressure on felt under making. Thus, in order to reduce applied physical pressure on felt during making of hand crafted woolen felt, a mechanized roller was developed which could move with hand while taking walking on the floor.

**Fig. 6** Mechanized rolling devices

A mechanized rolling device for making woolen felt was initiated at RuTAG, IIT Roorkee in mid of August 2015. The basic rolling structure has a set of two rollers, which would be pulled and pushed over a distance. The smaller roller would have wool rolled over it on canvass sheet as commonly practiced. The second roller (larger one) is used for energizing a small beater or weight drop on wool and also to add rolling support to the main rolling cylinder. The cylinders are made of stainless steel and mild steel light weight pipes. The rollers rolled the woolen material tightly and uniformly in felting mat. The mechanized roller felt machine can be used for all felting applications such as heavy rugs to feather-weight scarves, laminated or Nuno felt. Technical specification of mechanized rolling devices which are shown in Fig. 6, are given in Table 1.

Complete processing for making felt using mechanized rolling devices is shown with the help of photographs in Fig. 7. The term "Namda" shown in Fig. 7 is the local name (Some areas of Uttarakhand, Himachal Pradesh and Jammu & Kashmir) of the decorated felt sheet.

### *2.3 Modified Pump Used as Turbine for Pico Hydro*

Micro hydro power projects use available small water stream of water and do not contribute to environment damage, offering decentralized electrification at a low running cost and with long life. There are several potential sites of Pico hydro available in hilly regions. Currently, modified water mills and cross-flow turbines are being used for Pico hydro power plants. The capital cost for such plants is relatively high due

**Table 1** Technical specification of mechanized rolling device

| Sr. No. | Accessories | Dimension (mm) |
|---|---|---|
| 1. | Roller 1 | Diameter—216 mm, Length—855 mm |
| 2. | Roller 2 | Diameter—110 mm, Length—855 mm, Thickness—4.5 mm |
| 3. | Roller 2 cutting size | Width—25 mm, Length—752 mm |
| 4. | Bearing bracket | Diameter—80 mm (FL 206) |
| 5. | Handle | Diameter—25 mm, Length—1613 mm, Width—1200 mm |
| 6. | Bearing shaft of roller 1 | Diameter—29 mm, Length—1235 mm |
| 7. | Bearing shaft of roller 2 | Diameter—29 mm, Length—1235 mm |
| 8. | Channel | Width—105 mm, Length—435 mm |
| 9. | Rod | Diameter—10 mm, Length—1340 mm |
| 10. | Hexagon bolt | Diameter—15 mm, Length—60 mm |


**Fig. 7** Complete processing for making felt using mechanized rolling devices [6, 7]

to high equipment cost when compared with the small amount of power generation possible which is a constraint in the development of such a scheme. As turbines are site-specific, nonavailability of turbines is the major problem to exploit this potential. Using commercially available pump in turbine mode is one of the cheap and attractive alternatives for Pico-hydro generation. The research on using pumps as turbine (PAT) was started around the year 1930 when Thoma presented the first published work regarding pumps running in abnormal conditions [8]. In centrifugal pump, the fluid enters at suction side of pump at low pressure and gets energized by the shaft energy of impeller which is rotated by some external means and leaves the water at discharge side of the pump at high pressure. Whereas in case of PAT, the pump operates in reverse mode, i.e., water enters in the pump at very high pressure and moves through the impeller blades and releases its pressure and kinetic energy to the impeller shaft as mechanical energy and fluid comes out from the eye of pump at low pressure energy. In the reverse operation of pump it may be less efficient because the direction of flow is reverse and hydraulic and frictional loses increases sharply.

Based on earlier studies [9, 10], it was found that the poor part load efficiency is the major problem of PAT. In order to improve part load efficiency, RuTAG, IIT Roorkee attempted to modify centrifugal pump used as turbine by providing the guide vanes around the impeller which can be moved according to the flow or load. Testing of modified PAT is shown in Fig. 8.

These modified pumps will be useful in efficient generation of power throughout the year even when discharge in the stream varies significantly. These pumps will also be adapted to wider site parameters rather than just restricted to specific site. The estimated cost of a pump is about 0.5–0.6 lakh for 6 kW of power generation whereas the cost of a complete hydropower generating unit is nearly Rs. 1.25 lakh/kW.

### *2.4 Development of a Gravity-Based Ropeway*

Ropeways had been used for transporting woods from the higher reaches to the roadsides, and less used for the transportation of fruits and vegetables [11]. Keeping in view the tough geographical conditions and to overcome these obstacles, the ropeway technology was developed with support from the office of Principal Scientific Advisor to The Govt. of India, New Delhi. Generally, RuTAG Uttarakhand with the help of the scientists of IIT Roorkee, has provided the technical support for the establishment of gravity-based ropeway. The Department of Industrial and Mechanical Engineering of IIT Roorkee has made improvements and upgraded the traditional ropeway, keeping in view the safety and strength of the ropeway. The modified ropeway system is as shown in Fig. 9.

(a) Installation of PAT at Laboratory

(b) Testing of the pump for Power generation at Laboratory

(c) Testing of the pump for Power generation at Laboratory

**Fig. 8** Assembly and testing of pump as turbine [5, 6]

## *2.5 Development of Solar Energy Based Turpentine Oil Plant*

Pine Resin is available throughout the year in different places of the Uttarakhand, Himachal Pradesh, and J&K states. Turpentine is a fluid obtained by the complex distillation of pine resin. Resin obtained from trees contains 70% rosin and 14% turpentine oil which are widely used in the paper, soap, chemical, and paint industry as a solvent or thinner [13]. Thus, processing of resin is an important livelihood opportunity for the rural population at present in Uttarakhand. There are hundreds of resin-based industries in the State.

In order to obtain turpentine oil and rosin in plants, resin is processed in large containers at high temperature of at 180–200 °C. In the existing plant as shown in Fig. 10, wood is used as fuel for processing the resin. In addition to this, the equipment used in processing is energy efficient and crude in nature. Use of excessive wood

**Fig. 9** Gravity-based ropeway [12]

causes air pollution, and falling of trees causes degradation of forest area. Also, distillation process is becoming expensive due to the increasing cost of wood.

In order to bring down the requirement of wood fuel, it is essential to look into the viability of processing resin using locally available renewable energy sources, e.g., solar energy. Therefore, the objective of this project is to develop a solar energy based efficient plant with proper instrumentation to obtain a better and assured quality product. Schematic of solar energy based plant is shown in Fig. 11. A small-scale model of solar energy based turpentine oil extraction unit has been set up as shown in Fig. 12 using solar power heater as well-efficient woodstoves and experiments have also been conducted. The performance of the plant is continuously monitored under different parameters for improving the efficiency of modified turpentine oil plant.

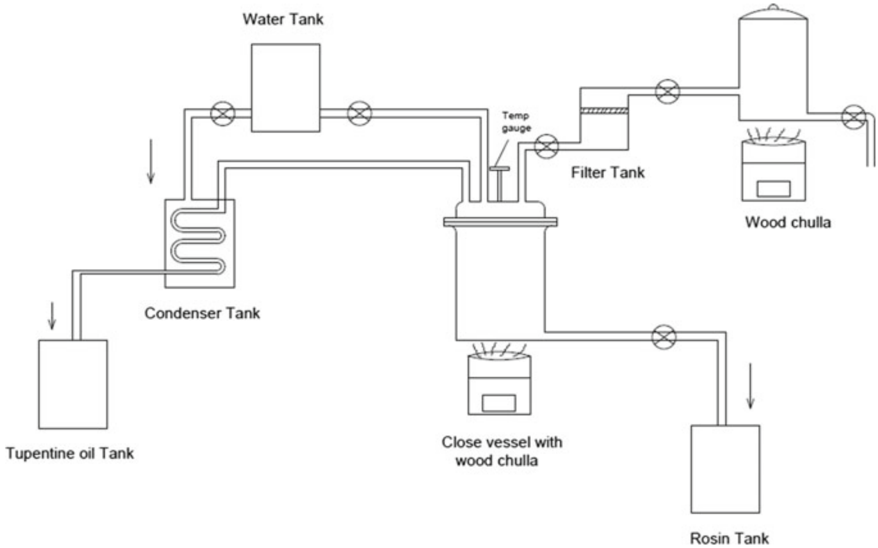


**Fig. 10** Schematic of existing turpentine oil plant

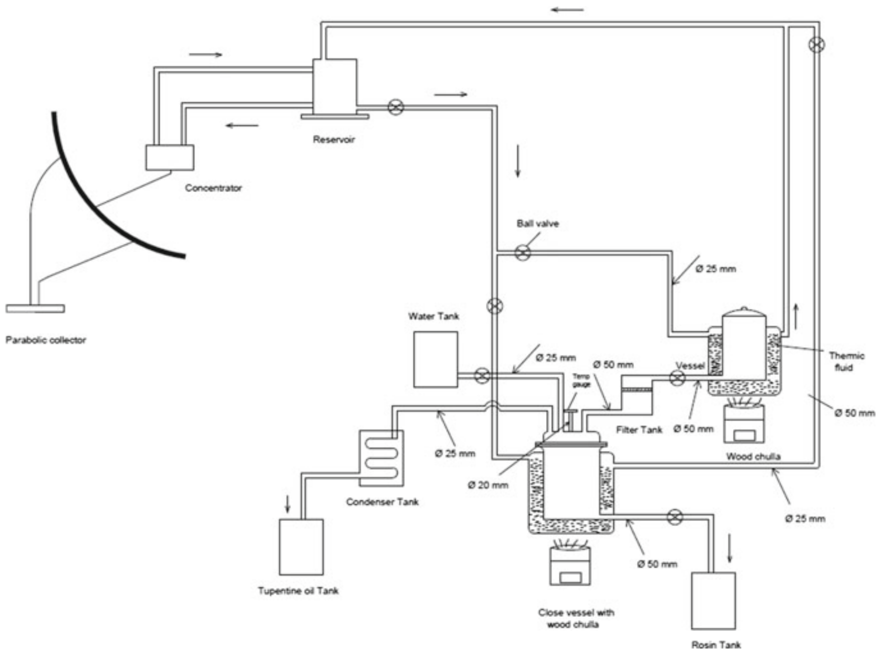


**Fig. 11** Schematic of solar energy based turpentine oil plant


**Fig. 12** Experimental setup of solar energy based turpentine oil extraction unit [14]

### *2.6 Development of Cold Storage Powered by Pico Hydro Power*

The Himalayan region is endowed with waterfalls, and rivers flowing down the hills. These water resources provide immense opportunities in the generation of small hydropower for infrastructural development and creating new and additional livelihoods for local people [15]. Pico hydropower (5 kW and below) generation can be used as highly remunerative power source for energizing chain of cold storage units for creating much-needed facilities for storage of off-season vegetable and fruits.

The objective of the project concept is to develop an integrated hydro power cold storage unit where the energy is used for storage of perishable goods, locally grown as well as imported goods from other areas, for local people to earn remunerative price. The excess power of the hydropower can also be used in energizing cottage industry and food processing unit to enhance earnings for local employment, providing services to local area, and making integrated hydropower cold storage a sustainable unit. Schematic of cold storage powered by Pico hydro power is shown in Fig. 13.

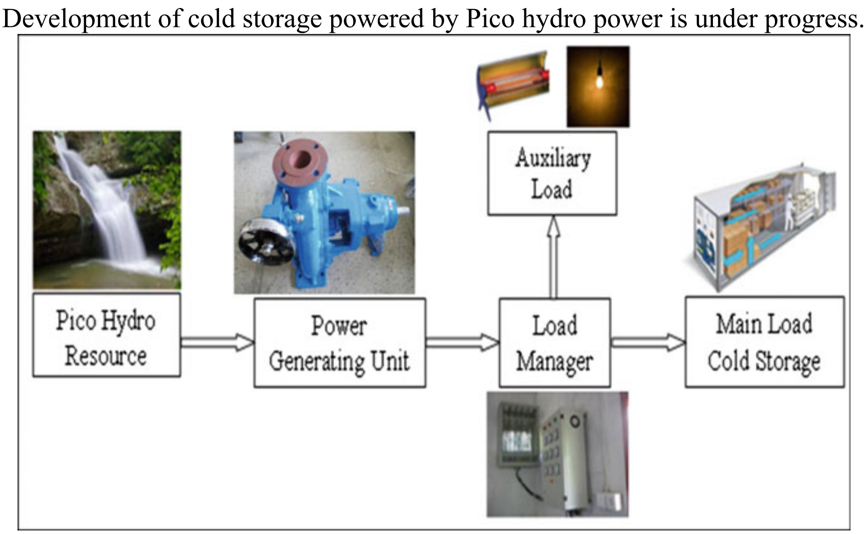


**Fig. 13** Schematic of cold storage powered by Pico hydro power

## 3 Conclusion

Since its inception in 2010, Rural Technology Action Group (RuTAG) at AHEC, IIT Roorkee has identified six projects in which technological interventions are carried out. Under this paper, the projects namely modified Bageshwari Charkha, development of a mechanized roller for felt making, modified pump used as turbine for Pico hydro, development of a gravity-based ropeway, development of solar energy based efficient plant for preparing turpentine oil and rosin from pine resin and development of cold storage powered by Pico hydro power are discussed in details. The modifications or upgradations in the existing projects were proposed on the basis of feedback of rural occupational groups. After modifying, a lab testing at AHEC and demonstration of the technologies at the site has been carried out to assess the performance. Training programs/workshops by RuTAG were also conducted to demonstrate the functioning of modified technologies under different projects. In future, the solar-powered batteries can be used for drive the motor in modified Bageshwer charkha whereas the large scale rollers can be used for making larger size felt in felt making machine.

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## References


1. Concept of RuTAG: The Office of the Principal Scientific Adviser (2017). https://www.google.co.in/search?q=rutag&oq=rutag&aqs=chrome..69i57j35i39j0l4.2120j0j7&sourceid=chrome&ie=UTF-8. Accessed 12 Mar 2017
2. Mehta GS (1996) Uttarakhand, prospects of development. Indus Publishing Company New Delhi, New Delhi
3. Mudgal R (1996) Economic dimensions of rural development. Sarup & Sons Publication, New Delhi
4. Thompson C (2011) Felt: Fluxus, Joseph Beuys, and the Dalai Lama. University of Minnesota Press
5. RuTAG (IIT Roorkee) at a Glance for the state of Uttarakand and Himachal Pradesh. Roorkee (2016). Accessed 12 Mar 2017
6. http://www.ahec.org.in/RuTAG/projects.html (2017). http://www.ahec.org.in/RuTAG/charkha_img.pdf. Accessed 12 Mar 2017
7. http://www.ahec.org.in/RuTAG/index.html (2018). http://www.ahec.org.in/RuTAG/charkha_img.pdf. Accessed 12 Mar 2017
8. Thoma D, Kittredge C (1931) Centrifugal pumps operated under abnormal conditions. Power 881–884
9. Sharma K (1985) Small hydroelectric project-use of centrifugal pumps as turbines. Technical Report, Kirloskar Electric Co. Bangalore, India
10. Ramos H, Borga A (1999) Pump as turbine: an unconventional solution to energy production. Urban Water 1:261–263
11. Aryal S, Giri S (2011) Gravity ropeway and tuin technology: an alternative transportation. Hydro Nepal 9
12. http://www.ahec.org.in/RuTAG/projects.html (2017). http://www.ahec.org.in/RuTAG/gravity_img.pdf. Accessed 12 Mar 2017
13. Potter FS, Schuerch C (1975) An industrial steam distillation: separation of rosin and turpentine from pine gum. J Chem Educ 52:672
14. http://www.ahec.org.in/RuTAG/index.html (2017). Accessed 12 Mar 2017
15. Chiyembekezo S, Kaunda C, Kimambo Z, Torbjorn, Nielsen K (2012) Hydropower in the context of sustainable energy supply: a review of technologies and challenges