RE TECHNOLOGIES FOR RURAL AMENITIES & PUBLIC FACILITIES IN MOUNTAINS

CURRENT STATUS AND WAY AHEAD

Renewable Energy Technology Series

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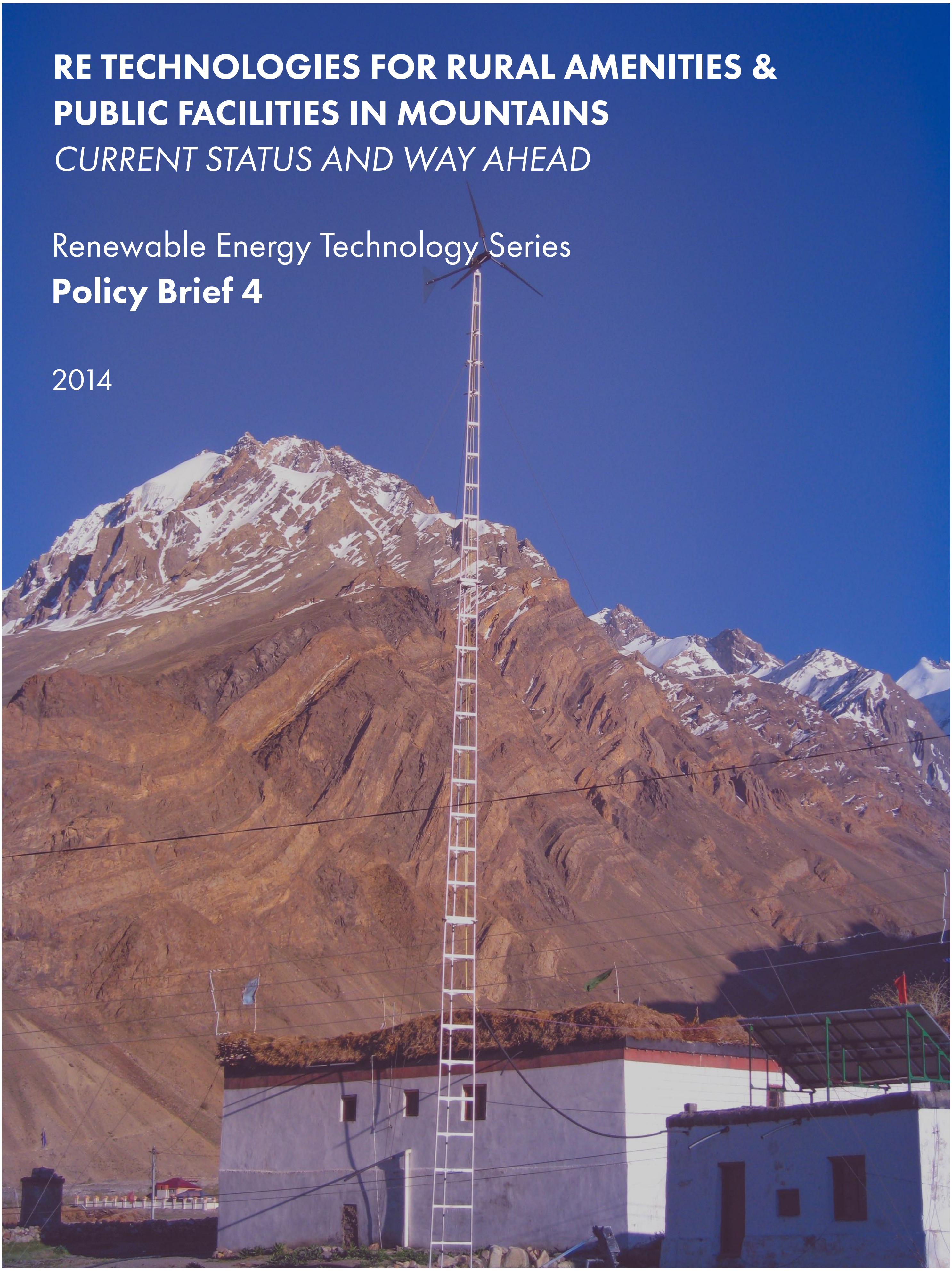


PRAGYA ENVIRON

INTRODUCTION

Access to modern energy services is a precondition for the development of any society and is the golden thread that interlinks economic growth with social equality and human development. Contemporarily, energy sources have become the basic drivers for sustaining development goals such as improving public health, enhancing education and advancing communication services. Worldwide, around 1 billion people are served by health facilities that have no access to electricity. The situation is equally daunting in the education sector where an estimated 50 percent of children in the developing world (291 million) go to primary schools without access to any electricity (Practical Action, 2013).

In India, a large portion of the rural population that comprises 60% of the total populace does not have access to reliable electricity or has limited access (NREL, 2012). This impacts the growth of public facilities, with 46 percent of health facilities serving an estimated 580 million people, without electricity. Lack of access has severly impeded the development of these societies.

Energy plays a transformative role in increasing the effectiveness and quality of rural amenities and public services across several spheres:

- Health care: hospitals, clinics, primary health centers and ICDS;
- Education: primary and secondary schools, colleges and training centers;
- Public institutions: government administrative offices, community centers, Panchayat bhawans, police stations,
- Religious buildings, weaving centers, warning signals;
- Infrastructure services: water pumping and street lighting.

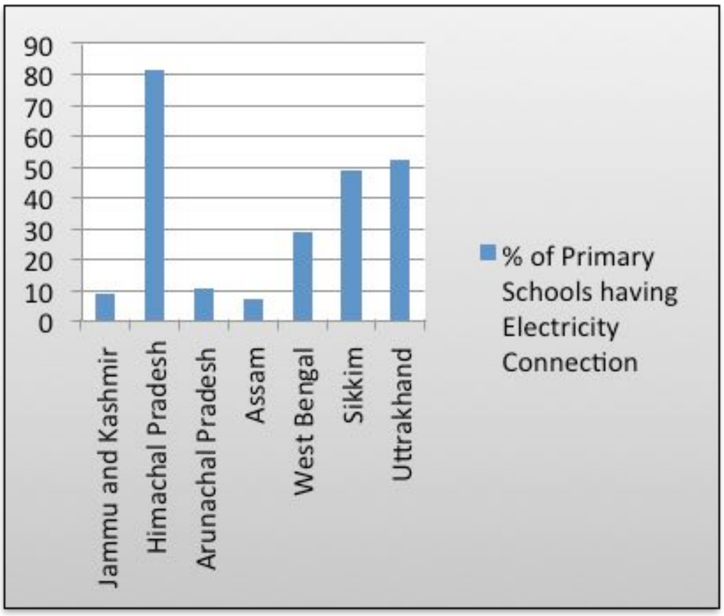
Ensuring accessible, affordable and clean energy access is critical for delivering these amenities, across India, but particularly in remote mountain regions. Communities cannot receive adequate health care if the public facility has no electric lighting, refrigeration, or sterilisation equipment, and is not able to attract skilled staff. Likewise, lack of electricity in schools impacts on teaching and learning (computer technologies) and physical infrastructure (lighting, space heating, water pumping and purification). There is a vital need to extend energy access through renewable resources, beyond the basic provision of minimum electricity to ensure continual growth of mountain regions and populations.

This policy brief reviews the current status of Energy in mountain regions for civic facilities in Health, Education and Public Institutions. The brief evaluates diverse Renewable Energy (RE) technologies from varied renewable sources such as solar, hydro, wind power. The current status of RE in the mountains, their utilization and contribution in building mountain infrastructure is assessed. Finally, the article spells out the barriers for uptake and the way ahead.

CURRENT STATUS OF ENERGY IN MOUNTAIN REGIONS

The energy scenario in mountainous regions of India is stark in comparison to the rest of the country. Acute shortage of energy has impeded the growth of public facilities in the region. Central Electricity Authority reports that the average base supply power deficit in mountain states amounts to 10% (CEA, 2011). Jammu & Kashmir and Arunachal Pradesh are amongst the highest energy deficit states with arrears as high as 25.4% and 14.9% respectively (ibid.). The energy paucity is reflected in the spheres of education and health (Fig. 1), and also gets mirrored in lower levels of productivity. In order to ensure the development of the region, it is essential to address these challenges and look at alternative sources of energy. RE solutions can be applied to overcome the energy paucity, thereby, leading to balanced and crucial development of public amenities.

HEALTH FACILITIES



WHO states "Health and energy are interdependent factors which largely determine the progress of rural development" (NREL, 2012). The pre-requisites for the efficient working of health centers are: condition of building; availability of clean and running water; presence of a telephone or some means of communication, basic necessities such as drugs and vaccines, and equipment such as refrigerators. All these operations are subject to availability of uninterrupted energy access. However, majority of health centers in mountain regions have inadequate or no power output. RE Technologies can prove to be a viable alternative source for energy supply to rural health facilities in mountain regions by providing energy access for following health related services.

- Drug and Vaccine: Refrigeration of medicines and vaccines is a big challenge for health centers in remote un-electrified regions. Solar Powered coolers can act as a Vaccine and Blood storage. WHO certifies these coolers for use in Health care systems.
- Evening Services in Health Centers: In mountainous regions, doctors and patients cannot utilize the evening service, as there is no light in the health center. Electricity generated from sources such as solar, wind or hydro can provide efficient light. Furthermore, light greatly improves emergency

treatment, birthing, maternity care, surgery, administrative tasks and other medical functions (Jimenez & Olson, 1998).

- Communications: Solar Systems can help in maintaining communication for emergency or ambulatory services. It can also help in facilitating linkages between health clinics and communities at large.
- Provision of Water: Mountain regions are rich in water sources. However, continual supply of clean water to health facilities is often a problem. Solar or wind power (or both) generated on site can economically meet the broad range of needs between manual and motor - driven pumps (ibid.).

Box1: Bangladesh Case of The Beneficial Effects of Energy on Health

The infant mortality rate in electrified Bangladesh households was 4.27%, whereas among non-electrified households in electrified villages and non-electrified villages experienced rates of 5.38% and 5.78% respectively. For further perspective, the infant mortality rate in households with electricity is 25% less than the national average (5.7%) and 35% less than the national rural average (6.6%). The study shows that if access to electricity is expanded to all (100%) rural households, the annual number of infant deaths that could be avoided would number roughly 36,818, i.e., 101 infant deaths saved daily.

Source: World Bank, 2005

EDUCATION FACILITIES

Lack of energy hinders the educational development of a child and the community as a whole in remote mountain regions. For instance in Arunachal Pradesh, only 10.8% schools are electrified and the proportion is even lower 9.27% in Jammu & Kashmir (OGD, 2012). Basic lighting and other services provided through deployment of RE Technologies can facilitate education processes in the following ways:

- Increase Efficiency: Energy provided for lighting through various RE sources (solar lighting systems, wind turbines) can help in extending learning hours in the evening as well as extend working hours for preparing lessons and administrative duties. Better energy access can improve indoor lighting for

Box 2: Case of Illuminating Dokania Charr II

Dokania Charr II is a small village in Kamrup District of Assam. The village is inhabited by a minority community with limited access to public amenities. To meet their energy needs, people use kerosene wicks that are harmful for health and environment. In order to meet the electricity requirement of the village, a 37Wp solar home lightning system was provided in each household under RVE scheme. The system has had an affirmative impact on the lives of villagers. Their children can study under light and people can also work until late hours. This has also resulted in savings in terms of kerosene use and development of human resource.

Source:http://mnre.gov.in/file-manager/annual-report/2013-2014/EN/renes.html reading and writing (through use of solar lanterns).

- Vocational tools: Besides schools, energy access is crucial to provision of educational services in vocational centers such as carpentry, handicrafts and computer skills.
- Additional Aids: Learning aids (such as audio, visuals, etc.) can be powered by RE Technology generated electricity.

PUBLIC INSTITUTIONS & SERVICES

Public institutions that can benefit from increased and efficient access to energy comprise government administrative offices, community centers, Panchayat bhawans, police stations, religious buildings, weaving centers, warning signals. Information on the level of electrification of these facilities in mountain regions is limited; nevertheless, it is asserted that energy access helps in expanding services of these institutions. For instance, local government offices and police stations are responsible for keeping public records such as demographic data, tax information and legal registrations, and they coordinate development work. These tasks can be made more efficient through use of computers (Practical Action, 2013) that can run through electrcity generated by RE sources such as hydro or wind technologies. In addition, infrastructure services powered through RE sources can be used for street lighting and for entertainment equipment required for social events that are held after dark.

INFORMATION AND COMMUNICATIONS

While ICT has been acknowledged as an vital tool for development, mountain regions still suffer from a digital divide as communities and institutions are excluded from access to technologies. RE Technologies can improve the socio-economic lives of communities through the means of RE-powered radio communications, telephones, mobile radio systems, TV and computer services.

RE TECHNOLOGIES FOR PUBLIC AMENITIES

This section highlights technologies from varied renewable sources such as solar, hydro, wind and examines their potential in providing energy access to public facilities in remote rural mountainous regions.

RE TECHNOLOGIES BASED ON SOLAR ENERGY

The Himalayan region receives sun radiation for 300 days a year for approximately 8 hours a day. The sunlight received can directly be converted into electricity through Solar Photovoltaic technology, thereby contributing to the development of public facilities aforesaid in mountainous region. Solar technologies that can be utilized for rural amenities and public facilities include:

Solar Indoor Lighting Systems

Solar indoor lighting systems are most suitable for provision of electricity for schools, community centers, and police stations. World Bank has identified Solar Systems as the least-cost solution to address lack of energy provision for off-grid locations (Aggarwal, et al., 2014). These systems are typically in the capacity of 50 to 80 Watts and can support multiple electrical appliances including TV, radios. Solar Systems are standalone electricity systems that include a set of solar PV panels, a battery storage system, an optional battery charging controller, and various end-use equipment such as fluorescent lighting.

Box 3:Case of Portable Mobile Chargers

Bedaguli is a small village in Western Ghats of Karnataka. Villagers' main link to the outside world and economic lifeline is the mobile phone. However, with no electricity in the village, charging a mobile phone is an expensive, time-consuming chore involving a 2-hour round bus trip to the nearest town. To aid the villagers, Buffalo Grid, a London-based company has introduced portable mobile phone charging unit powered by solar energy. The portable unit with a full solar charge can last for 3 days and charge around 100 phones a day.

Source: https://www.gov.uk

Economic viability: The cost of installing a solar indoor lighting system depends on the type of solar panel module and the storage unit used. Small solar systems that are able to power a few light bulbs, fans, and a television set have an upfront cost of around Rs. 45,000, while larger systems of 1 kW capacity can cost between Rs. 120,000 to Rs. 180,000 (Aggarwal, et al., 2014). The typical unit cost of energy generation from these systems is Rs. 37/kWh (ibid).

Solar Street Lighting System

Solar Street lighting system is an ideal system for illumination of streets, squares and cross roads located in areas that are not connected to the power grid. The system consists of a SPV module, luminaire, and battery with battery box. The SPV Modules convert solar energy to electrical energy during the day, which in turn is used to charge the battery that can be used at night. These systems are an effective medium for lightning, as they do not suffer from power outages. They are guaranteed to work in rainy season and are easy to install.

Economic viability: Solar Street lighting systems have zero running costs and do not entail cost of transformers or meters as done by the conventional lighting systems. These systems entail no or minimum maintenance costs for at least 5 years. The life cycle of solar panels is up to 25 years and the useful life of battery and controller extends up to 2 and 8 years respectively. The initial investment of the system is Rs 21,000 (www.solarstreetlightsindia.in, 2011).

Solar Lanterns

A Solar Lantern is a portable lighting device that produces Omni-directional white light. Consisting of a PV module, a battery, lamp and electronics, the lantern is suitable for electricity needs between 0.5 to 5 Watts, depending on the requirement (Arora, 2013). While solar lanterns are used for home use, they are appropriate for outdoor or indoor lighting in schools, community centers and other public institutions. They can be used covering a full range of 360 degrees. PV module converts sunlight into electricity, charges the battery that powers the luminaire, which consists of White Light Emitting Diode (W-LED), a solid-state device that emits light when an electric current passes through it (MNRE, 2012).

Box 4: Reasons for selecting Solar Photovoltaic Systems

- Cost: SPV systems are suitable for regions where the cost of extension of utility power line or using other electricity generating system is higher than installing a SPV system. They are the lowest cost option at a daily energy demand of up to 15 kWh, even under unfavorable economic conditions (such as high initial cost) (Jamil et al., 2012).
- Efficient: SPV systems are easy to install and have the maximum potential in terms of electrical energy output among all the RE sources (ibid.).
- Reliability: SPV modules are not disrupted by power blackouts as the source of energy is solar, making them reliable. In addition, SPV modules have less number of moving parts as compared to electricity generating systems.
- End User Friendly: Completely decentralized and reliable power solutions – can be installed at the user's place and also can be designed as per the usage pattern.

Economic Viability: Solar Lanterns are a viable option for areas that are un-electrified or where there is constant irregularity in supply of electricity. These systems are easy to maintain and are normally designed to be maintenance free units. A 4.5-volt solar module can provide light for 8 to 10 hours after 6 hours of charging on a sunny day. The useful life of a lantern is up to 15 years (Aathmika, 2012). The upfront cost of a solar lantern is Rs 2,500 to Rs 2,800 depending on the capacity desired (ibid.).

Solar-Powered Coolers

Solar-Powered cooler is a battery less technology that bridges the gap between development and health via an innovative technology. Solar cooler operates with a compressor that is powered directly by sunlight through PV panel. Instead of the battery, the cooler stores thermal energy in ice, while a thermostat maintains the required temperature for storage of medicine and other useful health related products. The ambient temperature maintained by solar coolers is 20º to 32ºC. The 'ice battery' can maintain an acceptable temperature for up to five days in low sun situations or when power is disrupted (Maté & McCarney, 2010). Recommended by WHO, these can be used for storing vaccines and medicines for health centers in remote un-electrified regions.

Economic Viability: Solar coolers' running costs are less due to no fuel consumption. Besides, there is little requirement of routine maintenance and repairs. However, the initial investment is high with commercialized price of solar coolers being approximately $1500 (Rs 92,000) (UNEP, 2005). The major cost incurred is from PV technology, but the prices for photovoltaic panels are coming down, which will further reduce the cost.

Solar-Powered Cookers

Solar-Powered cooker is a simple device that uses solar energy for heating or cooking purposes. One of the most common solar cookers for community cooking is dish solar cooker that is a concentrating type parabolic with aperture diameter of 1.4 meter and focal length 0.28 meter. The high temperature attained (nearly 400˚c) is useful for roasting, frying or boiling. These solar powered cookers can help in cooking for up to 40 to 50 persons at a time. They can be used to cover cooking needs in public institutions such as schools (e.g. for midday meal schemes) and for religious institutions etc.

Economic Viability: The benchmark cost of the cooker is Rs. 7,000/- and it can save up to 10 LPG cylinders/ year on full use at small establishments (Goswami, 2013).

RE TECHNOLOGIES BASED ON HYDRO POWER

Hydropower can be an efficient resource for power generation in rural, remote and mountainous areas of India, where there is unreliable supply of energy services. In such regions, there is less load density and grid extension is not feasible, thereby enhancing the desirability of small hydro as an alternative source to electricity besides photovoltaic.

Small-Hydro

Consisting of a Penstock pipe that supplies high-pressure jet of water to the turbine to operate the generator, these systems can produce electricity up to 5 kW. These systems are easy to use and feasible as hydro sources can be available 24 hours a day, 365 days a year. They are feasible for small, remote communities with adequate electricity to power buildings with small load such as public libraries, community centers, and religious buildings.

Economic Viability: The economic cost a small hydro system varies depending upon the size and installed capacity of the system. However, the initial cost of a small hydro system with the capacity of 3 kW is around Rs 25,000 while delivering 60% efficiency with the life cycle of 10 years (Motwania et al, 2013).

RE TECHNOLOGIES BASED ON WIND POWER

The cumulative potential of wind power in Himalayan mountain region is 5,866 MW (MNRE). However, wind speed values mostly below 4 m/s show that large-scale commercial power generation might not be feasible in the lower stretches of the Himalayas. However, the slow speed can be used for small wind technologies that can be used to power public health facilities such as police stations, community centers etc.

Economic Viability: Small Wind technology can be competitive with other RE Technologies. For instance, the installed cost of small wind power system is around Rs. 125/Watt in comparison to installed cost of PV (GWES, 2007). In addition, small wind systems can operate for long periods without attention and require inspection only every 2 years during their life span of 20 – 30 years.

INITIATIVES FOR PROMOTING RE FOR PUBLIC AMENTIES

The Central Government has initiated several schemes such as the Jawaharlal Nehru National Solar Mission (JNNSN). The Mission was launched on 11th January 2010 with the aim of reducing the cost of solar power generation in the country. The mission aims to provide lighting to remote rural regions by deploying 20 million solar lighting systems by 2022. Under JNSSN, 8,204 solar streetlights were installed in villages in Himachal Pradesh; In Uttarakhand 20,000 solar lanterns were distributed in flood-affected areas for household use and public amenities.

The Government of India has an array of different policies that provide incentives and financial subsidies on RE utilities, such as solar lanterns, indoor lighting systems, besides generation-based incentives of up to US$ 0.286/kWh to solar power plants. For small hydropower projects (less than 3 MW), incentives include concessions on customs duty, capital subsidies, 10-year tax holiday and other state-level incentives such as exemptions from sales and electricity tax and preferential tariffs.

Several state governments have initiated policy packages in the form of considerable tariff escalation for wind and small hydro projects. Himachal Pradesh provides a subsidy of Rs 45, 000 and Rs 75,000 for 2 MW and 5 MW hydro projects. Uttarakhand has set up single window clearance for RE power projects to facilitate quick and hassle free approvals and clearances for such projects.

BARRIERS TO UPTAKE OF RE TECHNOLOGIES

Despite policies and measures taken by the Government for promotion of RE, there still exists a wide disparity in the uptake of RE technologies. The barriers are as follows:

- Unbalanced polices exist where the existing policies and mechanisms focus on creating infrastructure for rural electrification. There is no particular focus on enhancing the access to electricity that creates infrastructure and community development through a specific program on rural amenities and public facilities.

- Lack of focus on mountain regions as the thrust of major policy measures are mainstream rural populations that reside in plains. Mountain region and communities take a backseat due to the difficult geographic terrain, uneconomical grid extension, dispersed and distribution population load.

- Unavailability of skilled human resource corresponding to RE sector that makes adoption and implementation difficult.

- Lack of awareness/knowledge among stakeholders, including consumers about the potential and suitability of renewables for development of public facilities.

- Despite these barriers, RE can prove to be a feasible option for advancing rural amenities in distant mountain regions. The need of the hour is to overcome these barriers, harness these technologies and ensure their availability and feasibility.

RECOMMENDATIONS AND THE WAY AHEAD

Recommendations on RE Technologies for rural amenities and public facilities should adopt a holistic perspective outlining the following steps:

- Introduce an integrated regulatory framework including policies and programs that incorporate mountain perspective and the energy needs of mountain population.

- Focus on Energy strategies that integrate RE within the development goals, with a special focus on rural amenities and public facilities.

- Pay exclusive attention on promotion and support of healthy decentralised energy market.
- Streamline RE processes so that they are followed by all, with closer nodal agency involvement with all communities.
- Design, implement and make a strong commitment to R&D for energy efficient, affordable RE Technologies.
- Implement schemes and incentives for the development of skilled manpower in mountain regions via the medium of trainings, study tours, scholarships.

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