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SCOPE OF RENEWABLE ENERGIES IN HIMACHAL PRADESH: PRESENT STATUS AND FUTURE PROSPECT

LEENA SHARMA[1] & ANJU [2]

[1]Dr.Leena Sharma, Assistant Professor Zoology, Govt College Daulatpur Chowk, Una (HP)
[2]Dr.Anju, Assistant Professor Physical Education, Govt College Daulatpur Chowk, (HP)

ABSTRACT

Natural resource depletion is now a days a crucial environmental problem that the country is facing. Himachal Pradesh is also not untouched. The energy demands in Himachal are increasing relatively at a high rate due to industrialization, increasing population, living standard, economic development and tourism and introduction of electric vehicles. The consumption of energy is relatively more than the generation of energy and possibly it will increase multifold in future. Fossil fuel consumption ends up in the emission of greenhouse gases during power generation, and as a fuel in vehicles, power generators etc. which is responsible for global warming and climate change. India has limited resources like fossil fuels, which will soon be exhausted. All over the world, people are making efforts to shift to renewable sources of energy like solar, wind, biogas and geothermal energy. To satisfy the endless energy demands, Himachal too is making efforts to move towards an alternate source of energy, that is, the non-conventional renewable energy. Himachal Pradesh has the adequate potential for developing solar power, wind power, hydropower, biomass, and biogas energy. There are enough opportunities with favorable geology and geography of the state. This paper reviews the scope of renewable energy sources in Himachal Pradesh. There is also an insight into the production of energy from all these renewable resources with respect to their potential and also the government and public sector support towards renewable energy.
Keywords: Energy, Renewable energy resources, Solar energy, Wind energy, Sustainability.

INTRODUCTION

Majority of the power generation in India is carried out by conventional energy sources like coal and fossil fuels, which contribute heavily to greenhouse gas emission and global warming. The consumption of energy is relatively more than the generation of energy. India has limited reserves of fossil fuels, which will be exhausted very soon due to increased industrialization and life standards of the people. The need for an hour is to switch to renewable energy like wind energy, solar energy, small hydropower, tidal energy, geothermal energy, biomass and biogas energy (Patel et al., 2015, Patel et al., 2017, AKS and Gaurtam, 2018). As the demand for fossil fuels has increased, the cost of using them has also increased. *India Boasts the World's Largest Renewable Energy Programs*. In India's villages and towns, a variety of renewable energy solutions have been created and utilized. In 1992, the Ministry of Non-Conventional Energy Sources (MNES) was established to oversee all aspects of non-conventional and renewable energy. The government of India also established the Renewable Energy Development Agency Limited (IREDA) to assist and give financial assistance for renewable energy projects in the form of subsidies and low-interest loans.

The overall potential for renewable power generation in the country as on March 31, 2017 is approximately 10, 01,132MW. This comprises the solar power potential of 649342 MW (64.86%). wind power potential of 3,02,251 MW (30.19%) at 100 m hub height, SHP (small

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hydro power) potential of 21,134 MW (2%), Biomass power of 18,601 MW (1.86%), 7,260 MW (0.73%) from biogas-based cogeneration in sugar mills, 2554 MW (0.26%) from waste to energy (Ministry of Power). All economic activities in a modern economy depend on energy to flourish and sustain. A well-established energy system fuels all sectors from agriculture to high technology-intensive IT sector, from manufacturing to medicine, thereby making development impossible without fueling the engine of growth. During the last two decades, India improved access to electricity covering 75 crore additional population. In the current century, India is also planning to make a move from non-renewable sources to renewable sources, viz. wind, solar, hydro-energy, biomass and geothermal. There is no denying that India has made significant progress in shifting energy use mix from conventional to non-conventional sources. so, as the Himachal Pradesh. However, in coming decades, with development and further population growth energy demand is expected to increase multifold. Presently, renewable energy sources make up only 18% of the total mix bag. Increasing this substantially is the need of the hour as it is inexhaustible and also clean. So, to meet the challenge, the State Government has come up with major policy and programmes. The focus of all those programmes is energy sustainability, efficiency, security and affordability.

The state of Himachal Pradesh has a geographical area of 55, 673 km^2 and lies between altitudes ranging from 350 to 7,000 meters. Most of the area lies above 1,000 meters and is mountainous. Kangra, Mandi and Shimla districts which lie at medium altitudes with respect to the state constitute almost 50% of the total population. The districts lying on the lower altitudes i.e., Una, Hamirpur, Bilaspur, Solan although smaller in terms of area, have higher population densities. The major contributor to the GDP of the state is Agriculture. Tourism also plays a predominant role. Energy problems in Himachal Pradesh are complex and area specific necessitating energy solutions with a decentralized focus. The Integrated Rural Energy Programme (IREP) was formed in response to this.

To provide thrust to this initiative as well as institutionalize programmes of renewable energy the Himachal Pradesh Energy Development Agency (HIMURJA) was established in February 1989. The objective of HIMURJA is to promote research and development in the field of non-conventional and renewable sources of energy. HIMURJA has been promoting renewable energy programmes with financial support of the Ministry of New and Renewable Energy (MNRE) and the state government. Efforts are continued for the promotion and propagation of renewable energy devices such as solar water heating systems; solar power is one of the most important inputs for economic growth and overall development of the state. Renewable energy options such as solar thermal, solar PV and small hydro hold significant potential as part of strategies for green growth in Himachal Pradesh. Resource availability of solar and wind energy varies with geographic location, topography, microclimate and many other factors. Hence understanding the regional availability of resources is essential for the

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design of conversion devices which could effectively utilize the potential. This also helps in the regional level energy planning.

PRESENT STATUS

The Renewable Potential of Himachal Pradesh: It can be seen that solar and small hydro together exceeds 99% of total estimated potential. Wind, biomass and waste to energy have very limited power generation potential compared to solar and small hydro and the state has been actively promoting the latter two technologies. Institutional setup of the power sector in Himachal Pradesh Through the Himachal Pradesh Power Sector Reforms Transfer Scheme (2010), Himachal Pradesh State Electricity Board Limited (HPSEBL) performs the functions of distribution, trading and generation of electricity while Himachal Pradesh Power Transmission Company Limited (HPPTCL) performs the function of evacuation of power by transmission lines. HPSEBL is responsible for the development, (planning, designing, and construction), operation and maintenance of power distribution system in Himachal Pradesh with inherent trading functions. The HPSERC is the State Electricity Regulatory Commissions created for rationalization of electricity tariff, policies regarding subsidies, promotion of efficient and environmentally benign policies. HIMURJA is the nodal renewable energy authority of the state and has been involved in promotion of renewables and formulation of policy. Department of Energy (DoE) is the state government department that formulates general policy within the general domain.

Small Hydro Power Policy: As a source of energy hydro power is economically viable, non-polluting and is environmentally sustainable. The Power Policy of the State attempts to address all aspects like capacity addition energy security, access and availability, affordability, efficiency, environment and assured employment to people of Himachal. The Small Hydro Power Policy came into force in 2006 and was amended in January 2010. The policy is applicable to hydro systems up to 5.0 MW. The main features of the policy are;

- SHP projects of up to 2 MW are reserved for Himachali and Cooperative Societies comprising Himachali. Furthermore, preference is given for Himachali until 5MW.
- The state government would acquire land for permanent structures and land for other purposes would be leased out by Government at approved rates.
- Operative period of the projects under this policy is 40 years after which the projects would be handed over to the Government.
- Power generated will be sold to HP State Electricity Board preferentially and if the developer intends to sell the power to a third party, he is free to do so at a higher cost.
- Wheeling charges for captive use is at 2% including losses and for sale and captive use of power outside HP, it would be 1% of the energy received.

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- No water royalty up to 5 MW for 12 years, 12% for next 18 years and beyond at 18% for sale within the state.
- For new projects upfront premium exempted for project capacity up to 2 MW.

Solar Power Policy Himachal Pradesh: Solar Power Policy of 2014 targeted to promote solar initiatives in the state. The policy targeted 50 MW of solar power installation from 2013 to 2017 (Phase I) and 250 MW from 2017 to 2022 (Phase II) Jawaharlal Nehru National Solar Mission (JNNSM). It promoted off-grid and decentralized solar applications and grid connected solar plants. It comprises of five different categories which as mentioned below;

- Category I (up to 100 kWp) – Provided only to Domestic consumers
- Category II (Integrated rooftop/small solar plants up to 1 MW) – Provided to Group of individuals, housing colonies, rural/urban housing schemes
- Category III (Solar power plants from 100 kWp to 500 kWp) – Made available for commercial, industrial, educational institutions and government buildings
- Category IV (Solar power plants from 100 kWp to 500 kWp) – It is provided to Solar plants installed on owned land or land leased from government/private entity
- Category V (Solar power plants above 500 kWp).

For category I, II and III the Tariff to be determined by HPERC on net metering basis and for categories IV and V, on competitive bidding basis. Under this policy it was instructed to developer to ensure 70% employment to be reserved for Himachali. Exemption from payment of electricity tax to the extent of 100% on electricity generated from solar power projects used for self-consumption/sale to utility for first 5 years was provided.

Solar Power Initiatives: Himachal Pradesh is a hilly state with generally clear sky. The average solar insolation in the state ranges between 4 to 5.25 kWh.m2/day with around 300 clear sunny days in a year. However solar power is expensive when compared to abundant and cheap hydro-electric power (with huge potential in the state). HPSERC has, however, made it mandatory for distribution companies and obligated consumers to purchase a percentage of power from solar project.

Solar Water Heating System: HIMURJA has been recognized as the best state-based nodal agency in the areas of promotion and market development of solar water heaters by the MNRE. Solar water heating systems of 1,629,970 liters per day capacity have been installed in different parts of the state. Solar water heating systems of 271200 LPD capacity have been installed through Market Mode under JNNSM, in the different parts of the State. Most of Himachal Pradesh is over 1,000 meters above sea level and is covered by mountains and hence, the need for water heater also arises due to firewood shortage. HIMURJA has successfully demonstrated the concept of community solar water heaters at several sites

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throughout the region and the benefits arising from substituting firewood as a fuel source. The hotel industry has been identified as the sector with the best long-term potential as tourism is a major industry in Himachal Pradesh.

Solar Cooker: A solar cooker is a device that cooks using sun energy, reducing the need for fossil fuels, wood, and electricity to a considerable amount. However, it can only be used to augment cooking fuel, not to completely replace it. It is a basic cooking device i.e., suitable for home use throughout most of the year, with the exception of the monsoon season, overcast days, and the winter months. The box type solar cookers with a single reflecting mirror are the most common. These cookers have become quite popular in rural regions where women spend a significant amount of time gathering firewood.

Solar Photovoltaic (PV): Using the photoelectric effect, a photovoltaic system transforms light into electrical direct current (DC). Solar PV has grown into a multibillion-dollar, fast-growing business i.e., continuing to increase its cost-effectiveness and, together with CSP, has the highest promise of any renewable technology. Lenses or mirrors, as well as tracking systems, are used in concentrated solar power (CSP) systems to focus a wide region of sunlight into a tiny beam. Concentrated solar power facilities were first produced commercially in the 1980s.

PV cells are typically constructed of silicon, a material that releases electrons spontaneously when exposed to light. The number of electrons emitted by silicon cells is proportional to the amount of light shining on it. The silicon cell is encased in a metal grid that guides electrons along a route to produce an electric current. This current is directed into a wire that connects to a battery or a DC device. One cell typically produces 1.5 watts of electricity. Individual cells are linked to make a solar panel or module with a power output of 3 to 110 watts. Solar panels may be linked in series and parallel to form a solar array that can produce as much power as space allows. Modules are typically intended to provide 12 volts of power. The peak Watt production of PV modules is measured at solar noon on a clear day.

- ***SPV Street Lighting System*** - A total of 44,338 points of SPV street lighting systems, 22,586 domestic lights and 32,649 solar lanterns have been installed/distributed in the state. A target of 66,940 SPV street lighting systems and 10,000 solar lanterns have been proposed in Himachal Pradesh under JNNSM.
- ***SPV Power Plant*** - A target of 1 MW capacity SPV Power Plants under MNRE, Govt. of India programme/ Tribal Sub Plan with the ratio 90:10 respectively has been proposed.
- ***SPV Lanterns*** - SPV Lanterns have been provided to the flood affected families of affected areas under JNNSM.

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Pumps for Solar Water: The pump in a solar water pumping system is powered by a solar-powered motor rather than traditional energy taken from the utility grid. A solar array placed on a platform and a motor-pump set compatible with the photovoltaic array make up an SPV water pumping system. It transforms solar energy into electricity, which is then utilized to power the motor-pump system. Water is drawn from an open well, a bore well, a stream, a pond, or a canal via the pumping system.

FUTURE PERSPECTIVE/GOALS

Short Term: The aim of the Government was to ease the route of power purchase from the privet honors and to develop policy and regulation for Net-metering through which consumer would able to sell the extra power generated through rooftop solar plant to the grid. The focus was energy generation from agro-residues (briquetting of crops residues) and gasifiers run on wood billets, crop and processing residues. Stand-alone power units run on small hydro and crop residues can be useful in promoting rural agro processing industries. Promotion of solar cookers, solar water heaters, solar dryers and photovoltaic for residential as well as commercial, industrial and agricultural sectors was emphasized. Targeted family and community size biogas plants run on cattle dung and alternate feed stocks and to promote *'farm level solar power generation'* where land-owing farmers can install solar power projects of 2-3 MW capacity. Such projects can have multiple purposes of generating clean energy, tackling the issues of land scarcity, result in additional income for the farmer as well as foster skill development. Up 500-1000 MW power generation was being targeted. Conduction of training and capacity-building programmes for local technicians, dealers and manufacturers, in order to ensure proper installation and maintenance of SWHs.

Medium Term: For SHP (Small hydro power projects) there is a need to reduce cost and time of clearances, statutory as well as administrative, by way of reforms and effective governance. Instead of obtaining No Objection Certificates (NOCs), focus should be on laying down norms and their compliance and enforcements of statutory provisions. Provide further regulatory support to SHPs in terms of providing evacuation arrangement, grid connectivity, open access and equitable wheeling tariff to make them competitive and provide level playing field to all the developers.

Develop the vast Spiti cold desert into a renewable energy hub by setting up a 1,000 MW solar and wind facility. Spiti has abundant sunshine and wind to generate energy.

- Develop low-cost domestic solar water heaters to attract a maximum number of residential customers.
- Creating awareness across the institutional sector with respect to the benefits of SWHs through focused seminars, campaigns and study tours in all major, potential districts.

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- Promotion of solar greenhouses for horticultural crops to supplement the income of the farmers as well as for space heating of houses in winters.
- Solar passive housing technology needs to be propagated in urban and rural areas keeping in view the vast potential of the technology for cold regions.

LONG TERM

- Support research and development, demonstration and commercialization of new and emerging technologies in renewable energy sector such chemical energy, geothermal energy, and bio fuels.
- Support research and development, demonstration and commercialization of hydrogen production, storage and distribution. Promote research and commercialization of storage technologies including fuel cells.
- Initiate move to electrify automotive transportation or develop electric vehicles - plug-in hybrids.
- Creation of conducive conditions for attracting private sector investment along with broader participation by public community/civil society.
- Provision of decentralized renewable energy for agriculture, industry, commercial and household sector particularly in rural areas thereby improving the quality of power and reducing transmission & distribution losses.
- Supporting specific projects and schemes for generating energy and conserving energy through energy efficiency.

POTENTIAL FOR NON-CONVENTIONAL SOURCES OF ENERGY IN HP

In the electricity sector, renewable energy accounted for 20% of the total installed power capacity (71.325 GW) as of 30 June 2018. There is a high potential for generation of renewable energy from various sources- wind, solar, biomass, small hydro and biogas. The overall potential for renewable power generation in the country as on March 31, 2017was approximately 10, 01,132MW. This comprises the solar power potential of 649342 MW (64.86%). Wind power potential of 3,02,251 MW (30.19%) at 100 m hub height, SHP (small hydro power) potential of 21,134 MW (2%), Biomass power of 18,601 MW (1.86%), 7,260 MW (0.73%) from biogas-based cogeneration in sugar mills, 2554 MW (0.26%) from waste to energy (MOP).

The Solar Energy Potential in Himachal Pradesh: Solar energy is the free and non-depleting power resource of energy. The solar radiation received outside the earth's atmosphere is 1367 W/m^2. However, on an average, the radiation received by the planet is 800 W/m2. The planet receives billions of MW solar power daily that is way enough to fulfill

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the energy demand of the country. The average intensity of radiation received in India is about 200 MW/km with a geographic region of 3.287-million-kilometer square. This accounts to 657.4 million MW of solar power. However, (85%) of the land is used for the agriculture and forests, (6.7%) land used for housing, (5.8%) land is either barren, snow bounded or typically inhabitable. Therefore, about (12.8%) of surface area mounting to 4.413 million sq. can be used for solar power plant installations (MNRE). Solar energy potential the solar energy potential in Himachal Pradesh has been assessed Considering the seasonal influence, Himachal Pradesh receives an average insolation of 5.99 kWh/m²/day in the warm summer months of March, April and May; 5.89 kWh/m²/day in the wet monsoon months of June, July, August and September; 3.94 kWh/m²/day in the colder winter months of end October, November, December, January and February. For the period from March to October the entire physiographic zones of Himachal Pradesh receive insolation above 4 kWh/m²/day, favoring commercial as well as domestic applications of solar energy. With the onset of winter by the end of October, the insolation in Himachal Pradesh drops down and a low insolation period prevails till the end of February. This confines the exploitation of the incident solar energy to domestic appliances like solar cookers, solar water heater etc. in winter.

As per the observation and data the solar products will help to meet rural needs. Solar lanterns will reduce the requirement for kerosene. Solar home lighting systems, solar street lighting installations, solar cookers will decrease the dependency on Hydro power.

Barriers and Challenges on Solar Energy – The main challenge of solar energy is its unavailability. The weather conditions are major issue on availability of solar radiation. So, we can't predict that for a specific time the solar energy will be available to us or not. Land availability is also low. Large land area is required, which typically is not feasible. The amount of land needed for utility-scale solar power plants is presently about 1km2 for every 20–60 MW generation. Storage problem is also a very serious problem. Suppose if the demand for power is not so high then the electricity produced by the solar plant will have to be stored somewhere to supply once demanded.

Installation of Grid-connected Solar Rooftop Power Plants **-** Jawaharlal Nehru National Solar Mission (JNNSM) was launched on 11 January 2010 with the target for Grid Connected Solar Projects of 20,000 MW by 2022. The Mission had adopted a three-phase approach. Initial four years (2009-13) had marked as Phase-I. The remaining four years of the Twelfth Plan (2013–17) had been marked as Phase-II and the thirteenth Plan (2017–22) was the Phase-III of the project. The aim of this project was to add 1,000 MW of grid solar power by the year 2013, and 3,000 MW by the year 2017 (Solar Energy Corporation of India). But in June 2015 the Union Cabinet of India gave approval for stepping up of India's solar power capacity goal beneath the Jawaharlal Nehru National Solar Mission (JNNSM) by five times, reaching 100 GW by 2022. The target comprised of 40 GW rooftop and 57 GW through big

and medium scale grid-connected solar power plants. By this step of government, India will become one of the greatest countries of the world in solar energy power generation. That new solar target of 100 GW is expected to reduce over 170 million tons of CO2 over its life cycle. The entire investment will be around Rs.600000 crores for 100 GW power generation. The Government of India is providing Rs. 15,050 crore subsidies to encourage solar capacity addition in the country. This subsidy will be provided for solar projects in many cities and towns. Solar power projects with an investment of about Rs. 90,000 cr. would be developed using the bundling method with thermal power.

The Wind Energy Potential in Himachal Pradesh: The Indian Government's Ministry of New and Renewable Energy proclaimed a new wind-solar hybrid policy in May 2018. This suggests that the same piece of land will be used to house both wind farms and solar panels. The Government is promoting wind power projects through private sector investment by providing fiscal and financial incentives such as Accelerated Depreciation benefit; concessional customs duty exemption on certain components of wind electric generators etc. Wind energy is the process of harnessing wind power to generate electricity. The wind's kinetic energy is transformed into electrical energy. Because of the earth's curvature, various parts of the atmosphere are heated to varying degrees when solar radiation enters the atmosphere. *The equator receives the most heat, while the poles receive the least.* Winds are created as air moves from warmer to colder locations, and it is these airflows that are captured in windmills and wind turbines to generate electricity. Wind power is not a new discovery; it has been utilized for millennia in the form of conventional windmills – for grinding maize, pumping water, and sailing ships. Wind energy potential shows wind speed increase for two occasions in a year. The first rise in wind speed happens during March which resides by June/July and again rises in September/October after the rainy season. This trend is not seen for Bhuntar where there is a single rise in wind speed reaching its peak in July/August.

Nahan records the highest wind speed with a monthly average of 6.5±1.1 kmph followed by Bhuntar with 4.2±1.6 kmph and Dharamsala with 4.2±1.3 kmph. monthly average wind speed variation for Himachal Pradesh. It is observed that, wind speed increases during the summer month of April and tallies with the on-site data. Since no on-site measurements are available for higher elevations (above 2500m), the wind maps could be relied upon to conclude that wind speed is relatively higher for regions like Lahaul-Spiti, Kinnaur and Eastern Kullu, when compared to lower elevations. From the application point of view, Himachal Pradesh can minimally support wind energy based agricultural pumps and electricity generation. With improved technology, wind power can now be used to create energy on a bigger scale.

The Biomass Power Potential in Himachal Pradesh: Biomass is a renewable energy source made up of carbon-based waste from human and natural activity. It comes from a variety of

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places, including wood industry by-products, agricultural crops, forest raw material, domestic trash, and so on. Biomass does not emit carbon dioxide into the atmosphere since it absorbs the same amount of carbon throughout its growth as it emits when burned. It has the benefit of being able to generate energy using the same equipment that is now used to burn fossil fuels.

Biomass is a significant source of energy and, after coal, oil, and natural gas, the most important fuel on the planet. Bio-energy, in the form of biogas, is anticipated to become one of the most important energy sources for worldwide sustainable development. Biomass, in the form of Biogas, has a better energy efficiency than direct burning.

Biogas is a clean and efficient fuel made from cow dung, human waste, or any other biological substance that has been fermented anaerobically. The biogas contains 55-60% methane and the remainder are mostly carbon dioxide. Biogas is a non-toxic fuel that may be used for cooking and lighting. The by-product can be used as high-quality manure.

Biomass fuels make for roughly a third of the country's overall fuel use. It is the primary source of energy for over 90% of rural families and around 15% of urban households. Energy and manure are produced using solely local resources, such as cow dung and other organic wastes. As a result, biogas plants are low-cost energy sources in rural regions.

The Hydropower Potential in Himachal Pradesh: Himachal is extremely rich in its hydroelectricity resources. The state has about 25% of the national potential. About 27,436 MW of hydroelectric power can be generated in the state by the construction of various hydroelectric projects on the five perennial river basins. Out of total hydroelectric potential of the state, 10,519 MW is harnessed so far, out of which only 7.6% is under the control of Himachal Pradesh Government while the rest is exploited by the Central Government. The state government has been giving the highest priority for its development, since hydroelectric generation can meet the growing need of power for industry, agriculture and rural electrification. It is also the biggest source of income to the state as it provides electricity to other states.

Himachal has enough resources to generate surplus power but in winter less flow of water in rivers and increases in lighting and heating load can result in power shortages that overshoot ten lakh units per day. Due to increased industrialization and rural electrification this figure is expected to rise even further.

Small Hydro Power Initiatives - Himachal has small hydro potential (i.e., up to the capacity of 25 MW) of about 2,500 MW, of which about the 350 MW have been commissioned, including about 100 MW in State public sector. About 1300 MW additional capacities have been allotted, mainly to private sector for execution, comprising of about 800 MW up to 5 MW and 500 MW between 5 to 25 MW. Himachal Pradesh has a Small Hydro Development

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Programme through which the state government has entrusted the responsibility of harnessing of small hydro potential up to 5 MW by private investment through HIMURJA. Himachal Pradesh is among the few States, which has streamlined and is continuously refining procedures/processes to minimize the bottlenecks.

Hydro Electric Projects being executed by HIMURJA Micro Hydel Projects under generation Lingti (400KW), Kothi (200 KW), Juthed (100 KW), Purthi (100 KW), Sural (100 KW), Gharola (100 KW), Sach (900 KW) and Billing (400 KW). Presently Four hydel projects in Tissa Region of Chamba-Sai kothi-I (15 MW), Sai kothi-II (18 MW), Devi Kothi (16 MW) and Hail (18MW) and Uhl HEP Stage-III (100 MW) on Neri khad at Joginder Nagar, District Mandi, are soon going to start the production.

The Geothermal Energy Potential in Himachal Pradesh: It is a type of energy that comes from the earth. It is trapped in the Earth's crust at a depth of 10 kilometer in the form of hot springs, geysers, and other natural phenomena. About 250 hot springs with temperatures ranging from 90 to 130 degrees Celsius have been discovered in areas like Puga Valley in Ladakh, Manikaran in Himachal Pradesh, and Tattapani in Shimla, Chhattisgarh, indicating that India's geothermal potential is largely found along the Himalayas. The National Aerospace Laboratory in Bangalore has established a pilot project near Manikaran for research and development as well as data collection in order to construct larger geothermal power plants.

The non-conventional and renewable energy industries in Himachal have a lot of room for growth. India is the only country with a dedicated ministry for non-conventional energy sources.

It is very important to mention here that India has the world's biggest decentralized solar energy program, the world's second-largest biogas and improved stove program, and the world's fifth-largest wind energy programme.

CONCLUSION

Any country's long-term economic success and progress are inextricably linked to the development and security of its energy sectors. In light of conventional energy sources' finite and limited reserves, as well as their environmental effect, a strong focus should be placed on the development of non-conventional energy sectors and their efficient usage for the benefit and advancement of society. Such efforts would also aid in the creation of a large number of job possibilities at all levels, particularly in rural regions. Energies like solar energy, wind energy and water power are generated from natural energy sources and in contrast to fossil fuels, these sources of energy never run out. With a way lower impact on the surroundings, using renewable energy helps to protect our planet by considerably reducing the quantity of carbon emissions that we produce. The scope for renewable energy is vast. A closer study of the available renewable resources like the one presented helps in the effective regional energy

planning and achieving ambitious targets already set. There is a high potential for generation of renewable energy from various sources- wind, solar, biomass, small hydro and biogas. There are enough opportunities with favorable geology and geography in Himachal Pradesh with the huge customer base and widening gap between demand and supply. Technological advancement, suitable regulatory policies, tax rebates, efficiency improvement in consequence to R&D efforts are the few pathways to energy and environment conservation.

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