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An Overview on the potential for Renewable Energy in Himachal Pradesh

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Abstract
The study examines the state of renewable energy sources presently and in the future in Himachal Pradesh, India. It explores several renewable energy sources that are attainable in the region, including wind, sun, bioenergy, small and large hydropower, and biofuels. By an investigation of installed capacity, tendered projects, projects currently in execution, and overall installed pipelines, the analysis offers an important understanding of India's capabilities with renewable energy as of 2022. The study stresses the crucial role of carefully planned investments, governmental frameworks, and tactical preparation in maximizing Himachal Pradesh's renewable energy resources. With India adopting aggressive goals for renewable energy, which include reaching net zero energy by 2070 and a 50% non-fossil fuel-based energy share by 2030, Himachal Pradesh is well-suited to be a major force in India's gradual move to renewable energy. We use secondary data from different government websites, annual reports and articles. The study also emphasizes how the deployment of renewable energy and environmental sustainability are all interconnected. Himachal Pradesh might add to national energy stability and autonomy while simultaneously satisfying its own individual energy needs properly by using resources like bio energy small hydropower, solar power, and wind energy.
Keywords*: Renewable Energy, Wind energy, Bio energy, solar energy, Hydro Power, Net Zero Energy, Sustainable Development, Energy Transformation.*

I. Introduction

India has begun to set up a bold road of energy transformation, intending to achieve net zero electricity by 2070 and 50 percent of its installed power capacity from non-fossil fuel-based energy sources by 2030. Getting the best use of easily accessible renewable energy alternatives is crucial for achieving the complex renewable energy goals and becoming self-sufficient in the area of energy. (1)

As India achieved its independence, the nation was still underdeveloped and primarily depended on coal to fulfill its energy needs. For a sustainable future, India has constantly been devoted to investigating further alternative sources of energy. Substantial hydroelectric power projects first appeared in India's energy scenery, indicating the beginning of the energy revolution. Several governmental and regulatory developments have supported the expansion of hydropower while making investments simpler over time. We presently rank fifth in the world for the potential to generate significant hydropower. The development strategies promote renewable energy, particularly in regions like Himachal Pradesh where there is an abundance of natural resources. Located within the Himalayas, Himachal Pradesh possesses a diversified culture that is deeply rooted in the surroundings, along with an ancient past. The state's energy environment has changed considerably in recent years because of a mixture of past incidents, present challenges, and preventive measures done by the state government and other sectors. In consideration of the nation's rapid rate of energy consumption growth, high coal consumption proportion, major reliance on imports to meet demand for petroleum fuels, and unstable global oil market, India has emphasized the promotion of renewable energy. Several renewable energy technologies (RETs) have gained significant popularity in the nation. Regarding total installed capacity, India comes in fourth in the world for wind energy, the technology with the most fast expansion and success. The largest small gases program and the second largest biogas program in the world are in India. (2)

Himachal Pradesh's history of utilizing renewable energy to encourage the economic growth provides proof of the state's devotion to using its wealth of natural resources for the good of both the environment and its citizens. Himachal Pradesh has changed over time, moving from being primarily dependent on traditional resources of energy to acknowledging the significance of renewable energy in encouraging sustainability and growth in the economy. The adventure began when the state looked at its hydroelectric potential at the very beginning of the 20th century. Starting in 1932, the Shul Project represented the start of a determined effort to

utilize the state's enormous water reserves for the generation of energy. The state afterwards saw the creation of a number of big and minor hydroelectric projects, which helped it, fulfill its increasing energy needs and established the basis for future economic growth, but the growing importance of renewable energy in Himachal Pradesh's energy environment wasn't realized until the late 20th century. The 1970s energy crisis and the state government's increasing worries about the environment led to an inquiry into alternative sources of energy. As a result, the first wind power facility in the state was established in 1982, bringing in a new era to Himachal Pradesh's growth of renewable energy sources. The state has advanced the use of renewable energy, especially solar and wind power, since then. A major turning point in the state's attempts to support renewable energy was the creating of the Himachal Pradesh Energy Development Agency (HIMURJA) in 1995. Several initiatives and programs targeting at increasing the proportion of renewable energy in the state's energy mix have been launched mainly in large part by HIMURJA. (3)

Due to encouraging government policies and incentives, the total amount of renewable energy projects in Himachal Pradesh has grown recently. The Himachal Pradesh Solar Power Policy was established by the state government in 2016 with the goal of boosting the growth of solar power plants across the region. In the same way, the 2019 launch of the Himachal Pradesh Wind Policy intends to promote the growth of wind-generating plants.

Renewable energy in India:

In India, the main objectives of making use of renewable energy include reducing climate change and enhancing reliability and availability. Applying sustainable energy and ensuring that everyone in the community has access to modern, convenient, and sustainable energy is important for the sustainable development. India aims to attain 50% aggregate integrated renewable power by 2030, net-zero emissions of carbon by 2070, and a drop of less than 45% in its overall economic carbon footprint by the end of the decade. India wants 500 GW of projected renewable energy capacity by 2030. India wants to generate five million tons of sustainable hydrogen by 2030.

A capacity of 125 GW for renewable energy will make possible this. In India, 50 solar power plants comprising 37.49 GW in capacity have been approved. By 2030, the amount of offshore wind power is predicted to reach 30 GW, with identified future locations. (4)

Present scenario of Renewable Energy in Himachal Pradesh:

The present scenario has become a number of possibilities and challenges in Himachal Pradesh's use of renewable energy for the economic growth. India's Himalayan region, located in Himachal Pradesh, has been blessed with a wealth of natural resources, including biomass, sun, wind, and hydropower. The state has been for decades one of the leaders in the production of hydropower, and a large portion of its energy mix comes from various hydroelectric projects. To ensure the economic growth, renewable energy alternatives must be embraced and the energy mix should be diversified, as becomes more and more obvious. It is estimated that Himachal Pradesh has a total hydro capacity of 25,000 megawatt. Among the renewable energy technologies, solar energy is one of the most feasible ways to go along with hydropower. The capacity objective set by the Indian government has been raised from 20,000 MW to 1,75,000 MW (175 GW), with 40 GW of that amount to be delivered using grid-connected rooftop solar mode by 2022. The H.P. State Government is eager to help meet the goals established for the advancement of solar power under the National Solar Mission. (5)

The state's total identified hydro power potential is around 27,436 MW, of which 10,781.88 MW are currently harnessed. The total harnessable power potential is 23,750 MW. By utilizing solar, hydro, and hydrogen energy as well as switching to green products that could improve the value and competitiveness of the state's exports, the government wants to establish Himachal Pradesh as the first green energy state by the end of 2025, with the goal to preserve the natural environment. The state government highlights the need to improve the present structure and emphasizes on using green energy to the best possible advantage to the state. Moreover, the State Government aims to develop 500 MW of solar construction between 2023 and 2024. Himachal Pradesh Power Corporation Limited (HPPCL) to install 200 MW of these; land for 70 MW of capacity has been identified; the rest of the sites will be confirmed soon. HIMURJA will install solar projects up to 150 MW in capacity with private participation; Himachal is would be given advantage when these projects are awarded. The projects will have capacities that vary between 250 KW to 1 MW. (5)

Types of renewable energy in Himachal Pradesh:

1) Bioenergy: Using the nation's plentiful amount of trash and biomass, energy recovery from these resources is a feasible option. Modern bioenergy is unusual because, along with producing clean fuels, it provides several social and environmental advantages. Applications of bioenergy, for instance, may reduce pollution of the air, water, and land. Furthermore, it can lower energy import costs and create employment and business opportunities domestically. It can support the growth of self-sufficient, independent communities. The

business sector can also benefit from carbon reduction potential in their sectors. Decreased costs for trash management and fertilizer subsidies are two other advantages. (1)

2) Small hydro power: Based on their scale, hydropower projects can be differentiated into minor and major groups. The size criteria used by various nations for classifying small hydropower projects differ. Hydropower stations in India are known as small hydropower plants if their total output is 25 MW or less.(1)

3) Solar energy: the endless supply of solar energy, as the Sun distributes all over the surface of the world; if properly utilized, we may harness almost 16,000 times more energy. In simple terms, you receive three times as much energy from your roof as you do from the interior of your property. In just eight years, 23 GW of installed solar capacity had been attained in India. The state of Himachal Pradesh aims to promote cumulative solar installations in all of its districts, with a focus on remote regions, in order to facilitate rapid development.(3)

4) Wind energy: The renewable energy resource wind is heavily available. Different places have different wind availability. A minimal wind power density of 400 W/m2 at a height of 30 m is required for optimal utilization of wind resources. The advanced world is developing wind energy for environmental reasons, and developing countries get drawn to it since it can be quickly constructed in regions where electricity is essential. In several instances, if fossil fuel sources are difficult to come by, it might be a reasonable choice.(6)

II. Literature Review

Vyas and Bakshi (2001) investigate patterns of energy use in homes. Monitoring the kinds and sizes of fuel used for domestic purposes is one of the goals. A sample of 120 houses was chosen using stratified sampling as part of the technique, and interviews were used to gather data. Results show that fuel use differs significantly between agricultural and non-agricultural households, with firewood being the main non-commercial energy source. The study highlights the possibility of improving conserving through renewable energy sources like solar energy and biogas and highlights just how important it is to understand rural areas' energy use patterns for sustainable resource management.

Prasad at el (2001) Analysis emphasized on fuel wood conservation through renewable energy technology in the Indian Himalayan region. The targets were to calculate the total amount of energy used at the time, identify the causes, and suggest measures to save energy. The methodology consisted of assessing gadgets like solar cookers, societal solar water heaters, and modified cook stoves in the field. The results showed major fuel wood reductions of up to 45% because of innovations like better cook stoves. Overall, the study showed the value of sustainable energy solutions in environmentally sensitive areas as well as the possibility of preserving fuel wood.

Mani et al. (2007) studied how much energy was utilized in Himachal Pradesh, India, for cultivating wheat and maize at various altitudes. The study revealed that low mountains used more energy than mid- and high-hill zones, primarily utilizing power for threshing and irrigation. Difficulties have been identified, including irregular input supply brought on the rough landscape. In order to increase crop yields and energy efficiency, recommendations included the implementation of small-powered equipment, precise input application, and efficient water management. This study highlights how essential it is to understand energy dynamics in hilly agricultural environments and offers methods for boosting resource efficiency and enhancing agricultural sustainability.

Sadorsky (2009) covers the gap in the literature by looking at the association between income and the utilization of renewable energy in emerging nations. Considering renewable energy is expected to develop at the highest rate among all energy sources, the study highlights the importance of renewable energy in resolving concerns about energy security and climate change. The importance of economic and environmental issues is further shown by Sadorsky's findings on income and carbon dioxide emissions as promoters of renewable energy usage in G7 countries. The research's emphasis on policy implications and income elasticity focuses attention to the possibilities for sustainable energy growth in emerging nations by emphasizing the relationship between income and consumption of renewable energy.

Apergis and Payne's (2009) study on the connection between renewable energy use and economic growth in nations in the OECD adds insight to this reservoir of knowledge. The authors present an in-depth examination of the relationship by using data from the World Bank and Energy Information Management covering the period from 1985 to 2005. Their results show a long-run equilibrium connection among capital formation, labor market participation, consumption of renewable energy, and real GDP.

Ramachandra (2010) emphasizes how essential it is to recognize the availability of resources in a given area while constructing optimal energy transformation devices and energy programs.

It focus on how different solar and wind energy resources are depending on factors like topography, microclimate, and geographic position. The study has a special focus on analyzing solar and wind potential using geographic information systems (GIS), remote sensing data, and ground-based measurements. In places

where data is poor, insolation is estimated using a variety of techniques, such as extrapolation and interpolation depending on meteorological characteristics. The study highlights how crucial it is to investigate the potential of renewable energy for regional energy planning and meeting sustainable development objectives.

Ramachandra (2012)studies on bioenergy planning in Himachal Pradesh, India, highlights the requirement for sustainable energy solutions through assessing bioenergy resources and degradation factors in hilly districts. The paper provides insights into the use of biomass and green energy attempts; emphasizing the essential part that bioenergy planning and resource management have in solving energy and environmental issues in hilly regions such as Himachal Pradesh. Also, it has been highlighted how important energy policy approaches are for encouraging renewable resources. All things taken into account, the research reviewed enhances our understanding of the complex problems related to sustainable resource management and bioenergy planning in mountainous areas.

Bilgili, et.al (2016) draw attention to the rising interest in studying the Environmental Kuznets Curve (EKC) hypothesis's validity in recent years. Scholars have concentrated their attention on studying the connection between economic growth, environmental deterioration, and the purpose of renewable energy utilization. The results of this research have been conflicting; some point to an inverted U-shaped relationship between environmental deterioration and economic growth, which is consistent with the EKC hypothesis

Bhattacharya et al. (2016) analyzes the connection between the use of renewable energy and economic growth in the top 38 nations. Understanding how renewable energy deployment influences sustainable economic development is the goal. The measurement of long-run output elasticities is conducted methodologically using panel data analysis and integration approaches. The findings show the consumption of renewable energy and GDP growth are positively correlated, with a rise in renewable energy consumption of 1% converting into an increase in output of 0.101%.

Supriya (2017) highlights the importance of sustainable energy supply for rural economic development is highlighted in this study. In order to sustain sustainability, it stresses the importance of boosting up the use of efforts to improve energy efficiency and renewable energy technologies (RETs) .The studies also emphasizes the significance of improved infrastructure, sustainability through programs for training, and RET certification. Overall, the study highlights how essential renewable energy is to increasing rural people's standard of life and argues for comprehensive programs to increase access to reasonably priced and dependable energy sources.

Rao (2017) analyzed the opportunities and challenges linked to small hydroelectric power plants in India. The author provides an in-depth investigation of the sustainability aspects of SHP development by referencing an extensive number of sources, including government data and scholarly literature. The study highlights the importance of suitable risk assessment and feasibility analysis while highlighting a need for a balanced strategy that takes consideration of the effects on the environment, society, and economy. The research study emphasizes how important sustainable energy practices are and how important it is to include environmentally friendly concepts into India's energy policies and development programs

Laledia and Kaur Channi (2023) analyze Himachal Pradesh, India's solar and wind energy capacity. The primary goal of the study is to examine the region's renewable energy sources' potential from both a technical and financial perspective. The outcomes highlight the importance that renewable energy in reaching carbon neutrality and offer insightful information to stakeholders and policymakers for developing sustainable energy plans. All things considered, this study improves green energy efforts and emphasizes the potential of solar and wind power in Himachal Pradesh and other states.

Research Gap:

The limited study of the economic and social implications of renewable energy projects in the region is a research gap in the research of the potential for renewable energy in Himachal Pradesh. The study might provide valuable insights into the broader consequences of Himachal Pradesh's conversion to renewable energy sources. In addition, studying social behavior, cultural variables, and community opinions around renewable energy projects could give a deeper understanding of the benefits and challenges concerning the development of sustainable energy in the area. In along with enhancing the research's significance and application, solving this research gap would assist Himachal Pradesh develop more environmentally friendly and socially acceptable energy policies and procedures.

Objectives of the study:

1) To examine the current status of renewable energy sources in Himachal Pradesh
2) To analyze the various types of renewable energy resources in Himachal Pradesh

III. Database and Methodology:

The study detailing Himachal Pradesh's potential for renewable energy employs a structured approach to explain the current state and the possible future development of renewable energy sources in the area. This research focuses on Himachal Pradesh's potential to generate renewable energy utilizing secondary data. The framework is provided by a literature review, which looks into what is known at present about renewable energy sources as well as how they influence sustainable development. To understand patterns of energy consumption and evaluate the potential of renewable energy sources in the region, data is collected via government websites official reports, and articles. The objective of this detailed process is to present an in-depth examination of the area's potential for renewable energy, with a focus on energy security, environmental sustainability, and economic prosperity.

Table 1 Renewable Energy Achievements in India (2022)

Renewable Energy Achievements in India(2022)				
Sector	**Installed Capacity (GW)**	**Under Implementation(GW)**	**Tender(GW)**	**Total Installed Pipelines(GW)**
Solar Power	63.3	51.13	20.34	134.77
Wind Power	41.93	12.93	1.2	56.06
Bio Energy	10.73			10.73
Small Hydro Power	4.94	0.54	0	5.48
Large Hydro Power	46.85	14.15		61

Source: Ministry of New and Renewable Energy

Table 1 shows the "Renewable Energy Accomplishments in India (2022)" in multiple fields. It contains details about installed capacity, current construction projects that have been set up, and the overall installed pipeline capacity estimated in giga-watts (GW). This table contains helpful data about the various types of renewable energy in India, particularly in biofuels, small and large hydropower, solar power, wind power, and bioenergy. Let's analyze every section's importance in terms of India's renewable energy environment in further details.

1. Solar Power: In 2022, solar energy is expected to have an installed capacity of 63.3 GW, which makes it an important participant in the country's renewable energy sector. With this large capacity, the entire nation shows its dedication to utilizing solar energy to carefully fulfill its increasing energy demands. Another sign of the ongoing effort to broaden the solar energy capacity can be seen by the data in the table, which shows that 51.13 GW of projects are at present in implementation. Furthermore, the 20.34 GW of tendered projects indicates the government's persistent effort to promote solar energy development through tendering methods. A positive trend for the development of solar energy in India is shown by the 134.77 GW of installed pipelines, thereby pointing to a significant pipeline of future solar projects.

2. Wind Power: Another substantial renewable energy source in the nation is wind energy, it is expected to have a total installed capacity of 41.93 GW by 2022. This shows how much wealth the whole country has made investments in wind energy projects to make use of its tremendous wind resources. The table demonstrates that continuous efforts have been initiated to expand the amount of capacity of wind energy production, with 12.93 GW of initiatives now in execution. The 1.2 GW of tendered projects show that the government is using public tendering to encourage and attract investments for wind power initiatives. By 56.06 GW of installed pipelines, India's wind power potential appears to be growing, helping the nation achieve its targets for renewable energy.

3. Bioenergy: Considering an installed capacity of 10.73 GW in 2022, bioenergy is an essential part of India's renewable energy supply. It provides an ecologically friendly replacement for fossil fuels in general through the use of a wide range of sources like biomass, biogas, and biofuels. According to the continued growth of bioenergy projects within the nation, the table suggests that 10.73 GW of projects are currently under construction. The concentration on bioenergy highlights India's attempts to expand its energy range while promoting environmentally friendly solutions. To cover India's energy requirements, the data in the table indicates that the bioenergy sector has the potential to grow and innovate.

4. Small Hydro Power: In the country, small hydropower projects are growing increasingly common; in 2022, they are expected to have a total installed capacity of 4.94 GW. These efforts serve as a flexible and renewable energy resource by using the energy of small-scale rivers and streams to generate electricity. The table highlights the continual growth of small hydropower generation with 0.54 GW of projects presently under operation. The absence of projects that were recently brought out to tender in this field suggests that more wants to be performed to bring in capital and promote small hydropower projects. The 5.48 GW of established pipes

demonstrates possibilities for smaller hydropower generation expansion in India, boosting its overall renewable energy targets.

5. Large Hydro Power: Having an installed capacity of 46.85 GW in 2022, large hydropower projects are currently a major source of renewable energy in India. These efforts utilize the immense capacity of dams and reservoirs of water to produce enormous amounts of energy. The table shows the ongoing growth of big hydropower infrastructure, displaying 14.15 GW of initiatives for ongoing development. This sector tends to be focusing on its present projects and capability to operate, as seen by a shortage of tendered projects. The data provided in the table indicates the crucial role of large hydropower in the energy mix of India along with how it contributes to helping the nation fulfill its energy requirements.

Table: 2 Himachal Pradesh Installed Capacity of renewable resources (2016-2024)

Himachal Pradesh Installed Capacity of renewable resources (2016-2024)				
Year	**Hydro Power(MW)**	**Solar Power(MW)**	**Bio Power (MW)**	**Small Hydro Power (MW)**
2016	9436.02	0.8	9.2	754.8
2017	9554.02	0.44	9.2	798.81
2018	9809.02	12.79	9.2	860.61
2019	9809.02	12.79	9.2	960.61
2020	9809.02	32.93	9.2	911.51
2021	9920.02	42.73	9.2	911.51
2022	10065.02	67.51	10.2	954.11
2023	10263.02	87.46	10.2	969.71
2024	10281.02	112.79	10.2	969.71

Source: India Climate & Energy Dashboard

In Table 2 the current capacity of renewable energy sources in Himachal Pradesh is displayed for the years 2016 to 2024. The data on the following four types of renewable energy sources are provided in the table: solar energy, hydropower, bioenergy, & small hydropower. The previously mentioned information provides important perspectives on the installation and growth of renewable energy generation in Himachal Pradesh within the given time.

1. Hydro Power (MW): The hydropower installed capacity in Himachal Pradesh is observed in the table that has increased significantly during 2016 – 2024. In 2024, the capacity is expected to have grown to 10281.02 MW against 9436.02 MW in 2016. It also indicates that the area has placed an increasing amount of focus on utilizing hydroelectric power, an energy source that is environmentally friendly.

2. Solar Power (MW): The data shows a significant rise in the installed solar energy generation capacity within Himachal Pradesh throughout a comparable time frame. By 0.8 MW in 2016 reaching 112.79 MW by 2024, the capacity grows substantially. It also shows how essential solar energy has become as an element of the state's inventory of renewable energy resources.

3. Bio Power (MW): The current capacity of bioenergy in Himachal Pradesh is listed as well in the following table. 9.2 MW is the relatively steady installed capacity between 2016 to 2024. Bioenergy, which is generated from organic materials, is crucial to the region's variety of renewable energy sources.

4. Small Hydro Power (MW): The data presented reveals a gradual rise in Himachal Pradesh's installed small hydropower capacity throughout 2016-2024. By 2024, the capacity will rise to 969.71 MW against 754.8 MW in 2016. In order to make optimal use of the energy capacity of the state's steep small streams and rivers, small hydropower projects are necessary.

Overall, the information presented in Table 2 indicates that the installed capacity of renewable energy sources in Himachal Pradesh continues to grow in an upward direction. The state's goal to move to a more environmentally conscious and sustainable energy sector can be seen in this upward trend. Himachal Pradesh is not just minimizing its carbon emissions but also enabling the country to accomplish its overall renewable energy goals by establishing a broad range of renewable energy sources, such as hydro power, solar power, bio power, and small hydropower.

Table: 3 Energy Generated and Consumed in Himachal Pradesh (Million unit)

Energy Generated and Consumed in Himachal Pradesh (Million unit)			
Item	**2020-21**	**2021-22**	**2022-23**
Energy Generated	1961.13	2203.606	2157.468
Energy Consumed by Stations auxiliaries	5.87	6.999	7.08
Gross energy Generated	1955.26	2196.607	2150.88
Energy Import	11845.77	12310.698	13448.465

Source: Himachal Pradesh State Electricity Board

The data on energy generated and consumed in Himachal Pradesh throughout a period of three consecutive years—2020–21, 2021–22, and 2022–23—is displayed in Table 3. Mentioned in the table includes energy generation, gross energy generated, energy imports in million units, and energy consumption by plant auxiliaries. To evaluate the sustainability of energy and self-sufficiency in the Himachal Pradesh region, it is necessary to understand the energy patterns within the region as a whole.

Himachal Pradesh observed manufacturing 1961.13 million units of energy in 2020–21. It demonstrates the amount of energy produced in the state as an entire that year. The energy employed by power plant support infrastructure and machinery is referred to as station auxiliaries, and it equaled 5.87 million units. 1955.26 million units of gross energy were produced, meaning the total energy generated is less than the energy utilized by station auxiliaries. In addition, the year's energy import of 11845.77 million units indicated how dependent Himachal Pradesh was on imported energy in order to satisfy its electrical requirements.

In 2021–2022, the region of Himachal Pradesh recorded a boost in energy generation, achieving 2203.606 million units, representing an increase in the state's energy production. Furthermore, station auxiliaries utilized 6.999 million units more energy. This year's gross production of energy, indicating the total energy output after taking into account station auxiliaries' utilization of energy, was 2196.607 million units. likewise, the area's dependence on external energy sources to satisfy its energy needs grew as the energy import increased to 12310.698 million units.

The amount of electricity produced in Himachal Pradesh over the most recent year, 2022–2023—was 2157.468 million units, a tiny decrease from the year before. A small spike in the use of energy was noticed by station auxiliaries, totaling 7.08 million units. The total energy produced during this year was equal to 2150.838 million units. It's interesting to observe that the energy import grew to 13448.465 million units, displaying an impressive rise in Himachal Pradesh's need for imported sources of energy to meet its energy requirements.

Table 3, as states that present an in-depth analysis of the energy generation and consumption practices in Himachal Pradesh. It illustrates the importance of comprehensive planning and developments in renewable energy to make sure the region's energy status is reliable and sustainable.

IV. Conclusion

India's high renewable energy aims, which involve attaining net zero electricity by 2070 including a 50% non-fossil fuel energy contribution by 2030, offer an unambiguous path for the nation's renewable energy development. With a wealth of natural resources and a capacity to produce renewable energy, Himachal Pradesh is well-suited to be an important force in India's migration to renewable energy. The study emphasizes how essential it is to have carefully constructed strategies, stable monetary support, and strong legal structures to take full advantage of Himachal Pradesh's renewable energy resources. The entire region can meet its energy requirements sustainably while contributing to national energy independence and safety by utilizing technologies that include bioenergy, small hydropower, solar power, and wind energy.

The study's conclusion continues by underlining how crucial it is to implement renewable energy solutions to tackle both problems of environmental sustainability and energy security. Himachal Pradesh could establish itself as a champion for changing to a zero-carbon economy by giving importance to the expansion of sources of renewable energy, thus establishing the path for other regions to adopt this approach in the global effort towards a future with renewable energy sources.

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