**Spectrum of Humanities & Social Sciences**
Volume 1, Issue 1, April 2025
ISSN 3059-9849 (Print)
Published by Graduate School of Humanities and Social Sciences
Mid-West University, Birendranagar, Surkhet, Nepal
https://muodgshss.edu.np

***Peer Reviewed Article***

# Use of Renewable Energy and Sustainable Development in Nepal

**Bhupendra Bahadur Shahi, PhD Scholar**
Assistant Professor
Mid-West University, Nepal
shahibhupendra45@gmail.com

**Article History**
*Received: 6 Jan 2025; Reviewed: 20 Feb 2025; Revised: 5 March 2025; Accepted: 5 April 2025; Published: 21 April 2025*

## Abstract

*This paper examines Nepal's energy use having the objective of how renewable energy is creating a sustainable development, focusing on the role of electricity in development and the potential of renewable energy for sustainability. This study employs mixed research design following descriptive analysis. Nepal faces energy shortages, particularly in oil, gas, and coal, with domestic energy largely relying on biomass sources like firewood, crop residues, and animal dung. Fossil fuels are heavily imported, straining the economy and creating financial challenges, especially due to the rising cost of petroleum imports. Limited access to environmentally sustainable energy impacts both national development and the living standards of Nepal's people. The use of conventional energy sources not only increases costs and wastes time but also harms the environment. Energy consumption correlates with major indicators of human development, including life expectancy, literacy rate, health, sanitation, housing, and income, that are all influenced by energy availability and quality. Although Nepal's major renewable resource hydroelectricity that it has great potential, its growth has been lagging due to reasons such as lack of domestic investment, political instability, and poor policy implementation because its users were 3909641 in 2018 and 5134058 in 2023 that it has been found its users increment as 1124417 (NEA, 2023). Thus these issues delay the country's development journey toward sustainable use of energy and development sustainability in Nepal.*

**Keywords**
*Renewable energy, Sustainable development, Hydro-electricity*

## Introduction

Energy is the major factor of development and it is essential for the overall social and financial advancement of a country. In the history of humanity, energy power has always found to be the primary factor behind sustaining the development sectors. Forhuman life, energy has always provided an engine for economic and social advancement. Energy has been crucial for economic and social progress throughout history. The Industrial Revolution marked a key turning point, significantly increasing global energy consumption with the introduction of steam power and coal. As technology advanced, energy demand grew,

driven by innovations like electricity and petroleum. Energy remains a key factor in shaping economic growth, social structures, and living standards, with ongoing technological advancements continuing to influence production and consumption patterns (REN21, 2014). Based on this consumption pattern and its utility, renewable energy sources are frequently refilled by nature, such as the sun, the wind, water, and plants. This type of energy cannot be exhausted and is constantly renewed. However, majority global people are utilizing fossil fuels for heating, cooking, powering in their homes and using as fuel in their vehicles. The similar situation also in the case of using energy in Nepal found has been found that it still largely depends on non-renewable source of energy 'fossil fuels' such as coal, gas, and crude oil (NPC, 2015).

Harris et al. (2011) have stated that renewable energy that it is significant to measure the level of development of a country through energy consumption. His idea mainly focused on that energy is one of the essential has to sustain countrywide development sustainably. Energy consumption is central to sustainable development as it impacts economic growth, quality of life, and environmental sustainability (Sharma et al., 2020). Similarly, Nepal has different energy constraints like limited infrastructure, high biomass reliance, and poor access to modern energy in rural areas. These constraints hinder economic development and exacerbate environmental degradation (Sharma, 2019). The country's underdevelopment of energy infrastructure also results in frequent power cuts and dependence on foreign fuels (Bhandari, 2021).

Nepal's energy sector depends heavily on traditional sources like biomass and imported fossil fuels, although it is endowed with tremendous renewable energy resources, including hydropower. Sustainable energy alternatives are vital to meet growing demand while minimizing the adverse impacts on the environment (Bhandari & Tiwari, 2021). Thus, it has been a hopeful agenda that most of the nations are putting an emphasis on renewable energy following sustainable goals and changing their policies to manage environmental impact, and looking for alternative energy sources. Renewable energy stands at the base of the evolution of sustainable development of a country. It is fundamental to development by providing major benefits in the areas of the economy, employment, health, literacy, and sanitation. For the enhancement of economic growth, environment, and the quality of life of people, short term or long term renewable energy supply is required. Therefore, this research issue can be significant for assessing the real situation to examine the interrelationship between trends of using energy and sustainable development in Nepal.

## Literature Review

Review of literature is the essential part of reviewing related literatures based on secondary source of information in any research. In the process of this research study, essential literatures haven been reviewed from secondary sources of information having the purpose of narrowing specific research gap and making this research finding more reliable. There are numerous ways to understanding sustainable development. Individuals frequently are giving attention on economic development with the objective of expanding efficiency, making more occupations, and generating more wealth. The concept of Sustainable development is well defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). Sustainable development is that development that leads to the fulfillment of the needs of all human generations on an equity basis and sustainable development is the concept of qualitative growth than quantitative growth within the development segment.` Sustainable development leads to the fulfillment of the needs of all human generations on the value premise and it is the concept of qualitative growth than quantitative in the development segment. It is also, "a concept of sustainable development must remedy social inequities and environmental damage while maintaining a sound economic base" (Harris, 2000). The next strong argument in the issue of use of renewable energy for development sustainability emphasized on sustainable energy solutions that are paramount to meeting fundamental human needs, particularly in rural areas (Bhattarai & Sharma, 2022)..

Sustainable development has become at the heart of ongoing public approaches, procedures, and improvement plans in various nations. The United Nations General assembly has brought a set of Global Sustainable Development Goals (SDGs) consisting of 17 targets and 169 targets to the United Nations in New York opened by the Working Group. In addition, a basic arrangement of 330 indicators was presented

in March 2015 (Lu, Nakicenovic, Visbeck, &Stevance, 2015). In the similar way, the Sustainable Development Goals bring betterworth and need to the systematic neighborhood of the people than the Millennium Development Goals. Planning, worldwide monitoring, and modeling of several factors at social, economic, and ecological locations are all necessary for planning for climate change, renewable energy, food, health, and water placement. In the case of interrelation with sustainable development, renewable energy development can also contribute to improved energy service dependability, particularly in regions where grid power is prevalent. Safety can be improved by a diversified portfolio of energy sources, effective management, and well-designed systems (Edenhofer et al., 2011).

Sustainable energy sources are widely available and fairly compared to fossil and larger and less tradable sources of electricity. Electricity reduces level of environmental impacts, energy import, can improve and the supply options, and alleviates economic weakness in the scarce global energy security.Nepal's first sustainable development concept was adopted by the Eighth Five-Year Plan (2049-54) which has been focused on a policy of tree planting for protecting the environment and wild lives. This step was key turning point in hydroelectric and solar energy discovering new resources to alter the energy needs from traditional to ultra-source of energy to improve the quality of life of the people in Nepal.

Harris (2000) emphasizes the energy consumption as an index of the standard of living and sustainable development. He also suggests proper planning is needed to perform in order to avoid issues related to using fossil fuels because they are finite and hurt the environment; in fact, they still make up the vast bulk of the world's energy supply. Renewable energy is a key driver of sustainable development in Nepal and contributes to reducing greenhouse gas emissions, improving access to energy, as well as energy security (Dahal & Bhattarai, 2020). The integration of solar, wind, and hydropower energy contributes towards the transformation of the nation into a sustainable and resilient energy system (Adhikari, 2021). Alternative technologies such as biogas, improved cooking stoves, and off-grid solar systems have played a significant role in the pursuit of sustainability and the energy needs of rural communities (Sharma & Pradhan, 2019). These technologies have reduced environmental impacts, improved public health, and contributed to economic development (Bista, 2020).

Hydropower is Nepal's biggest energy source and possesses great potential for enabling sustainable development (Mahat et al., 2018). It provides clean, renewable energy and can drive economic growth through power export. However, hydropower projects face issues such as finance, social impacts, and environmental concerns (Upreti & Shrestha, 2019). Therefore, renewable energy derives from limitless sources, which is naturally replenished on a human timescale, in contrast to fossil fuels from finite sources. Renewals are abundant forms of energy because they do not produce exhaust and will not pollute the planet by emitting toxic chemicals and gases. It protects people from the externalities of the environment and it has an essential role in the production of goods and services, which contributes to welfare. By using renewable energy, living standards can be improved and sustainable development can happen (UNDP, 2015-35).

### Objective of the Study

General aim of this research paper is to analyze the role of renewable energy use and its impact on development. The major purpose of this study is to assess how renewable energy is creating a sustainable development of a nation in the livelihood of the people in Nepal.

## Methodology

This paper highlights and interlinks with the concept of use of renewable energy and development. The study is done based on the analysis of major factor affecting as renewable energy for the development sustainability in Nepal. This research employs mixed method research following descriptive analysis. The study has occupied secondary source of data which are more qualitative and less quantitative in nature; for this purpose; some relevant renewable energy based data of Nepal Electricity Authority (NEA) from 2018 to 2023 was collected with selecting to the hydro electricity as a major case reference in this study. The collected data has been analyzed using simple statistical techniques (percentile and ratio) with supporting by textual thematic analysis techniques.

## Results and Discussion

### Use of Renewable Energy Sources in Nepal

Nepal has been actively relying on assistance between the two to develop a framework that includes hydropower. The historical background of hydropower in Nepal was not that long. The country's first hydropower agenda was built in 1911 with the support of the United Kingdom at a 500KW capacity Pharping hydropower plant (Dhungel, 2016).

Most of the rural areas of Nepal are being inaccessible because of the hard topographical setting and the dispersed type of settlement. A dependable electrical system which serves the whole population may be a desirable long-term objective. Due to the low population density and increased technical losses that come along with expanding transmission networks, grid expansion has rarely been the most cost-effective way to give access to rural areas (Alliance for Rural Electrification, 2009). Thus, the commercial sources of energy are not reaching to the remote parts of the country as the demand of rural areas.

In the highland and middle land in Nepal, there are many rivers and streams with high-speed gravity flow from where the electricity can be generated through hydro. The electricity helps to reduce the indoor pollution the one hand and on the other hand, it will significant for the sustainable use of the available potentially renewable resources. In Nepal, the situation sources of energy are quite suitable according to the topographical setting and the settlement patterns of the country for the fulfillment of the demand of energy. The 2011 National Population Census found that 67 percent of households (nearly 94 percent of urban households and 61 percent of rural households) provide energy access, although the amount and standard of supply can be uncertain (CBS, 2011). Current levels of access to modern energy services and resources fail to meet the needs of most Nepalese particularly the rural-urban topography condition in Nepal. This is mainly due to how difficult it is to build transmission lines on uneven, hilly terrain. Governments should therefore introduce regulations to encourage the development to affordable renewable energy sources such as hydropower, solar, wind and biogas, as well as more effective use of conventional biomass fuels that controls over the imported fuels as well as fragile economic condition (NEA, 2020).

**Table1**

*Level of Imported Fuel Consumption in (Kiloliter)*

| Source of Energy | 2017/18 | 2018/19 | 2019/20 |
|---|---|---|---|
| Diesel | 488675 | 566827 | 512128 |
| Petrol | 1588869 | 1714917 | 1473536 |
| Kerosene | 22337 | 25004 | 137424 |
| Aviation Turbine Fuel | 197220 | 200108 | 137424 |
| Liquefied Petroleum Gas (M.T.) | 370560 | 429609 | 449063 |

*Source:* Nepal Oil Corporation, M.T. = Metric Ton

Economic derivatives are perceived by the country itself to be the most essential part of energy production and use. Because of it and, many of the clean energy research studies appeared to focus on perspectives of economic and environmental change however they were equally significant in social and cultural growth in particular. Similarly, in the table 1, data on imported non-renewable fuel consumption trend from 2017 to 2020 shows, petrol is in the first rank, diesel in second, and liquefied petroleum gas found in third rank consumption in Nepal. Thus, many people still like to use fossil fuels, although the likelihood of renewable energy sources is immense.The country is being highly dependent on imported fossil-based energy sources because Nepal is still lagging behind in the production process of its own fossil-based energy and it has also failed to meet the target for building large and medium mega-hydropower projects. Thus, country faces the challenges of extend the electrical power system, and faces frequent power shortages

## Major Renewable Energy Sources in Nepal

There are three types of energy sources in Nepal. They are commercial, conventional, and alternative clean energy (WECS, 2006). Commercial energy sources include electricity from conventional fossil fuels, carbon-intensive energy sources (coal and oil), and large-scale hydroelectric power plants that leave no environmental footprint. Conventional energy sources include biomass components such as animal manure, biogas, and agricultural by-products used for direct burning of firewood.

Alternative energy sources include all unconventional energies such as hydroelectric power, solar energy, different types of biomass energy, biogas, and wind energy together account for approximately 85% of Nepal's total energy consumption and about 28% of Nepalese households filled with traditional biomass energy that they do not have access to electricity (CBS, 2011).

## Hydropower Energy in Nepal

Hydroelectric power is the main source of base load power generation due to the stability of the generator. Despite its high initial capital costs, it provides one of the cheapest and cleanest power sources. Hydroelectric power makes renewable energy considered an energy source that has lower levels of greenhouse carbon dioxide (CO2) production. As a sustainable energy source, hydroelectricity a important commercial common energy sources. Through constructing dams and seawalls, large reservoirs and using drive turbines in the stream or river for generating electricity that it accepted 556.8 MW in Nepal (NEA, 2023).

Source of electricity is generally more reliable than wind and solar (especially if powered by tidal power compared to riverside) that helps store power for peak demand. Similar to wind power, hydro power is in some cases more feasible as a commercial energy options depending on consumption and type but relating with asset class, it probably consumed for off-grid residential production. The total number of NEA consumers increased by 6.81% from last year's 4,782,710 to 5,108,588. Throughout the year, NEA is serving 5,80,177 consumers through 516 communities and 1,882 load centers under CRED and it reached the overall number of NEA customers increased by 6.17% to 5,648,042 in the fiscal year 2079–2080 from 5,319,645 the previous year. 513,984 customers of NEA are receiving power through 471 Community through this F.Y. 2079–2080 under CRED. (NEA, 2020/21; NEA, 2022/23).

**Table 2**

*Five Years Comparison in Numbers of Electricity Users in Nepal*

| Year | Numbers Consumers |
|---|---|
| 2018/2019 | 3909641 |
| 2019/2020 | 4217710 |
| 2020/2021 | 4528411 |
| 2021/2022 | 4766021 |
| 2022/2023 | 5134058 |

*Source:* NEA, 2022/2023

Above result depicts the level of electrification process in Nepal is slow instead of being rapid construction and its use for achieving the national target of 2085BS. From the date 2018/2019 to 2022/2023, Nepal has increased the access of only 1224417 populations as electricity consumers which is comparatively small size in number than other nations in SAARC that this result has predicted the other five year till 2085BS. Thus, the decade of electrification 2075 to 2085BS probably would not be success to meet its targets.

## Nepal's Progress in Hydro-Electricity Comparing with some SAARC Countries

Nepal's energy demand has evolved over time with significant reliance on traditional means like fuel wood. Hydroelectric power emerged as a vital part of the country's energy mix in 2023. The Nepal Electricity Authority (NEA) achieved an installed capacity of hydropower at 626.7 MW by the year 2022, generating 3,242.5 GWh of electricity. The country's overall energy consumption in FY 2078/79 totaled

639.97 PJ. Renewable energy, i.e., hydro, accounted for 2.52% of the total energy mix. The growth in renewable sources, especially hydropower, reflects the increasing role of new energy solutions in Nepal's energy supply (Energy Synopsis Report, 2024 WECS).

South Asian countries have registered impressive development in hydropower and renewable energy. Nepal has seen growth in its hydropower sector, with installed capacity at 626.7 MW in 2022, being a major contributor to the energy mix (NEA, 2022). Nepal has also seen positive development in renewable energy, with hydropower leading the energy sector. Afghanistan, in 2020, achieved 19% of the overall energy supply from renewable sources, including hydropower, despite a slight decline in renewable supply (International Renewable Energy Agency, 2020). The energy capacity of Bangladesh was 24,911 MW in FY 2022-23, with focus placed upon the growth of renewable energy, although individual contributions of hydropower are not discussed (Report of Bangladesh Power Development Board, 2022-23).

In the context, with an installed capacity of 2,334.1 MW in 2022 and exports of 7,240 GWh, hydropower continues to be a major source of energy for Bhutan (Bhutan Energy Data Directory, 2022). Hydropower is a significant component of India's renewable energy mix, helping to reach 1,09,885 MW of total renewable capacity by 2022 (Energy Statistics India, 2023). 25.8% of Pakistan's total capacity, which was 41,050 MW in FY 2023, comes from hydropower (Economic Survey Report of Pakistan, 2022-23). With hydropower accounting for 28% of total electricity output, Sri Lanka also depends on this source (Report of Ministry of Power and Energy, Sri Lanka, 2022).

## Policies and Plans for Hydro-Electricity Development in Nepal

A variety of legislative and strategic initiatives are included in Nepal's energy strategy with the goal of growing the country's energy industry. While water resources conservation and balanced usage are the main objectives of the Water Resources Act of 1992, the Nepal Electricity Authority Act of 1984 governs the production and distribution of electricity (Government of Nepal, 1992). Both the 1992 and 2001 Hydropower Development Policies promote private sector participation in hydropower development (Hydropower Development Policy, 1992, 2001). Community electrification is supported by the NEA Community Electricity Distribution Bye Laws of 2003, and local governments are empowered to supervise small and micro hydropower projects under the Local Self-Governance Act of 1998 (Nepal Electricity Authority, 2003).

In the similar spirit, the Rural Energy Policy of 2006, which encourages the use of renewable energy technologies in rural areas, complements the National Water Plan of 2005, which establishes goals for rural electrification (Government of Nepal, 2005, 2006). The Renewable Energy Subsidy Policy (2000-2016) and the RE Subsidy Delivery Mechanism for Special Programs (2018) both encourage off-grid electrification (Ministry of Energy, 2018). By 2030, energy efficiency is to quadruple, according to the 2018 National Energy Efficiency Strategy (Ministry of Energy, 2018). However, Nepal has increasingly focused on renewable energy, notably solar, wind, and biomass, to reduce its reliance on foreign fuels and diversify energy supply (Shrestha, 2020). The government has initiated policies and incentives in favor of renewable energy technologies but efforts are deterred in disseminating these technologies (Koirala&Thapa, 2021).

**Table3**

*Province wise Distribution of Consumers' Number of Hydro-Electricity*

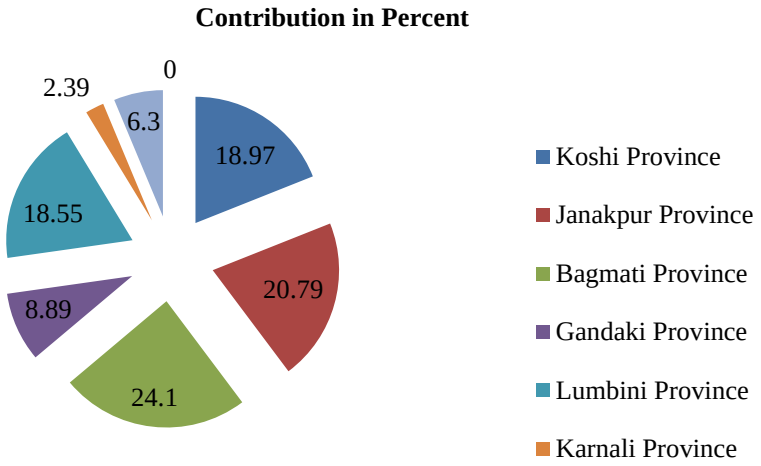
| SN. | Name of the Province | Number of Consumers (2020/21) | Number of Consumers (2022/2023) |
|---|---|---|---|
| 1 | Koshi Province | 858961 | 977100 |
| 2 | Madhesh Province | 941535 | 1059669 |
| 3 | Bagmati Province | 1091623 | 1190691 |
| 4 | Gandaki Province | 402706 | 480862 |
| 5 | Lumbini Province | 840075 | 947311 |
| 6 | Karnali Province | 108205 | 139073 |
| 7 | Sudurpaschim Province | 285306 | 339352 |

*Source:* NEA, (2020/21; 2022/2023).

Table 3, shows the data and status of province wise number of consumer's distribution of hydroelectricity in which total consumption level was found very low with comparing to the population in Nepal. The data depicts the very number of consumers found in Bagmati province and the lowest in Karnali Province. According to the result hydroelectricity infrastructures services and facilities is minimal in Karnali and Sudurpaschim provinces even having the high potentiality in of production respectively.

**Chart 1**

*Province wise overall Contribution of Hydro-Electricity*



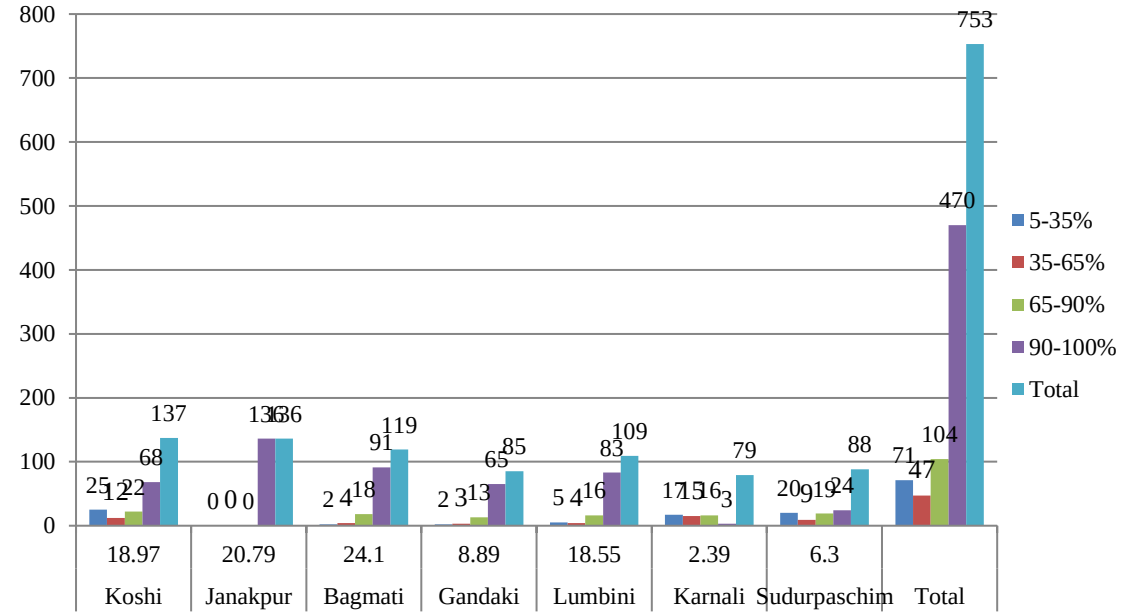

*Source:* NEA, (2020/21).

The data presented in the chart 1, has illustrated the province wise overall contribution is also very low; and here also the level of Karnali province found measurable it means the level of development of Karnali People is probably high measurable that most of them, they have still excluded from using electricity or depended on the non-renewable energy of fire wood or other sources.

The present scenario of electrification of household based on local levels is given in the table4 which is not sufficient however it has played the significant role in sustainable development in reducing the cost of imported non-renewable energy in Nepal. The government of Nepal has declared year 2075-2085 as Energy Decade and various distribution projects are scheduled to initiate and complete within this period.

**Figure1**

*Number of Local Levels based on Electrification Percentage*




*Source:* NEA, (2020/21)

The data presented in the figure number 1, pictures out the level of electricity consumers' category and revenue collected category in which in the year 2020/21, DCSD collected the revenue of NPR. 70.99 billion. The given data shows out of total consumers of NEA 92.91% are domestic consumers whereas the revenue from the domestic consumer is the highest with 39.63% share and industrial consumer fared second with 39 %; the situation is not satisfactory that the high consumption category has low revenue collection and unproductive as well from the perspective of sustainability. However, hydroelectricity is the dominant source of electricity in Nepal and accounts for over 90% of the country's entire energy production. However, usage is erratic due to seasonal fluctuation in the flow of water and transmission issues (Nepal Electricity Authority, 2023). The situation of this electricity domination and its major consumption sectors are wisely described in the table number 4.

**Table 4**

*Distribution of Electricity Consumers' Category and Contribution of Revenue Collected Category*

| Consumers' Category (GWH) | Types of Uses Percent 2022/2023 | Revenue Collection Category Percent 2022/2023 |
|---|---|---|
| Domestic | 92.32 | 38.15 |
| Commercial | 0.76 | 11.43 |
| Industrial | 1.31 | 38.44 |
| Irrigation | 3.34 | 0.39 |
| Non-commercial | 0.70 | 4.30 |
| Non-domestic | 0.09 | 3.87 |
| Others | 0.48 | 3.43 |

*Source*: Nepal Electricity Authority (NEA), 2022/2023

The above situation mentioned in the data in the table number 4, indicates the slow motion of hydro-electricity development in Nepal because the country it has the high potentiality of generating (83000 MW) electricity from source of easy viable rivers and streams but only the 710 MW of total produced 1182 MW

electricity. However, for its better and long term development of electrification Nepal; total 186 projects have been implemented, there are 177 33/11kV electrification, system improvement and refurbishment projects, 33kV6/8MVA substation projects and five line construction projects. Out of total 186: 136 projects are completed and 50 are ongoing in terms of sustainable electrification in Nepal (NEA, 2020/2021; 2022/2023).

## Solar Energy

Sunlight is one of the most abundant and free energy sources on earth. The quantity of solar energy that hits the Earth's surface in one hour exceeds the total amount of energy the earth needs in one year from other sources. In Nepal total production of solar energy is 86.94 MW; 25 MW is installed by NEA and 61.94 by solar system thus, it can be a perfect renewable energy source, but the amount of solar energy available varies by time of day and seasons well as geographic location (NEA, 2023).

Solar energy directly harnesses the limitless power of the sun to generate heat, light, and electricity. Being renewable and sustainable, solar energy is utilized using panels and mirrors. Two types of solar energy technologies are available in Nepal: solar thermal and photovoltaic (PV). Solar thermal systems include solar water heaters, solar dryers, and solar cookers. Photovoltaic systems include solar communication systems, photovoltaic systems, photovoltaic systems, etc. Solar cells convert sunlight directly into electrical energy through the assumed photoelectric effect. Nepal saw an early case of PV electrification in the countryside when three PV mini-grids were installed in 1988/1989 with the support of the French government (Rai and Piya, 2003).

## Wind Energy

Wind is an abundant source of clean energy. Although wind energy is one of the cheapest and cleanest renewable energy sources, wind is still unharnessed energy resource in Nepal (WECS, 2010). Nepal has produced 113.6 KW wind energy that it is strongly influenced by local topography, water body weather patterns, vegetation, and other factors (NEA, 2023). Level of wind energy is heavily affected when "harvested" by wind turbines, the wind's flow can be used to generate electricity. Wind is still one of Nepal's untapped energy resources. It is not yet known atnational level how great that possibility is in the country. According to the study, in Palpa, Mustang, and Khumbu regions in Nepal, the potential for generating wind power has been shown to be good. Kaligandaki alone between Jomsom and Chusang alone has an estimated potential of 200 MW, that, if it fully utilized, it could provide 500 GH/year of energy (Dangrid, 1992).

## Biomass Energy

Biomass is a non-fossil organic substance of naturalsource. Nepal has produced 6 MW biomass energy (NEA, 2023). Nepal's biomass resources include fuel wood and products derived by the agricultural residues such as fodder grasses and shrubs such as rice husks, as well as animal waste and waste from forestry, agricultural, municipal and industrial activities such as sawdust and aquatic biomass. Non-fossil based biomass energy is a clean energy form that can be obtained biologically from living materials such as waste, wood, and alcoholic fuels. Biomass sources are specially designed to generate electricity or generate heat from it.

## Biogas Energy

Nepal has produced 74MW biogas energy that it is prepared when organic substance is digested in an anaerobic situation. The organic things which are being used in the production of biogas are typically consists of animal dung, human excreta, cattle manure, wastewater, kitchen waste (NEA, 2023).

Since the early 1990s, the most common biogas plant in developing countries has been the small domestic fixed dome model. Kitchen waste, toilet was tending animal manure are commonly used in domestic biogas plants. There are increasing efforts to utilize biogas produced from animal manure, manure, and vegetable waste in anaerobic bioreactors. Currently, there are over 170,000 domestic biogas plants in Nepal. Development in this area is supported by the Biogas Support Partnership (BSP), an independent non-profit organization funded by the Netherlands, Germany, and Nepal (Gautam, Baral, & Herat, 2009).

The first official biogas program was initiated by the Government of Nepal (HMGN) in 1974 and consisted of a construction loan from the Agricultural Development Bank of Nepal (ADBN). Accordingly, in 1977, the Gobar Gas project, a government controlled company was prone to promote the biogas technology development and the promotion of large-scale dissemination, was established (Mendis & van Nes, 1999: 1518). Of course, each biogas plant saves a lot of firewood. Biogas plants are more significantly efficient to manage excrement and wastewater, greatly improving hygiene.

## Energy Supply

Due to the harsh terrain environment and scattered settlement types, rural areas in Nepal are inconvenient for transportation. As table national network serving all citizens could be an attractive long-term vision. However, grid expansion does not necessarily prove to be the most cost-effective way to expand access in rural areas, mainly due to sparse population densities and increased technical losses from grid expansion (Rural Electrification Alliance, 2009). Therefore, commercial energy will not reach the remote areas of the country like the demand in rural areas. As well, the cost of infrastructure development is about 10 times different between lowlands and highlands. At the same time, the supply of electricity from the national grid is also quite expensive in these rural settlements. The cost of commercial energy sources is also increasing in rural areas due to the increased cost of energy transportation. At this time, the poor population is forced to use traditional energy sources, which leads to unsustainable use of local resources.

## Renewable Energy and Sustainable Development

Renewable energy sources have supported the improvement of technologies and innovations in a country, which is understood through the economic support of people's livelihoods and social development. These developments mean that renewable energies are in many circumstances cheaper than fossil and nuclear plants. Thus, more affordable for a larger number of consumers in industrialized and developing countries additionally, there are growing awareness of renewable energy resources and technologies and their ability to keep pace with increasing energy demands. At the same time, these renewable energies create jobs, accelerate economic development, reduce local air pollution, improve public health, and reduce CO2 emissions (REN21, 2014).

There are numerous ways to understanding sustainable development. Sustainable development is well defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). Similarly, the sustainability has significant relation with the level of renewable energy consumption that it has a great potential and can provide a wide range of socio-economic and environmental benefits for the development of specific regions. Sustainable energy source, hydroelectricity a major commercial energy sources developed and generate electricity it accepted 556.8 MW in Nepal (NEA, 2023). In recent years, alternative energy technologies have made significant developments in terms of performance and cost reduction. The enormous obstacle to development would be posed by fossil energy supremacy. It is generating not only an energy problem but also social, environmental, cultural as well as economic problems for the nation in general, underdeveloped and developing countries in particular to evaluate renewable energy opportunities on a global scale, it is important to consider the disparities between advanced and underdeveloped countries and the "particular needs and strengths" of both countries (Ahuja and Tatsutani, 2009).

In the context of maintaining sustainability in development and for sustainable development, the United Nations General Assembly has proposed asset of global Sustainable Development Goals (SDGs) comprising17sub-goalsand169goalstotheUnitedNationsinNewYork, Initiated by a working group. Additionally, a basic set of 330 indicators was published in March 2015 (Lu, Nakicenovic, Visbeck & Stevance, 2015). The Sustainable Development Goals are more valuable and needed to the scientific community than the Millennium Development Goals. Planning for climate change, renewable energy, food and health, and water deployment requires planning, global monitoring, and modeling of many variables in social, economic, and environmental locations (Hak, Janouskova, & Moldan, 2016). From this point on, the NPC report (2015), the country's manageable progress plan gathers to become the goal of improving Nepal's finances for government support and prosperity of the country. The successful use of Nepal's 1,000-year

progress goals has opened another path to achieving the projected economic progress goals for 2016-2030. To ensure community development and government support, Nepal has made steady progress towards achieving the Sustainable Development Goals at all levels, both public and local, and in neighboring areas. Indeed, long before the UN Global Plan, the Nepalese public authority had long put forward a public plan to end poverty, improve education for the nation, and various proposals based on this.

## Conclusion

The level of production and consumption of hydro-electricity as renewable energy source is found unsatisfactory in terms of its potentiality and viability in Nepal because the data shows the hydro energy, accounted at 2.52% of the total energy mix in 2022/23. Thus, the speed of hydro-electricity production trend is slow and its distribution system also found to be uneven mainly in the case of rural and geographically remote areas in Nepal. However, the different policy measures and speed of ongoing hydro-power projects after 2021, it has created the positive hope in the country for its production in terms of achieving development sustainability in Nepal. Thus, the use of more renewable energy is one of the key indicators of for measuring development sustainability. The overall utilization and use of own production based renewable energy source in Nepal is regarded inadequate comparing to other countries in the SAARC, particularly comparing with the speed of neighboring countries Bhutan and India. A person's livelihood is a means of securing the necessities of life as a lifelong activity that is indispensable to daily life. Peoples' Livelihood is sustainable when they can consume more renewable source based energy they can improve their well-being. For this purpose, Nepal is leading the concept of sustainable development with quantitative expansion on the premises of equitable distribution system for the qualitative transformation of peoples' livelihood. However, the government efforts are being ineffective and insufficient for materializing the plans in to action in time. It would be better that a policy drive for the development of decentralized, cost-effective and efficient off-grid renewable resources, like solar energy, can be a sustainable and affordable path for the country moving forward to increase energy penetration the increase demand in rural areas and maintaining sustainability in development in Nepal.

## About Author

Bhupendra Bahadur Shahi is an assistant professor, Mid-West University Surkhet and PhD Scholar, Tribhuvan University Kirtipur, he is an Expert in Rural Development having 17 years teaching experience.

## References

Adhikari, D. (2021). *Renewable energy in Nepal: Opportunities and challenges*. Nepal Journal of Renewable Energy, 13(1), 55-70.

Ahuja, D., &Tatsutani, M. (2009). Sustainable energy for developing countries. *SAPIENS, 2*. https://journals.openedition.org/sapiens/823

Alliance for Rural Electrification. (2009). *Annual report*. https://www.aler.renovareis.org/2009annualreport.pdf

Bangladesh Power Development Board. (2022-23). *Report of the Bangladesh Power Development Board*. Bangladesh Power Development Board.

Bhandari, B. (2021). *Energy constraints in Nepal: The road ahead*. Nepal Energy Review, 7(2), 112-125.

Bhandari, R., & Tiwari, P. (2021). *Sustainable energy solutions in Nepal*. Journal of Sustainable Development in Nepal, 5(4), 101-118.

Bhattarai, P., & Sharma, D. (2022). *The role of energy in achieving sustainable development goals in Nepal*. International Journal of Development and Sustainability, 8(3), 205-221.

Bhutan Energy Data Directory. (2022). *Bhutan energy data directory 2022*. Ministry of Economic Affairs, Royal Government of Bhutan.

Bista, P. (2020). *Alternative energy technologies for rural development in Nepal*. Renewable Energy Resources, 9(1), 60-73.

Brundtland Commission. (1987). *Our common future*. World Commission for Environment and Development. https://sustainabledevelopment.un.org/5985pdf

Central Bureau of Statistics (CBS). (2011). *Population census of Nepal*. Kathmandu.

Dahal, S., &Bhattarai, S. (2020). *Renewable energy for sustainable development in Nepal*. Renewable and Sustainable Energy Reviews, 16(3), 1458-1473.

Dhungel, R. K. (2016). A history of FDI in hydro development in Nepal. *Journal of Water, Energy and Environment, 18*. https://doi.org/10.3126/hn.v18i0.14639

Economic Survey Report of Pakistan. (2022-23). *Economic survey 2022-23*. Ministry of Finance, Government of Pakistan.

Edenhofer, O., et al. (2011). The IPCC special report on climate change mitigation. *Intergovernmental Panel on Climate Change (IPCC)*. https://www.economicpolicyresearch.org/wpoooo04

Gautam, R., Baral, S., & Heart, S. (2009). Biogas as a sustainable source in Nepal: Present status and future challenges. *Renewable and Sustainable Energy Reviews*, *13*(1), 248–252.

Government of Nepal. (1992). *Water Resources Act, 1992*.

Government of Nepal. (2005). *National Water Plan, 2005*.

Government of Nepal. (2006). *Rural Energy Policy, 2006*.

Hak, T., Janoukov, S., &Moldan, B. (2016). Sustainable development goals: A need for relevant indicators. *Ecological Indicators, 60*, 565–573. https://dl1cuni.cz/918352

Harris, I., Mumford, C., Naim, M., Palmer, A., & Potter, A. (2011). Assessing the impact of cost optimization based on infrastructure modeling on CO2 emissions. *An International Journal of Production Economics*, *131*(1), 1-10. https://doi.org/10.1016/j.ijpe.2010.03.005

Harris, J. M. (2000). *Basic principles of sustainable development*. Dimensions of Sustainable Development, Tufts University, Medford, Massachusetts, USA. https://books.google.com.np

Hydropower Development Policy. (1992, 2001). *Hydropower Development Policy of Nepal*.

International Renewable Energy Agency. (2020). *Renewable energy capacity statistics 2020*. International Renewable Energy Agency.

Koirala, P., &Thapa, S. (2021). *Promoting renewable energy: Government policies in Nepal*. Journal of Nepalese Energy Policy, 6(2), 90-103.

Lu, Y., Nakicenovic, N., Visbeck, M., &Stevance, A. S. (2015). Policy: Five priorities for the UN sustainable development goals. *Nature, 520*, 432–433. https://www.nature.com/articles/520432a

Mahat, T., Shrestha, A., & Pradhan, K. (2018). *Hydropower potential and development in Nepal*. Nepal Energy Review, 4(3), 36-50.

Ministry of Energy. (2018). *National Energy Efficiency Strategy, 2018*.

Ministry of Energy. (2018). *Renewable Energy Subsidy Policy (2000-2016) and the RE Subsidy Delivery Mechanism for Special Programs*.

Ministry of Power and Energy, Sri Lanka. (2022). *Report of the Ministry of Power and Energy, Sri Lanka, 2022*. Ministry of Power and Energy, Sri Lanka.

Ministry of Statistics and Programme Implementation, Government of India. (2023). *Energy statistics 2023*. Ministry of Statistics and Programme Implementation, Government of India.

National Planning Commission (NPC). (2015). *Annual report*. Government of Nepal.

National Planning Commission (NPC). (2049). *Eighth five year plan*. Ministry of Finance, Government of Nepal.

Nepal Electricity Authority (NEA). (2020/21). *Distribution and consumer services directorate, yearbook 2020/21*. https://nea.org.np/admin/assets/2020pdf

Nepal Electricity Authority (NEA). (2022). *Annual report 2022*. Nepal Electricity Authority.

Nepal Electricity Authority (NEA). (2022/23). *Distribution and consumer services directorate, yearbook 2022/23*. https://nea.org.np/admin/assets/2022pdf

Nepal Electricity Authority. (2023). *Annual energy generation and consumption report*. Kathmandu: Nepal Electricity Authority.

Nepal Electricity Authority. (NEA). (2003). *Community Electricity Distribution Bye Laws, 2003*.

Nepal Oil Corporation (NOC). (2006). *Nepal Oil Corporation, M.T.*https://noc.org.np

Pokhrel, P. (2022). *Energy cost dynamics in Nepal: An overview*. Journal of Energy Economics, 14(1), 98-105.

Rai, S., &Piya, R. (2003). Stimulating rural development through solar energy. In *Conference proceedings on renewable energy*.

REN21. (2014). Geothermal power growth: A comparison with other renewables. https://opendocs.ids.ac.uk/20.500.12413/775

Sharma, D. (2019). *Energy constraints in Nepal: A critical analysis*. Journal of Nepalese Energy Studies, 11(2), 74-88.

Sharma, R., & Pradhan, N. (2019). *Alternative technologies for sustainable development in Nepal*. Renewable Energy Technologies, 8(1), 34-47.

Sharma, R., Singh, S., & Gupta, R. (2020). Energy consumption and its impact on sustainable development. *Journal of Sustainable Development, 15*(3), 45-60.

Shrestha, R. (2020). *Renewable energy solutions for rural Nepal*. Journal of Energy Solutions, 10(2), 112-130.

Thapa, M., & Sharma, G. (2021). *Energy cost analysis in Nepal: Challenges and solutions*. Nepal Journal of Energy Economics, 17(1), 27-41.

Thapa, S., Maharjan, L., & Sharma, N. (2022). *Hydroelectricity consumption trends in Nepal (2018–2024)*. Nepal Energy Review, 6(2), 74-89.

United Nations Development Programme (UNDP). (2015–2035). *The SDGs in action: Sustainable development goals*. https://www.undp.org

Upreti, B. R., & Shrestha, M. (2019). *Hydropower and its sustainable development: A case study of Nepal*. Journal of Sustainable Energy Studies, 12(1), 33-48.

Water and Energy Commission Secretariat (WECS). (2006). *Energy sector synopsis report Nepal*. Government of Nepal. https://wecs.gov.np/pdf

Water and Energy Commission Secretariat (WECS). (2010). *Energy sector synopsis report Nepal*. Government of Nepal. https://wecs.gov.np/pdf

Water and Energy Commission Secretariat. (2024). *Energy sector synopsis report 2024 (FY 2079/80)*. https://wecs.gov.np/source/ESR_2024.pdf