Government of Nepal
Water and Energy Commission Secretariat
Singhadurbar, Kathmandu



ENERGY SECTOR SYNOPSIS REPORT

2024

2081

Executive Summary

Water and Energy Commission Secretariat (WECS) is the focal organization of Government of Nepal for collecting, analyzing and publishing the data related to water and energy. WECS is publishing Energy Synopsis Report since its establishment. This Synopsis Report is the flagship publication of Nepal's energy sector. The current report has been prepared to provide the information about key trends and insights of Nepal's energy supply and consumption in the fiscal year 079/80 (2023). In addition, it provides the energy consumption in different sectors viz. Residential, Commercial, Industrial etc. The Overall energy consumption of this fiscal year 079/80 is estimated at 532.42PJ, which is 16.81% lower than the consumption of 640 PJ in previous year (FY 078/79). Energy resources of Nepal is classified as traditional energy (Fuelwood, Agriculture Residue and Animal Dung), Commercial energy (Coal, Petroleum Products, Electricity) and Renewable Energy (Solar, Wind, Microhydro, Biogas etc.).

The consumption of Traditional, Commercial and Renewable energy resources are 63.87% (340 PJ), 33.03% (175.87 PJ) [25.80% (137.38 PJ) fuels and 7.23% (38.49 PJ) grid electricity] and 3.1% (16.5 PJ) respectively. Overall consumption of traditional resource has decreased by 17.2% as compared to previous FY. Likewise, overall consumption of commercial resource excluding grid electricity has reduced by 24.27% as compared to previous FY. The import and national production of coal has decreased than previous FY. Consumption of coal is reduced by 41.50% and petroleum product is reduced by 16.14%. The effect of financial recession happening worldwide has also hit the economic activities in Nepal. As the economic activities went down, it has an effect on the consumption of commercial energy, particularly coal and petroleum products. The consumption of electricity has increased by 21.18% in FY 2079/80. The electricity sector experienced significant growth in both internal sales and exports, with internal sales reaching 9,358 GWh and exports at 1,346 GWh. According to the 16th Periodic Plan, 98% of the population now has access to electricity in which 96.7% is from grid connected electricity whereas 1.3% other isolated off-grid system (Solar, Wind, Mircohydro). The per capita electricity consumption has reached 369.58 kWh. The construction of 5,742 circuit km of transmission lines (66 kV and above) supports this increased accessibility. The shift from petroleum to electricity for transportation further underscores the decreasing reliance on fossil fuels. The energy efficiency of electricity and renewable sources is significantly higher compared to petroleum products and coal. This higher efficiency leads to less wastage of energy during consumption, making renewables a more sustainable and cost-effective option in the long run. A positive trend for the utilization of renewable energy sources was observed with an increase by 2.39% compared to the previous fiscal year. Despite their relatively small contribution, renewable energy resources are gradually becoming a more significant part of Nepal's energy mix, steering the nation towards a sustainable future.

Sector wise energy consumption is also assessed. The residential sector dominates energy consumption with 60.75%, which is followed by the industrial sector (20.91%), transportation sector (10.43%), the commercial sector (5.04%), construction and mining sectors (1.92%) and the agriculture sector (0.95%).

This report recommends to include hydroelectricity as renewable energy resource in the analysis in coming FYs as electricity was kept in the commercial energy resources category till date. WECS has recently completed the detailed survey about energy supply, consumption and developed different scenarios of demand upto 2050 in all the 7 provinces of Nepal. It is also recommended to firm up and consolidate the energy consumption analysis with the use of such surveyed data in coming FYs.

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List of Abbreviations

AEPC	Alternative Energy Promotion Centre
ATF	Aviation Turbine Fuel
B.S.	Bikram Sambat
CBS	Central Bureau of Statistics
DoC	Department of Customs
DoED	Department of Electricity Development
DoFSC	Department of Forest and Soil Conservation
DRE	Department of Renewable Energy
FY	Fiscal Year
GDP	Gross Domestic Product
GJ	Giga Joule
GVA	Gross Value Added
GWh	Gigawatt hour
HH	Household
IEA	International Energy Agency
IPP	Independent Power Producers
IPPAN	Independent Power Producers' Association Nepal
IRENA	International Renewable Energy Agency
kL	Kiloliter
kW	Kilowatt
kWh	Kilowatt Hour
kWp	Kilowatt-peak
LPG	Liquefied Petroleum Gas
MoALD	Ministry of Agriculture and Livestock Development

MoEWRI	Ministry for Energy, Water Resources and Irrigation
MoF	Ministry of Finance
MoFE	Ministry of Forest and Environment
MTOE	Million Tons of Oil Equivalent
MW	Megawatt
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
NEA	Nepal Electricity Authority
NOC	Nepal Oil Corporation
NPC	National Planning Commission
NRs	Nepalese Rupees
OL	Other Lands
OWL	Other Wooded Land
PJ	Peta Joule
PV	Photovoltaic
RSS	Rastriya Samachar Samiti (National News Agency)
SAARC	South Asian Association for Regional Cooperation
SDG	Sustainable Development Goal
STEPS	Stated Policies Scenario
TJ	Tera Joule
TOE	Tons of Oil Equivalent
USD	United States Dollar
WECS	Water and Energy Commission Secretariat

Chapter 1: Introduction

Energy is not merely a measure of a nation's status and development but is an essential indicator of a country's economic standing and future prospects. Geopolitics is intertwined with it as a tool that provides insight into the overall potential of a given country, while also greatly impacting the world economy. This report examines the relationship between supply, demand and distribution in the global energy market as a factor that affects the economic systems of different countries. Thus, the need to build an enriched energy database cannot be overemphasized. It is useful in planning and strategizing in order to prevent future blackouts and to ensure sustainable development of energy power sources.

While undertaking the development agenda for Nepal, systematic energy studies and the establishment of strong databases are prerequisites. These elements serve as a base for strategic management, planning future infrastructure, and financial investment in the energy sector. They help to shift to renewable materials and provide an indication of how sustainable power use will look like in the future. The Energy Synopsis Report serves as a working manual in terms of compiling the various analyses and gives the stakeholders the essential information that is necessary for decision-making to ensure that Nepal gets a stable, sustainable, and secure energy system.

The Water and Energy Commission Secretariat (WECS) has a critical role in the process by gathering and supplying energy information, participating in the formulation of goals, and engaging in energy planning and the formulation of long-term energy policies. From 1990 to 1995, WECS in cooperation with other organizations carried out Sectorial Energy Supply/Demand Profiles at the regional level and Residential Energy Supply/Demand Profiles at the district level with an update in 1995/96. WECS in its 1998/99 survey included both traditional and modern industrial sectors in Industrial Sector Energy Consumption. Further surveys on commercial, transport and agricultural energy consumption were conducted in 1998/99, 1999/2000 and 2000/01.

In 2010, WECS published the Energy Synopsis Report, providing baseline information on energy resources and their distribution across different regions of the country. Continuing this effort, in 2011/12, WECS conducted a National Survey of Energy Consumption and Supply Situation in Nepal, which analyzed energy demand and supply across various economic sectors and regions. In 2013, WECS prepared the National Energy Strategy and Vision 2050, forecasting future energy demand and conducting scenario analyses for energy planning. The Energy Synopsis Report published by WECS in 2023 included detailed analysis of energy consumption and supply situations in Koshi Province, Madhesh Province and Bagmati Province.

1.1 Geography of Nepal

Nepal is a landlocked country, China in the north and India in the south, east and west. Additionally, the country can further be divided into three main physiographic regions: Terai, Hilly and Himalayan from east to west. The Terai region in the south covers about 23% of the total area, Hilly region in the north covers roughly 42% and Himalayan region in the far north covers about 35%. The altitudes in these regions vary greatly, from 60 meters above sea level in the Terai to 8,848.68 meters at the top of Sagarmatha (Mount Everest) in the Himalayan region. The Hilly region has valleys, flat lands, hills and mountains between 600 to 3,000 meters. The Himalayan region has 200 peaks above 6,000 meters and 13 peaks above 8,000 meters.

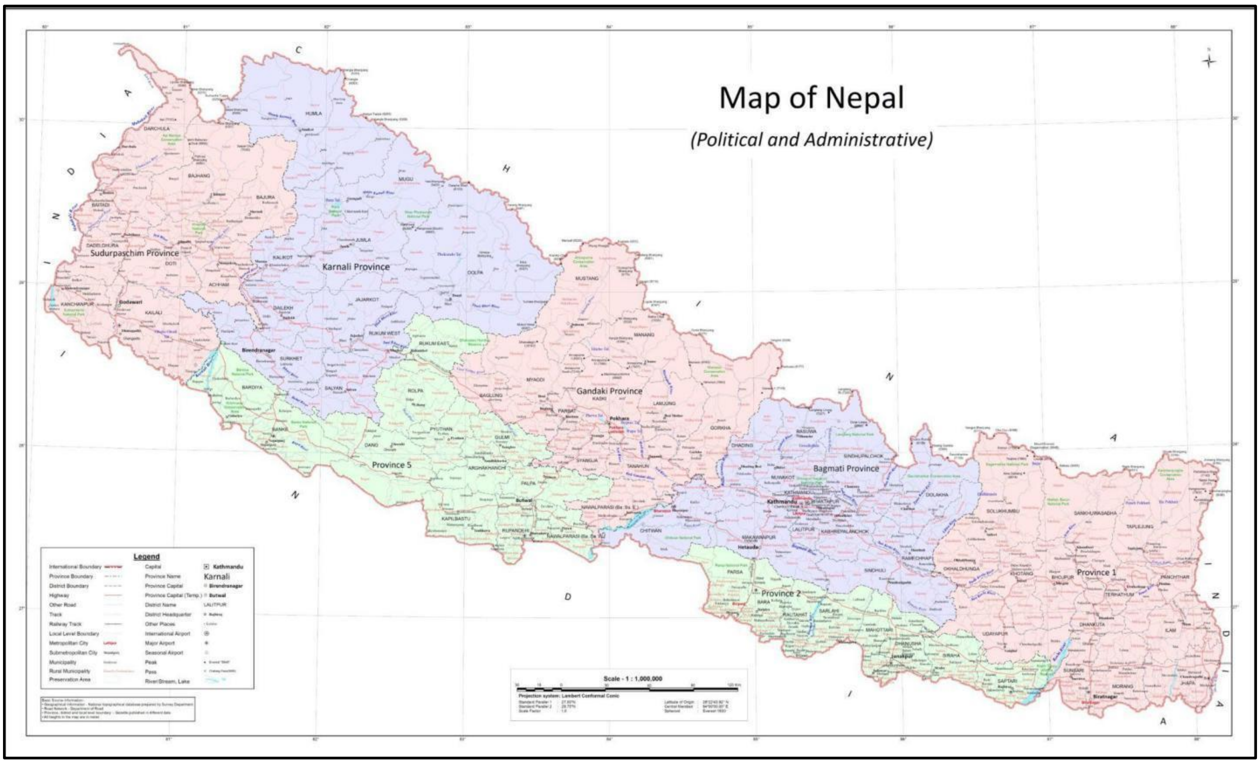

Figure 1.1: Political and administrative map of Nepal
(Source: https://www.dos.gov.np)

Nepal has three major river systems: Koshi, Narayani and Karnali which flows from north to south and are the tributaries of Ganges in northern India. The country lies in a subtropical climate zone and has a diverse climate from tropical in Terai to alpine and tundra in the northern parts. Temperature in Terai is 5°C to 47°C, in Hilly region 0°C to 28°C and in Himalayan region 16°C to below 0°C. Precipitation varies across the country, eastern region receives more rainfall than the western region and some central areas receive high rainfall. About 80% of the annual rainfall occurs during the monsoon season.

Nepal has rich biodiversity with a wide range of flora and fauna. But the country's natural resources are not sufficient to meet its economic needs. Commercial fuel resources are scarce, some methane gas reserves are found but petroleum deposits are not in significant amounts. Renewable resources, arable land is economically important but hydropower is largely untapped. Among metallic minerals, copper, gold, lead and zinc are found in abundance, only lead and zinc are commercially viable. Non metallic minerals like marble, talc and limestone are found to be commercially viable and dolomite and magnesite are found in deposits.

1.2 Demography of Nepal

According to the 2021 Census Report, the total population of Nepal was reported at 29,164,578, with a population density of 198 persons per square kilometer. The annual population growth rate was reported as 0.92%, with 6,666,937 households in the country, and an average household size of 4.37 persons.

Nepal's population distribution according to the urban, peri-urban, and rural areas are:

- Urban Areas: 27.1%
- Peri-Urban Areas: 39.7%
- Rural Areas: 33.2%

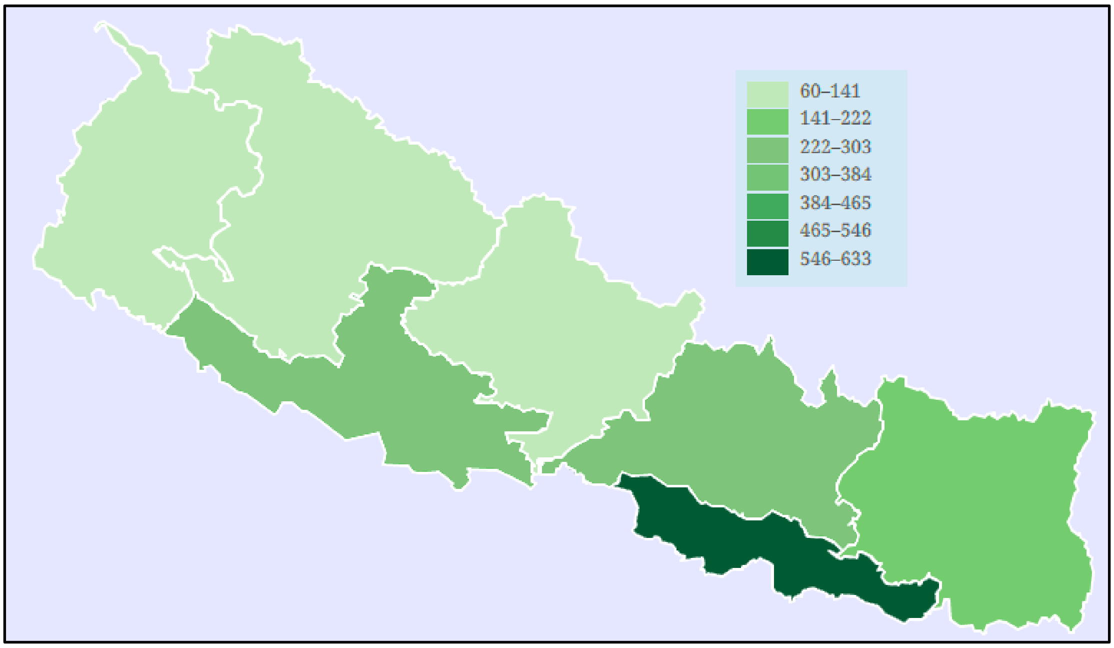

Figure 1.2: Population density by province
(Source: CBS, 2021)

The population distribution varies according to the different geographical regions:

- Terai Region: The majority of the population resides here, with 71.8% living in urban areas and 28.2% in rural areas.
- Hilly Region: 63.3% of the population lives in urban areas, while 36.7% resides in rural areas.
- Mountain Region: 35.6% of the population lives in urban areas, and 64.4% lives in rural areas.

The capital city, Kathmandu, is the most densely populated district, home to 7% of the total population. Madhesh Province is the most densely populated province, with 633 persons per square kilometer.

1.3 Economy of Nepal

The global economy in 2023 grew by 2.7%, and it is projected to continue expanding at a rate of 3.2% in 2024. Nepal's economy is estimated to expand by 3.87% in FY 2023/24, a slight improvement from the previous year's growth of 2.31%. The consumer price inflation (CPI) for 2023 is found to be 7.93% and in the present context of 2024 CPI stands at 6.08% until mid-march. The total Gross Domestic Product (GDP) in 2022 shows $41.18 billion dollars and in 2023 $40.91 billion and per capita GDP in 2022 is $1348.2 which changed to $1324.0 in 2023 (World Bank Open Data,2024).

Agricultural production has continued to show satisfactory growth, favored by monsoon rains that have positively impacted rice and other summer crops. However, challenges remain due to the unpredictable nature of winter rains affecting winter crop yields. The industrial sector's expansion is projected to remain diminished with an estimated decline of 1.6% (MoF, 2023), contributing 4.87% to the GDP. The service sector, while still dominant, is expected to face a slowdown with a projected contribution growth rate of 1.8%.

The economic activities in Nepal have faced significant challenges, hindering expansion. Among these challenges are increased current expenditure and fluctuating revenue collection. The cautious monetary policy implemented in Nepal has notably impacted investment figures, leading to a decreased flow of credit to the private sector and constrained capital expenditure across various government levels.

According to the World Bank's Nepal Development Update, private investment has remained sluggish, as evidenced by decreased imports of capital and intermediate goods. This sluggishness is attributed to the cautious monetary policy measures that have reduced the availability of credit for private enterprises (The World Bank, 2024).

Additionally, fiscal austerity measures have resulted in a contraction in public consumption and investment. (The World Bank, 2024) highlights that recurrent and capital expenditures were reduced as part of efforts to mitigate revenue shortfalls, reflecting a significant decrease in government spending. These combined factors have contributed to restrained economic activities and moderated growth observed in Nepal’s economy.

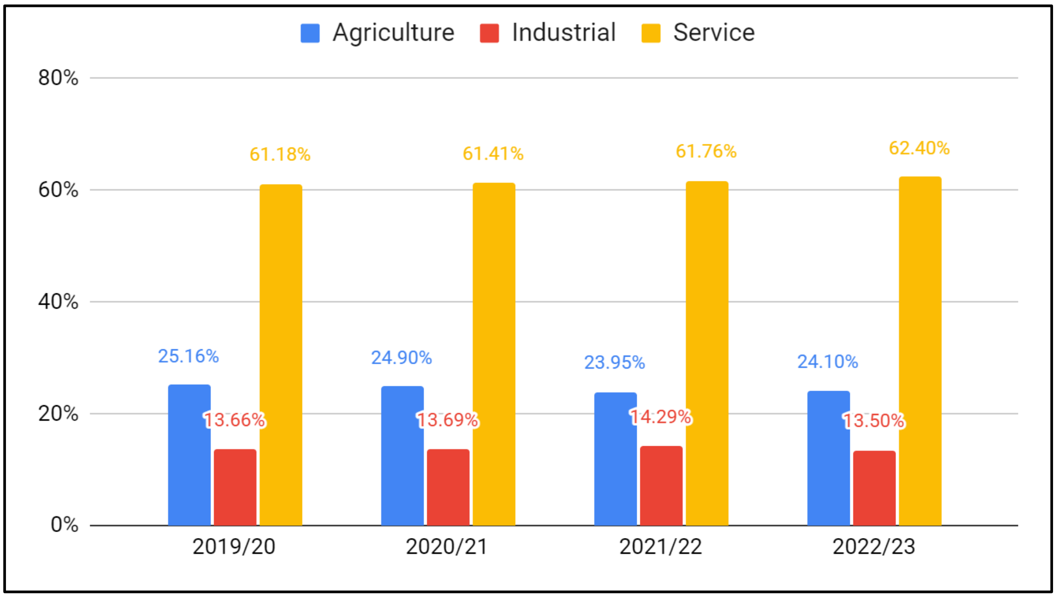

Figure 1.3: GDP composition trend line[1]
(Source: Economic Survey Report 2079/80)

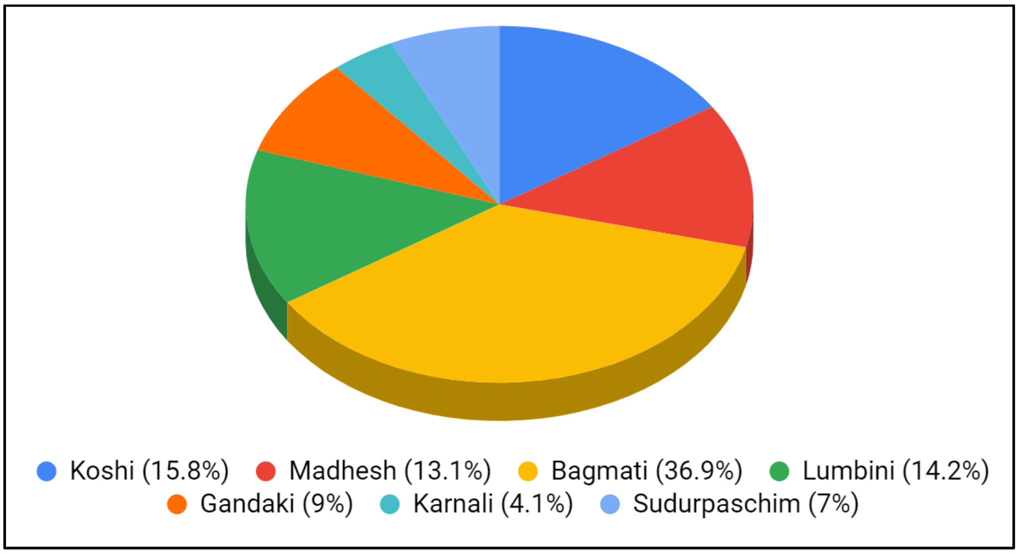

Figure 1.4: Province-wise GDP distribution
(Source: Economic Survey Report 2079/80)

The per capita gross national income (GNI) of Nepal increased from $1,405 in 2023 to $1,456 in 2024, indicating an upward trend. However, economic indicators suggest restrained economic activities and moderated growth. The World Bank projects a further increase in national disposable income per capita to $1,640, but emphasizes that overall economic growth remains moderate.

For FY 2079/80, the total value added by the agriculture sector is estimated to grow as the growth rate for agricultural and non-agricultural sectors are 2.73% and 1.92%, respectively. The growth rates in the previous fiscal year for the aforementioned sectors were 2.24% and 6.56% respectively showing a fall in the growth of non-agricultural sectors. [1]The service

[1] Annex: Table I

sector's contribution is expected to be 62.4%, with the industrial sector at 13.5%, and the agriculture sector accounting for 24.1% of GDP.

1.4 Energy Scenario of Nepal

According to Nepal's 2010 energy synopsis report, the country's overall energy consumption was 401 PJ in 2008/2009. Fuelwood accounted for the majority of energy use (77.7%). In addition, agricultural residue and animal manure provided 4% and 6%, respectively, to the energy mix. Petroleum fuels accounted for 8% of total energy usage, while coal and electricity, combined, contributed 4%. The traditional sources accounted for 87% of the total consumption, followed by commercial sources (12%) and renewable sources (1%).

Nepal's energy use has varied over the years. Fuelwood accounted for 62% of total energy usage in 2019, totaling 589 PJ. Agricultural residue and animal manure constituted 3.1% and 3.2%, respectively, while petroleum products made up 15.4%. Coal consumption accounted for 6.9%, LPG for 3.3%, and electricity for 3.9% of total energy use, and the renewable sources accounted for 2.1% of the total energy mix. The distribution of energy sources, classified as traditional, commercial, and renewable, accounted for 68.3%, 29.6%, and 2.14%, respectively.

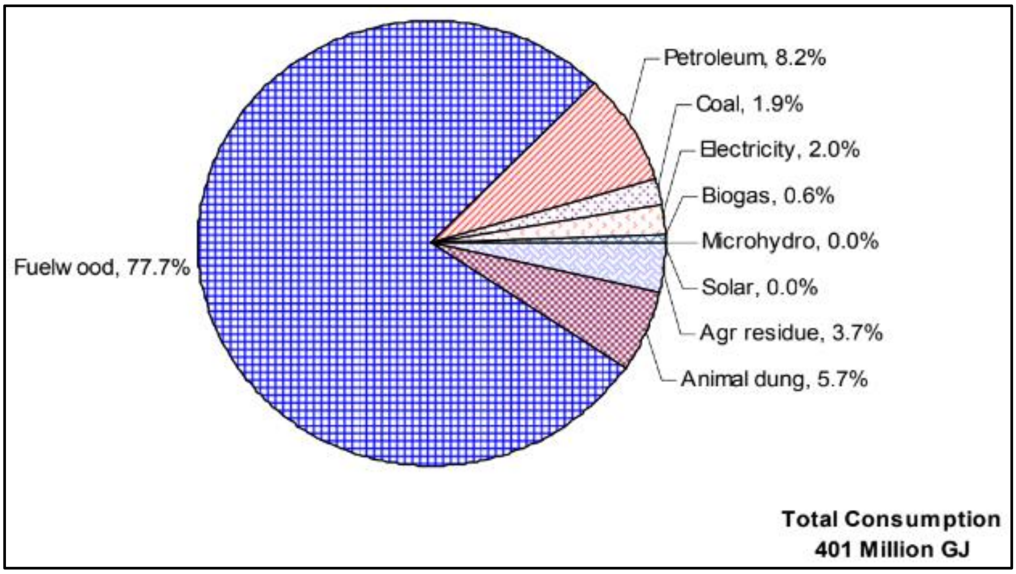

Figure 1.5: Total energy consumption by fuel-types (FY 2008-09)
(Source: Energy Synopsis Report 2010, WECS)

In 2020, the total energy consumption decreased slightly to 566 PJ. Fuelwood remained the predominant energy source, increasing to 64.9% of the total mix. Other sources, including agricultural residue and animal dung, remained relatively stable. However, petroleum fuels decreased to 10.8%, while coal and LPG showed minor increases. Electricity consumption slightly rose to 4.1%, and renewable sources increased to 2.6%. Traditional energy sources represented 71.3% of the total mix, commercial sources decreased to 26.2%, and renewable sources matched the previous year's figure at 2.6%.

In 2021, Nepal's total energy consumption increased to 626 PJ. Fuelwood remained the primary energy source, albeit decreasing to 60.4% of the total mix. Petroleum fuels decreased slightly to 14.3%, while coal increased to 9.3%. LPG and electricity consumption remained relatively stable. The renewable energy sources experienced a slight increase, reaching 2.4% of the total mix. The distribution of energy sources showed traditional sources at 66.3%, commercial sources at 31.3%, and renewable sources at 2.4%. These fluctuations in energy consumption and source distribution highlight the dynamic nature of Nepal's energy landscape over the years.

The Energy Synopsis Report of 2023 provides a comprehensive overview of the energy sources in Nepal and the overall consumption situation. Traditional energy consumption constitutes 64.17% of the total energy consumption. Nepal Electricity Authority (NEA) played a pivotal role in the commercial energy sector, achieving an installed hydropower capacity of 626.7 MW and generating 3,242.5 GWh of energy by 2022.

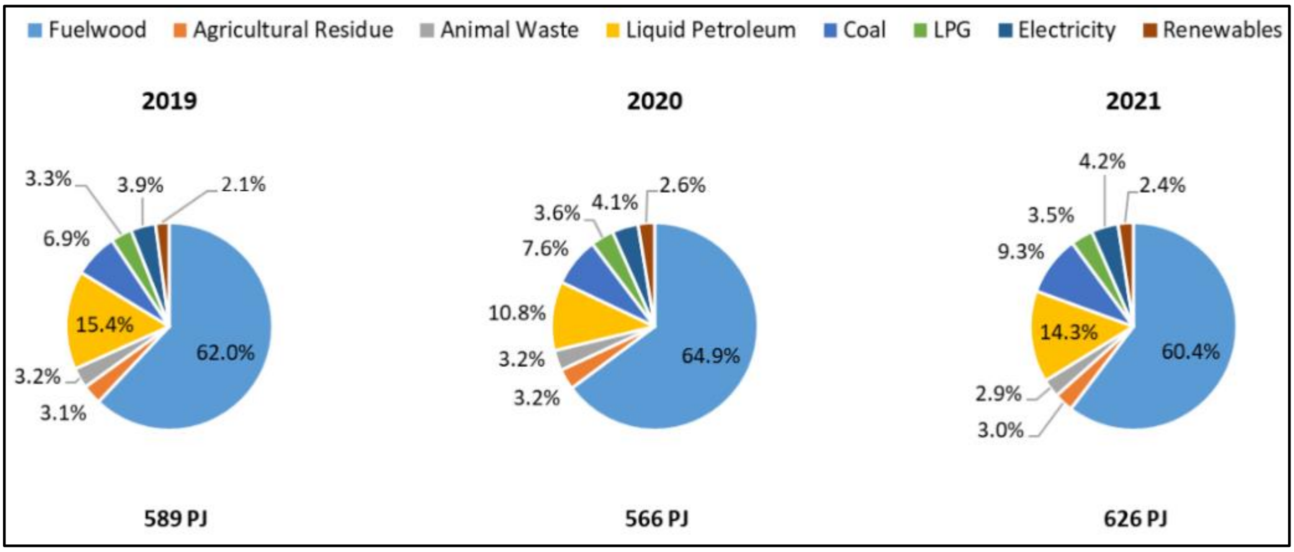

Figure 1.6: Energy consumption of Nepal in 2019, 2020, and 2021
(Source: Energy Synopsis Report 2022, WECS)

Notably, in FY 2078/79, electricity production increased by 14.61% compared to FY 2077/78, with the Independent Power Producers (IPP) accounting for 1,709 MW of installed capacity. The petroleum sector, operated by the Nepal Oil Corporation (NOC), endures shifts in petrol, diesel, kerosene, and LPG sales, while coal production mostly serves the brick-making industry. Electricity and other commercial fuel usage make up 4.96% and 28.35%, respectively. Modern renewable sources, such as micro/pico hydro plants, biogas, solar PV systems, and wind energy, are emerging as viable options, with solar PV systems alone having a theoretical capacity of 2,100 MW. In fiscal year 2078/79, total energy usage was reported as 639.97 PJ. Renewable energy (without grid electricity) accounts for 2.52% of the energy mix and has a positive trajectory.

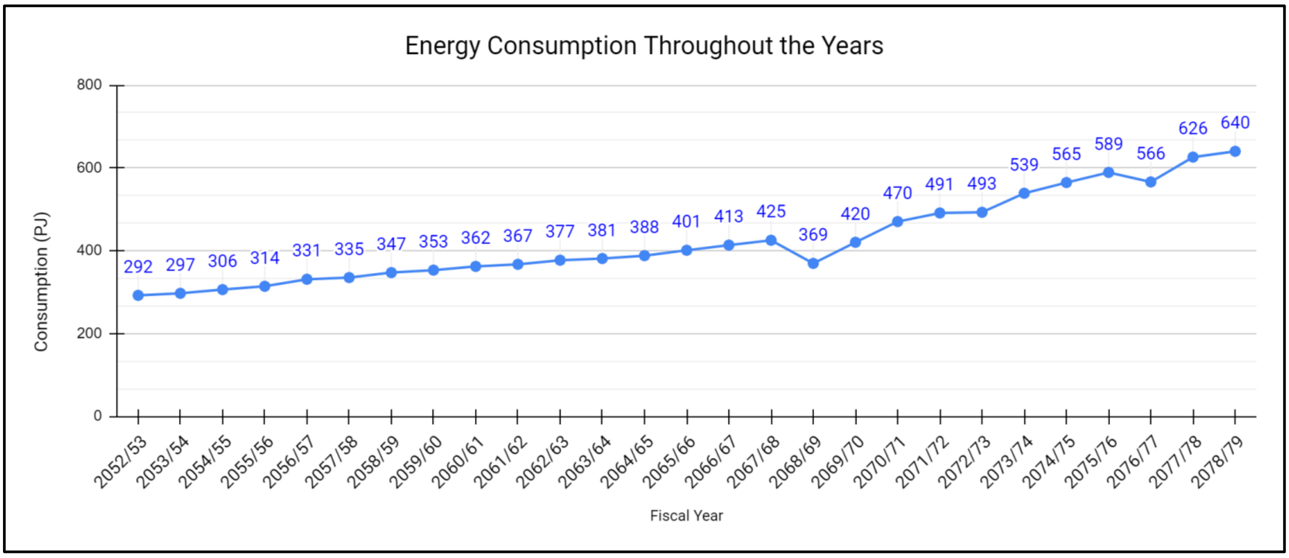

Figure 1.7: Nepal's total energy consumption up to 2078/79[2]
(Source: Energy Synopsis Report 2023)

The residential sector was the major area of energy consumption, accounting for 60.59% of the total consumption. This is followed by the industrial sector, the transportation sector, the commercial sector, the construction and mining sector, and the agriculture sector, consuming 22.17%, 10.49%, 4.79%, 1.02%, and 0.94% of the total consumption, respectively (Figure 1.8).

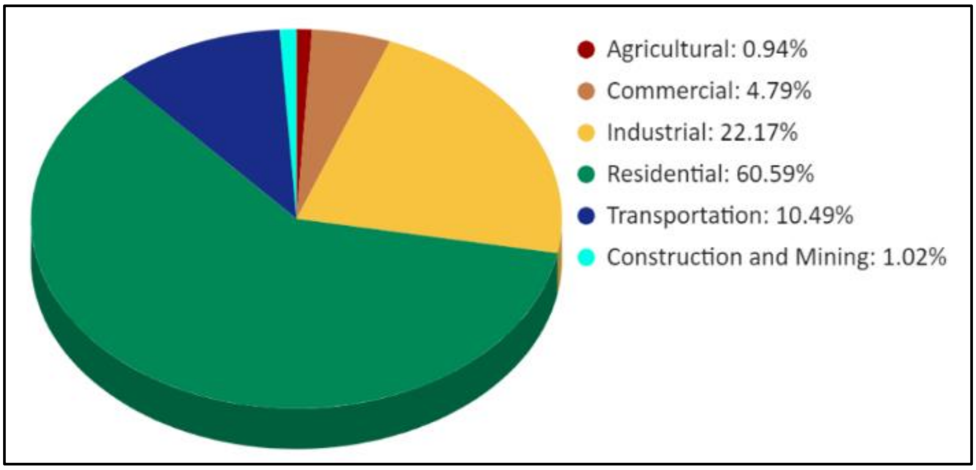

Figure 1.8: Sectoral energy consumption of Nepal in FY 2078/79
(Source: Energy Synopsis Report 2023, WECS)

According to the CBS (2021), the total number of households was 6,666,937, with an average household (HH) size of 4.37 persons per HH. The census report showed that the majority of households relied on wood for cooking, followed by LPG (44.3%), electricity (0.5%), cow dung (2.9%), biogas (1.2%), and kerosene (0.05%). Other sources accounted for 0.1% of fuel for cooking. For lighting, electricity accounted for 92.2%, followed by solar (6.6%), kerosene (0.6%), biogas (0.03%), and other sources (0.6%).

[2] Data in graph is presented in rounded format. See Annex B: Table II

Chapter 2: Literature Review

2.1 Energy Classification Trend

The classification of energy in Nepal is different from that of the global trend. The study of reports from various nations as well as the global energy reports reveal that the energy classification is based on the source of the energy. The energy from sources such as coal, hydropower, and nuclear sources are classified under the same name. Energy from sources such as solar, wind, and biomass are classified under modern renewables. Petrol, diesel, kerosene, etc. are classified under petroleum products. The energy from traditional sources, such as fuelwood, animal, and agricultural residues is rarely mentioned. The terms fuelwood and firewood are used synonymously (Fuel Wood-An Overview | ScienceDirect Topics).

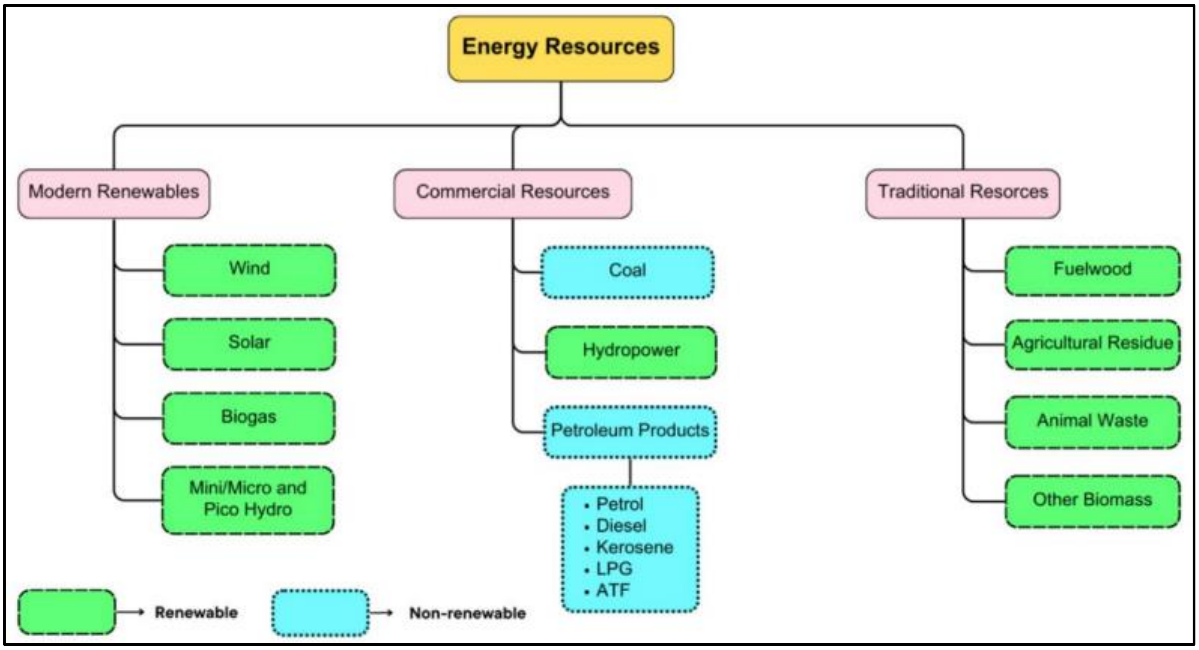

Figure 2.1: Energy sources of Nepal
(Source: Energy Synopsis Report 2023, WECS)

In the case of Nepal, energy sources have been classified into three categories: traditional, commercial, and modern renewables. Fuelwood, agriculture residue, animal dung (animal waste), and other biomass (bagasse) are classified under traditional resources. Coal, hydropower, and petroleum products are categorized under commercial resources. Wind, solar, biogas, and mini/micro and pico hydropower are classified under modern renewables (Figure 2.1).

In addition to this, the imported electricity can be classified under commercial resource and nationally generated hydroelectricity can be classified under renewable energy. Thus, the modified energy resource classification could be as shown in Figure 2.2.

Figure 2.2: Modified energy classification

2.2 Overview of the Energy Outlook of Other Nations

2.2.1 SAARC Nations

2.2.1.1 Afghanistan

According to the International Renewable Energy Agency, the energy intensity of Afghanistan in 2020 was reported at 2.6 MJ/USD. The non-renewable energy supply was about 159.6 TJ and that of the renewable was reported at about 36.8 PJ, amounting to a total energy supply of 196.4 PJ. Renewable energy accounted for about 19% of the total energy supply. The primary energy trade comprised an import of 134.8 PJ and an export of 9.3 PJ. The household sector was the major consumer, consuming 15,490 TJ. The industry sector accounted for the consumption of 764 TJ of energy. Other sectors accounted for 8,728 TJ of energy consumption. In 2019-2020, there was an increase of 5.8% in the non-renewable energy supply but a decrease of 0.4% in the renewable supply. Overall, the growth in the total energy supply was 4.6%.

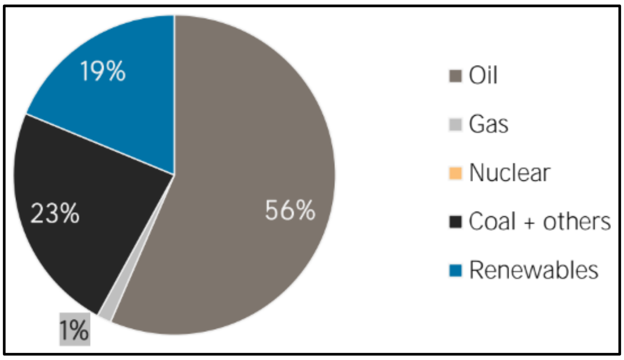

Figure 2.3: Afghanistan's total energy supply in 2020

(Source: IRENA Annual Report, 2023)

2.2.1.2 Bangladesh

According to Bangladesh's Annual Report 2022-23, the Bangladesh Power Development Board (BPDB) added 3,149 MW of new generating capacity during the fiscal year 2022-23. The new capacity included installations by BPDB, Independent Power Producers (IPPs), and power imports. This addition brought the total generating capacity of the country to 24,911 MW, representing an annual growth rate of 10.8%. Additionally, 29 power generation projects with a total capacity of 10,881 MW are under construction. The per capita generation and consumption were reported at 518 kWh and 464 kWh, respectively. The per capita generation increased to 602 kWh after the inclusion of captive and off-grid renewable energy. The power generation in Bangladesh is sourced from a diverse range of fuels as shown in Figure 2.4. The chart shows that the nation is still heavily reliant on fossil fuels. The report also highlights the potential for further development of renewable energy sources to reduce carbon emissions and enhance energy sustainability.

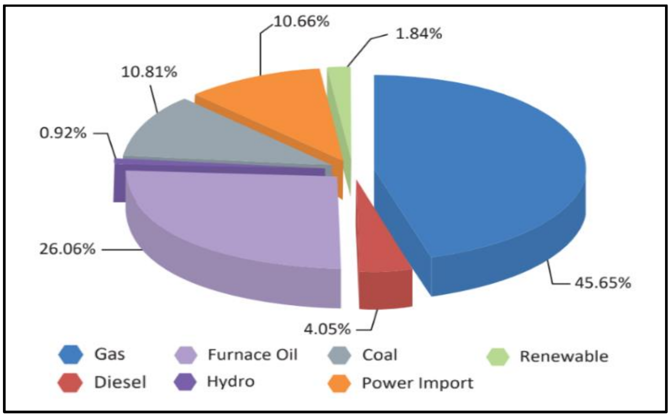

Figure 2.4: National installed capacity of Bangladesh by fuel type
(Source: Annual Report 2022-2023 (Revised), 2024)

2.2.1.3 Bhutan

The Bhutan Energy Data Directory 2022 highlights the reliance of Bhutan on electricity, fuelwood, coal, and diesel. Electricity is the largest contributor to the energy supply with an estimated hydropower potential of 37,000 MW.

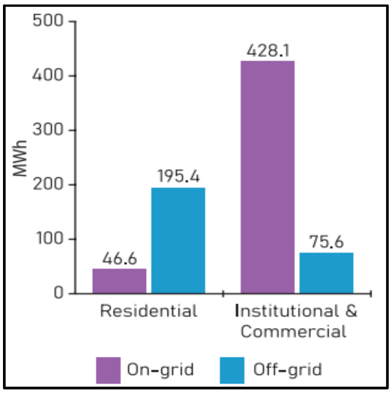

Figure 2.5: Solar electricity generation in 2022 (MWh)
(Source: Bhutan Energy Data Directory 2022)

The current installed capacity of the country is reported to be 2,334.1 MW. The power export peaked at 9,186 GWh in 2020 but declined to 7,240 GWh in 2022. Bhutan lacks domestic reserves of petroleum products and thus are imported from India. Fuelwood is a significant source of energy in rural areas. Additionally, 8,306 biogas plants are under operation, generating 6,116.9 MT of biogas per year. Wind and solar power potentials for the nation are estimated at 761 MW and 12,000 MW, respectively. The potential for waste-to-energy conversion is estimated to be about 49.23 MWh per day. The consumption of petrol, diesel, and electricity was reported to be 34,575.57 kL, 88,131.36 kL, and 0.57 GWh, respectively.

2.2.1.4 India

According to the Energy Statistics India 2023 report, the installed capacity of electricity increased by 4.68% to 4,82,232 MW in FY 2021-22. The nation's energy mix was observed to be shifting from conventional to renewable with an increase of 16.4% in installed capacity of renewable energy sources other than hydro. The thermal sources capacity grew only by 0.06%. The total installed capacity of grid interactive renewable power reached 1,09,885 MW in 2022, experiencing a growth of 14.0%. Out of the total installed generation capacity of renewable sources, solar power (including rooftop solar) accounted for 49.1% of generation, followed by wind with 36.7%, and bio-power and waste-to-energy generation with 9.7%, respectively.

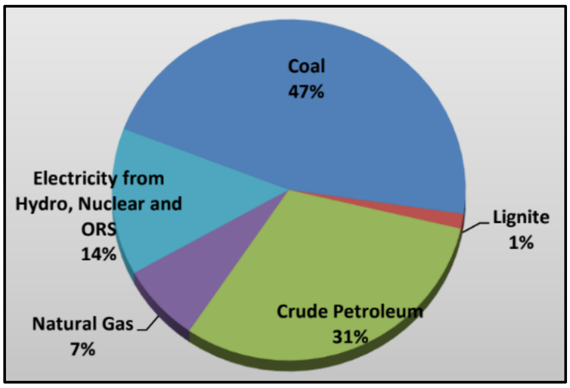

Figure 2.6: India's source-wise consumption of energy in 2021-22
(Source: Energy Statistics India 2023)

The consumption in FY 2021-22 was reported at 33,508 PJ. Coal and lignite consumption increased, accounting for 48% of the total consumption, followed by crude oil at 31% and electricity at 14%, respectively. The consumption of petroleum products grew by 5.77% standing at 204.23 Million tonnes (MTs). Of the total consumption, high-speed diesel oil (HSDO) accounted for 37.55%, followed by petrol at 15.10%, LPG at 13.87%, and pet coke at 7.72%. Electricity consumption increased to 12,96,300 GWh where the industrial sector was the largest consumer sector (41.16%), followed by the domestic sector (25.77%), the agriculture sector (17.67%), and the commercial sector (6.29%).

2.2.1.5 Maldives

Maldives is a nation with multiple islands. The nation lacks domestic reserves for fossil fuels and thus heavily relies on imports. Diesel is predominantly used in power generation, industrial processes, and maritime transport. Petrol is mainly used for road transportation, aviation fuel is used for airplanes, and LPG is used for cooking, rapidly displacing biomass as the main energy source for domestic purposes in small inhabited islands. In 2019, Maldives imported 723,000 tons of refined petroleum products. The fuels are shipped to all inhabited islands to ensure availability across the country. The country also has potential for renewable sources of energy such as solar, wind, and ocean energy and also has potential for manufacturing hydrogen fuel. However, only 37 MW of renewable energy is generated as per the Road Map for the Energy Sector 2020–2030 report (2020).

Maldives achieved universal access to electricity in 2008. Diesel generators are installed in inhabited and resort islands, with additional renewable energy systems totaling 21.5 MW. In 2020, the installation of rooftop solar PV panels in the Greater Male Region increased, with over 3,000 kWp installations.

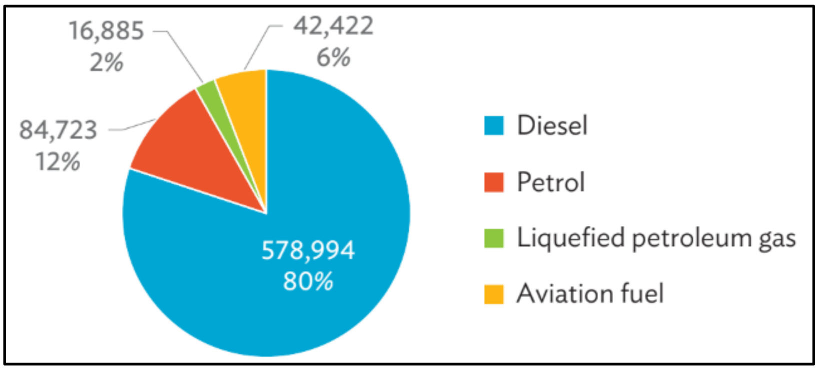

Figure 2.7: Fuel imports by Maldives in 2019 (tons)
(Source: A Brighter Future for Maldives Powered by Renewables, 2020)

2.2.1.6 Pakistan

According to the Economic Survey Report of Pakistan 2022-23, the total installed capacity was 3,300 MW. Six nuclear power plants are under operation and contribute 3,560 MW to the installed capacity. As of July-March FY 2023, the total installed capacity reached 41,050 MW, and the electricity generation reached 94,121 GWh. Hydel (hydroelectric), nuclear, renewable, and thermal sources contributed 25.8%, 8.7%, 6.8%, and 58.7% to installed capacity, respectively (Figure 2.8). The motor spirit, high-speed diesel, and furnace oil consumption was lower, which constituted nearly 95% of the total. Petroleum products and crude oil imports were 6,118.3 thousand MT and 5,858.4 thousand tonnes, respectively. Also, the natural gas consumption in July-March FY 2023 was estimated to be at 3,267 MMCFD of which regasified liquefied natural gas was 626 MMCFD.

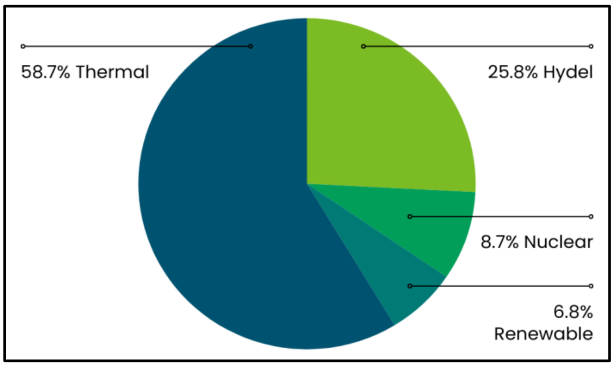

Figure 2.8: Percentage installed capacity of energy resources in Pakistan
(Data source: Economic Survey Report of Pakistan 2022-23)

2.2.1.7 Sri Lanka

According to the Progress Report - 2022 by the Ministry of Power and Energy of Sri Lanka, as of September 2022, the total installed capacity of the national power grid reached 5,024 MW. Renewable energy sources accounted for 58% of the total installed capacity while fossil fuel accounted for the remaining 42%. Within the fossil fuel sources, 18% of energy was generated from coal and 24% was generated from thermal oils. Hydropower is the major source of renewable energy with a share of 28% while other renewables such as wind, solar (ground-mounted & rooftop), mini-hydro, biomass, and municipal solid waste contribute 30% to the capacity mix (Figure 2.9). A total gross power of 11,199 GWh was generated from January to August of 2022. 44% of the electricity share was generated by renewable energy sources, with major hydropower contributing 28% of total electricity. Fossil fuels (coal and thermal oil) accounted for 56% of electricity generation. The electricity demand decreased slightly by 0.1% during the first and second quarters of 2022.

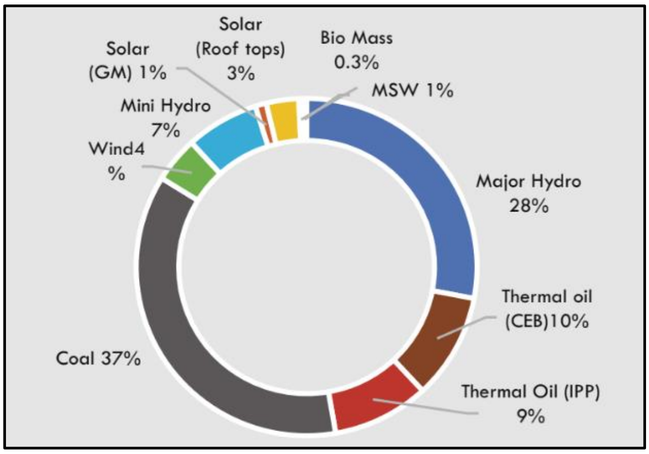

Figure 2.9: Sri Lanka's total generation (up to August 2022)
(Source: Progress Report - 2022, Ministry of Power and Energy Sri Lanka)

2.2.2 China

China plays a significant role in global energy trends due to its changing economy and transition to clean energy. The country is a major contributor to rising global coal, oil, and natural gas consumption. As per the World Energy Outlook 2023, China's economy is reaching a saturation point. This saturation is expected to lead to a lower demand for energy in the future in energy-intensive sectors such as cement and steel industries.

According to IEA, in 2021, the energy source of China is dominated by coal, accounting for 61% of its total energy supply (Figure 2.10). This is followed by oil (18%), natural gas (8%), biofuels and waste (4%), wind and solar (4%), hydro (3%), and nuclear energy (3%). The net energy import accounted for 21.7% of the total energy supply, which was an increase of 816% from 2000-2021. Coal accounts for the major part of electricity generation (63%), generating 5,417,484 GWh of electricity. Hydropower follows with the generation of 1,338,999 GWh of electricity accounting for 16% of the electricity supply. Electricity accounts for 28% of final energy consumption followed closely by oil products which account for 27% of the total final consumption. In the case of sectoral consumption, the industrial sector accounts for 49% of total energy consumption, followed by the residential sector (16%), and the transport sector (15%). The remaining sectors account for 20% of the total sectoral consumption.

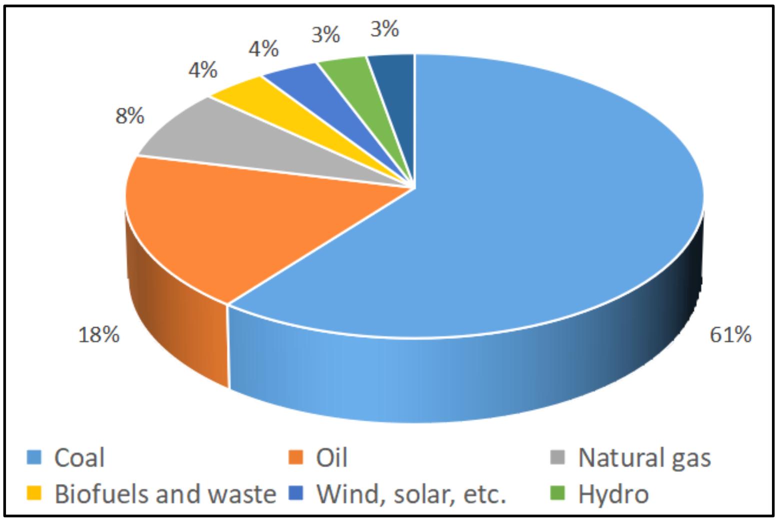

Figure 2.10: Total energy supply of China in 2021
(Data source: IEA, 2021)

2.2.3 United States of America

The United States, a major global energy consumer, recorded a total primary energy consumption of 25,32.21 MTOE (13.18 quadrillion Btu) in 2022 (U.S. Energy Information Administration, 2023). Petroleum remained the dominant source, constituting 36% of the energy mix. Natural gas followed closely, contributing 33%, while renewables and coal accounted for 13% and 10%, respectively. This diverse energy mix shows the country's significant reliance on fossil fuels, although there is a noticeable shift towards renewable energy sources. The total generation was 4.24 trillion kilowatt-hours (kWh).

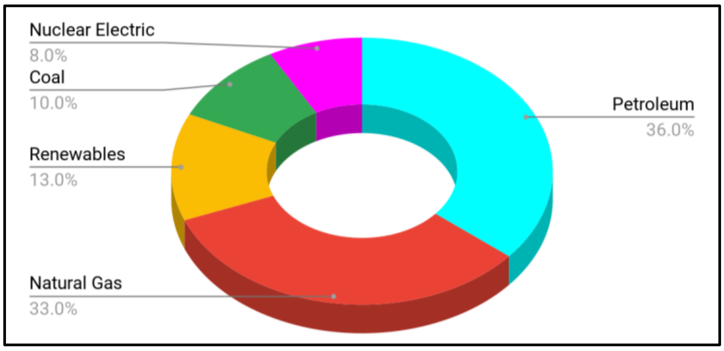

Figure 2.11: Energy consumption of the US in 2022
(Data source: U.S. Energy Information Administration, 2023)

In 2022, the energy generation in the United States consisted of fossil fuels (coal at 19.5%, natural gas at 39.8%, and petroleum at 0.9%), nuclear energy (18.2%), and renewable energy sources (21.5%). The renewable sources included solar (3.4%), wind (10.2%), geothermal (0.4%), biomass (1.3%), and hydroelectric (6.3%).

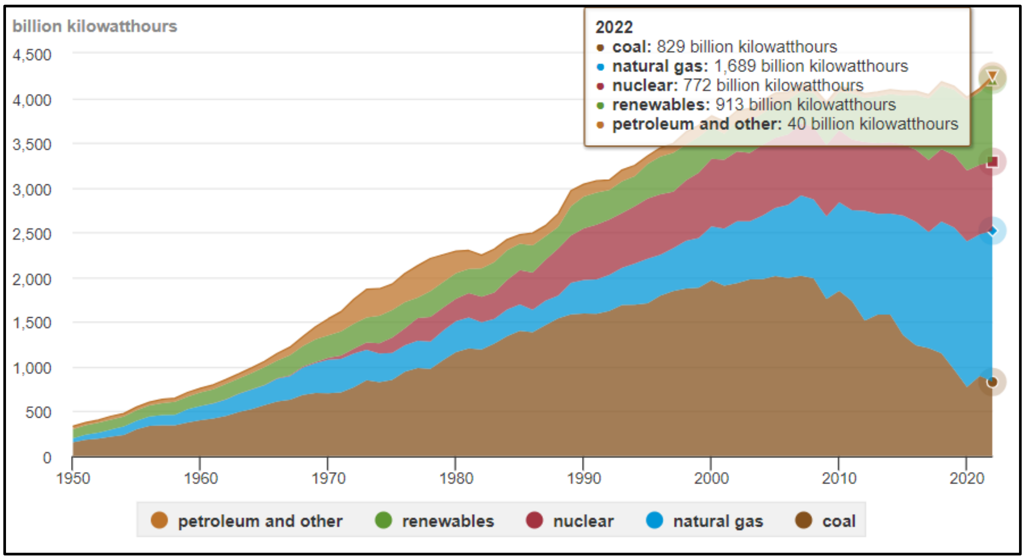

Figure 2.12: US Major Energy Generation Source, 1950-2022
(Source: U.S. Energy Information Administration, 2023)

2.2.4 Germany

Germany's energy mix in 2022 was dominated by renewable energy, a key aspect of the country's Energiewende policy. The country's final energy consumption was estimated at 270 MTOE (Enerdata, 2023). Mineral oil was the largest energy source at 33 percent of the total energy consumption in the region. 5% of the total consumption of the food items in consideration. Natural gas was 26 percent of the total energy consumption in the world in 2013. 2%, while coal has been at 20%. 1% and renewable sources at 19%. 9%. Nuclear energy contributed 3.2% of the total energy mix while the remaining 0. 8% of the total. Germany has made a significant investment in renewable technologies, especially in wind and solar energy to shift away from nuclear and coal. This strategic shift is geared towards the attainment of sustainable energy, and the placing of Germany on the map of the world's leading producers of renewable energy.

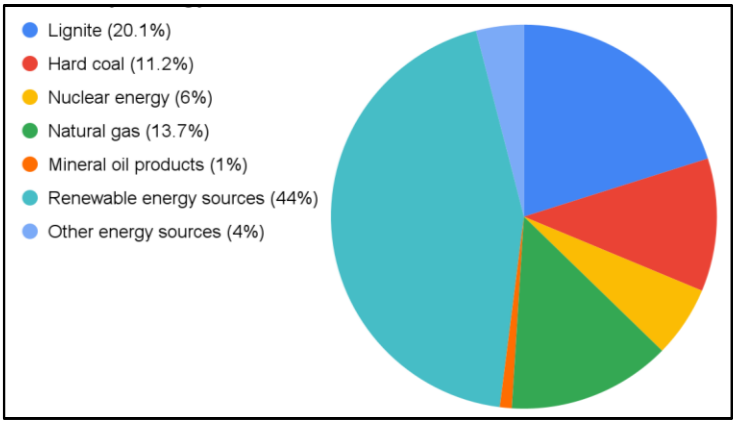

Figure 2.13: Germany Energy Production, 2022
(Source: Arbeits-gemein-schaft Energie-bilanzen (AGEB), 2022)

In 2022, the energy generation in Germany was distributed among various sources. The largest portion was recorded in renewable energy sources at 44.0%. Among renewables, wind power accounted for 21.6%, solar PV for 10.4%, biomass for 8.0%, and hydropower for 3.0%. Conventional energy sources included lignite at 20.1%, natural gas at 13.7%, and hard coal at 11.2%. Nuclear energy contributed 6.0%, while other energy sources made up 4%. Mineral oil products had a minor share of 1.0%. The total energy generation for the year was 577.9 billion kilowatt-hours (kWh).

2.2.5 United Kingdom

According to the data obtained in 2022, the United Kingdom's total primary energy consumption was 169. 2 MTOE, with natural gas as the most significant energy source, accounting for 37% of the total. Oil was the second most used fuel type, accounting for 34%, while renewables were 23% and nuclear energy 15%. The UK has been trying to attempt to reduce the carbon intensity of the energy sector with a key aim of increasing the share of renewable energy. The country has set an ambitious goal of achieving net-zero carbon emissions by 2050 and has made massive investments in the development of offshore wind farms and other renewable energy sources.

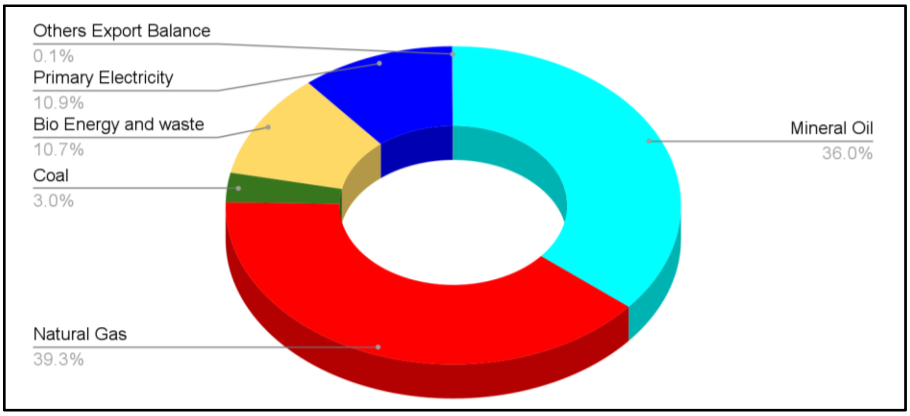

Figure 2.14: Energy mix of the UK 2022
(Data source: UK Energy in Brief, 2022)

2.2.6 Ghana

The total energy supply of Ghana in 2021 reached 12,371 kTOE which is double the value of 6,255 kTOE in 2000, representing an annual growth rate of 3.3% (Figure 2.15). In 2021, biomass accounted for about 34% of the total energy supply, followed by oil (35%) and natural gas (26%). The total final consumption was reported at 9,345 kTOE, with the final electricity and petroleum consumption increasing by the compound annual growth rate (CAGR) of 4.7% and 5.7%, respectively. Biomass consumption declined by 0.4% during 2000-2021. In comparison to 2020, the final energy consumption in 2021 increased by 692 Ktoe, representing an annual increase of 8%.

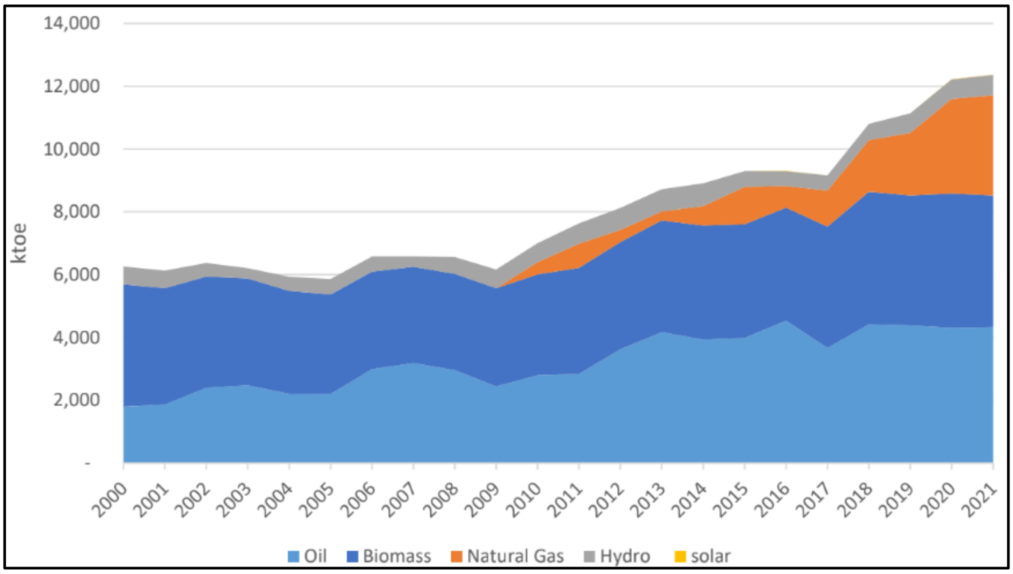

Figure 2.15: Total energy supply of Ghana
(Data source: 2022 National Energy Statistics, Ghana)

Based on sectoral energy consumption, the residential and transport sectors dominated the consumption scene by accounting for 38.9% and 38.3% of the total energy consumption. The industry sector accounted for 16% of consumption followed by the service sector accounting for 5.1%, and the agriculture sector accounting for 1.72% of final energy consumption. The total grid-installed electricity generation capacity, including distributed generation, was reported at 5,481 MW. The total installed thermal generation capacity quadrupled an annual average growth rate of 14.3%, reaching 3,753 MW in 2021.

2.3 The Global Energy Scenario

The World Energy Outlook 2023 by IEA offers a global perspective of the energy sector and its future prospects and the possible challenges and prospects for change towards a green economy. Even though the pressures on the global energy world which the energy crisis precipitated has been slightly eased in the medium term, the report paints a precarious picture of a system that is already volatile due to the fluctuations in the fossil fuel prices and the uninterrupted geopolitical crises.

In 2022, the total final energy consumption (TFC) was 442 EJ. The industry sector is the most energy-consuming as well as the CO_2-emitting sector. It accounts for 38% of the TFC, consuming 167 EJ, and accounts for 47% of CO_2 emissions. The total energy consumption in the building sector was reported at 133 EJ, with an increase of an average of 1% per year over the last decade. The energy demand in the transport sector increased by 4% and reached 116 EJ. The consumption of oil accounted for 90% of this growth and electricity demand was about 60% higher than in 2019. Other end uses account for the remaining 27 EJ of consumption.

Improvements in access to electricity and clean cooking have stalled or even regressed in some places. But at the same time, it is stated that there has been a 40% rise in investment in clean energy since 2020 based on emissions cut and economic considerations. The World Energy Outlook by the IEA provides a plausible strategy to avoid the rise in global temperatures to 1.5°C, further progress is needed to meet the goals of the Net Zero Emissions by 2050 Scenario. The solar PV is expected to make a fairly large contribution to the increase in installed power capacity. But, relying solely on solar PVs cannot achieve the climate goals but can contribute substantially to the reduction of fossil fuel utilization and act as a key driver in the shift towards the use of renewable energy.

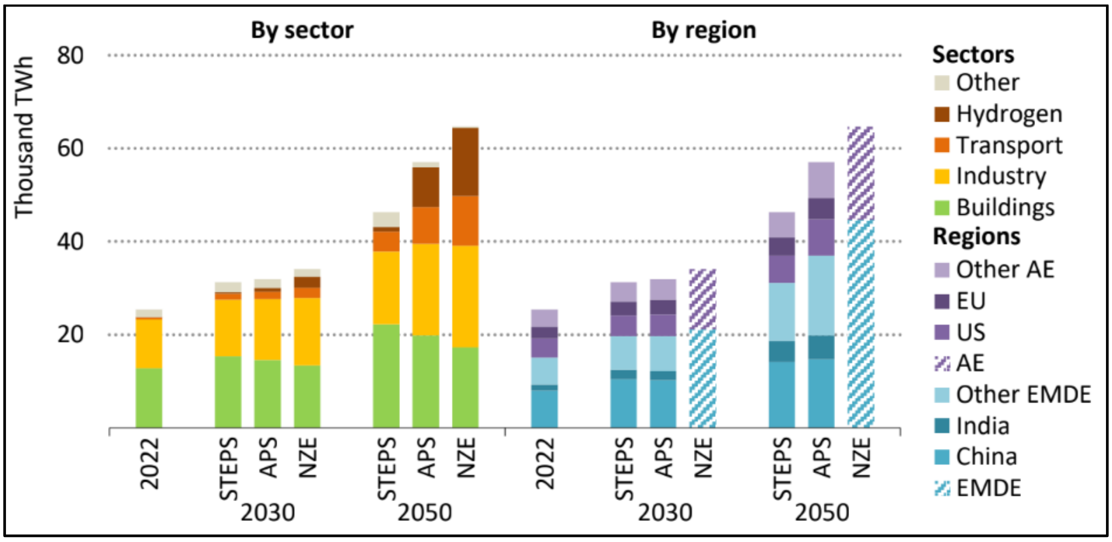

Figure 2.16: Electricity Demand by Sector and Region, and by Scenario
(Source: World Energy Outlook 2023)

The IEA has developed following three scenarios and policies to project the future of energy systems and their impact on climate change:

- **Net Zero Emissions by 2050 (NZE) Scenario:**
    - This scenario outlines a pathway for the energy sector to limit global temperature rise to 1.5°C above pre-industrial levels by 2100, with limited overshoot. This is in sync with critical UN Sustainable Development Goals relating to energy like improving air quality and ensuring that all people have access to modern, sustainable, reliable energy by 2030. The challenges include high emissions and slow progress towards the achievement of the SDGs, but

other emerging trends in clean energy transformation suggest that it is still possible to achieve the goals of the NZE Scenario.

- **Announced Pledges Scenario (APS):**
    - This scenario assumes that the governments will fulfill all climate-related commitments they've announced, including net zero emissions targets and Nationally Determined Contributions (NDCs). Pledges from businesses and other stakeholders are considered to enhance government ambition. However, most governments lack policies to fully achieve their commitments, making significant progress necessary. The APS is linked to a temperature rise of 1.7°C by 2100.
- **Stated Policies Scenario (STEPS):**
    - This scenario reflects the prevailing direction of energy system progression based on current policy landscapes.
    - Unlike APS, it focuses on what governments are actually doing to achieve targets, rather than what they say they will do.
    - The STEPS accounts for policies and measures in place or announced, without assuming aspirational targets will be met and is associated with a temperature rise of 2.4°C by 2100.
- **Energy and Climate Policies:**
    - The IEA conducts an annual review of policies, regulations, targets, and announcements affecting the energy system, vital for its Outlook reports.
    - This review encompasses responses to recent global energy crises, including measures like the US Inflation Reduction Act.
    - Various policies impacting energy systems are covered, such as oil and gas licensing, methane reduction, and initiatives for energy access.
    - Recent developments highlighted in the review include:
    - The European Union's increased climate ambition, marked by new targets.
    - Japan's implementation of the Green Transformation program to enhance renewable energy and nuclear power.
    - Canada's allocation of substantial funding for clean energy initiatives.
    - Just Energy Transition Partnerships (JETP) agreements signed by countries like Indonesia, Vietnam, and Senegal to accelerate decarbonization in their power sectors.
- **Industrial Policies:**
    - Countries are enacting targeted policies to boost clean energy manufacturing, as depicted in IEA scenarios.
    - China dominates the manufacturing capacity across various technologies.

- The US has implemented tax credits and federal support to encourage investment in clean energy.
- Canada is backing critical minerals and clean energy manufacturing through support mechanisms.
- The EU's Green Deal Industrial Plan focuses on amplifying investment in clean technology manufacturing.
- India has introduced a production-linked incentive scheme to promote battery and solar PV manufacturing.

Ultimately, the report emphasizes the availability of lasting solutions and the urgent need to harness existing technologies and policy experience to drive meaningful progress towards a sustainable energy future.

2.4 Nepal’s Energy-Related Plans and Policies

The energy related policy of Nepal includes a variety of legislative and strategic steps, designed to advance the country's energy sector. The Nepal Electricity Authority Act of 1984, which regulates electricity generation and distribution, and the Water Resources Act of 1992, which promotes balanced use and conservation of water resources, are two key policies. Similarly, the Hydropower Development Policy of 1992 and 2001 encouraged private sectors involvement in hydropower, while the Local Self-Governance Act of 1998 allows local governments to oversee mini and micro hydropower projects. The NEA Community Electricity Distribution Bye Laws of 2003 offers support for community electrification. The National Water Plan of 2005 establishes time-bound targets for rural electrification, while the Rural Energy Policy of 2006 emphasizes renewable energy technology in rural regions. Off-grid electrification is funded by the Renewable Energy Subsidy Policy (2000-2016) and the RE Subsidy Delivery Mechanism for Special Programs (2018). Furthermore, the National Energy Efficiency Strategy of 2018 seeks to double national energy efficiency by 2030.

2.4.1 Second Nationally Determined Contribution

In accordance with the 2015 Paris Agreement, the Government of Nepal has presented its own enhanced version of the Nationally Determined Contribution (NDC) for the period of 2021-2030. The quantified targets of NDC regarding the energy sector are listed below:

- Expansion of the clean energy generation from around 1,400 MW to 15,000 MW. Mini/micro-hydropower, solar, wind, and bio-energy should contribute 5-10% of the generated energy; of which 5,000 MW is an unconditional target.

The remaining expansion is contingent upon funding provided by the international community:

- Increase the reliable supply of clean energy, ensuring universal access.
- Increase the quantity (kWh), quality, reliability, and affordability of electricity access derived from renewable sources.

- ➢ Strengthen transmission and distribution infrastructure to facilitate the expansion of e-cooking, e-heating, e-transport, and charging stations.
- ➢ Foster an enabling environment for providing power to small and mid-size enterprises (SMEs) through distributed renewable energy generation sources.
- ➢ Promote public electric mobility through incentives, including subsidy policies and other financial mechanisms.
- ➢ By 2025, NDC aims to ensure that at least three provinces operate electric public transport systems, establish vehicle fitness test centers in three provinces to monitor and regulate vehicular emissions, and ensure that all metropolitan cities have roads equipped with bicycle and pedestrian lanes.

❖ The total energy demand of Nepal should be met by 15% of renewable (clean) energy sources.

2.4.2 The 15th Five-Year Plan

The 15th Five-Year Plan (Fiscal Year 2019/20–2023/24) has been prepared with the objective of implementing the development policy to cause the massive economic and social transformation to address the citizens' expectations of development and prosperity, to achieve rapid and high economic growth and to ensure equitable distribution and redistribution (National Planning Commission, 2019). The following points highlight the expected outcomes of the implementation of this plan in the energy sector:

❖ **Hydropower**

- ➢ The hydropower installed capacity will have reached 5,000 MW.
- ➢ Access to electricity will have been extended to all local levels and achieve 100% coverage of the population.
- ➢ Per capita electricity consumption will have reached 700 kilowatts per hour.
- ➢ The proportion of renewable energy in energy consumption will have increased from 7% to 12%.
- ➢ The total length of transmission lines with capacities of 66 kV and above will be extended to 8,000 circuit kilometers.
- ➢ Transmission lines of 33 kV capacity will have been extended to 7,300 circuit kilometers.
- ➢ Transmission lines of 11 kV capacity will have been extended to 43,352 kilometers.
- ➢ Electricity leakage will be reduced to 12.3%.

❖ **Alternative energy**

- ➢ Additional electricity access:

- With the generation of 13 MW from micro and small hydropower, 125.4 MW from solar power, and 10 MW from wind energy, an extra 7% of the population will have gained access to electricity.

➢ Renewable energy installations:

- Two hundred thousand household biogas plants and five hundred thousand improved stoves and gasifiers (using thermoelectric technology) will have been installed.
- Production of bio-briquette pellets will reach at least 20,000 metric tons per year.
- Alternative energy technology will have facilitated energy access for 2,000 small and medium enterprises.

➢ Carbon trade revenue:

- Revenue from carbon trade will have been generated by developing two additional carbon projects.

➢ Biogas and L.P. Gas initiatives:

- A total of 500 high-capacity biogas plants will have been installed.
- Import substitution of 40,000 metric tons of L.P. Gas will have been achieved.

2.4.3 The 16th Five-Year Plan

The concept paper for the 16th five-year plan (FY 2081/82-2085/85) was made public on 6 August 2023 by the National Planning Commission. The paper outlines the plan for the coming five years. It aims at the country's economic development. It carries the core theme of good governance, social justice and prosperity. The plan is set to be implemented in mid-July 2024. It includes various themes like: Economic growth, production enhancement, employment, social security. Infrastructure urbanization, gender empowerment, poverty mitigation and sustainable development.

The plan aims to significantly boost power generation. It targets a capacity of 11800 MW by its conclusion. This increase is expected to facilitate the export of electricity valued at Rs 41 billion annually where 96.7% of population have on grid and 1.37% have off grid access to electricity. The trade deficit is assumed to be reduced by 4% with the generation of this electricity. Another essential objective is to guarantee universal access to electricity for all citizens and per person electricity consumption rising to 700 kWh. This demonstrates a dedication to inclusive development. These initiatives underscore a concerted effort to strengthen the energy sector. They drive economic growth while fostering societal equity and sustainability. (RSS, 2023).

2.4.4 National Adaptation Plan (NAP) 2021-2050

The Nepal National Adaptation Plan (NAP) specifies essential initiatives in nine thematic sectors based on the National Climate Change Policy (2019). These initiatives prioritize short, medium, and long-term adaptation efforts to address climate risks while aligning with national economic and development priorities. Implementation of NAP involves a number of entities, including the Environmental Protection and Climate Change Management National Council, the Ministry of Forests and Environment, and others, as well as stakeholders from academia, development partners, the media, and the commercial sector. The Ministry of Forests and Environment is responsible for monitoring and reporting, with five-year assessments anticipated, including updates in 2031 to reflect changes in the economy, policy, and climate threats. The plan includes 64 key programs with a total budget of USD 47.4 billion until 2050, requiring both local (USD 1.5 billion) and external financing (USD 45.9 billion). Capacity building, climate-informed decision making, early warning systems, and resilient infrastructure development are examples of specific water resource and energy measures.

2.4.5 Sustainable Development Goal (SDG) and Nepal's Progress

The 2023 Agenda for Sustainable Development is a framework established and adopted in 2015 by all United Nations member states. It is a universal roadmap for achieving peace, prosperity, and sustainability worldwide. There are 17 interconnected Sustainable Development Goals (SDGs) central to this agenda which collectively address pressing global challenges and advocate for integrated solutions. SDG-7 directs attention to the energy sector, emphasizing the aim of ensuring universal access to affordable, reliable, and sustainable energy.

Figure 2.17: Sustainable Development Goal 7

(Source: United Nations, 2023)

2.4.5.1 Proposed SDG Targets for Nepal

The proposed targets for Nepal are

- 99% household electricity accessibility
- Reducing fuelwood usage to 30%
- Limiting LPG usage to <40% of households
- Generating 15,000 MW of installed capacity

- Increasing per capita electricity consumption to 1500 kWh

2.4.5.2 Progress of Nepal in Achieving SDG Targets

The progress of Nepal as of 2022 according to the Energy Synopsis Report 2023 in fulfilling the aforementioned goals is highlighted below:

1. 94% of Nepal's population has access to electricity, increasing at a significant pace.
2. 6.9% of the total population has access to renewable energy.
3. Renewable energy accounts for 2.52% of the total final energy consumption mix (16.11 PJ).
4. 92.2% of households use electricity as the main source of lighting.
5. 51% of households use fuelwood for cooking.
6. 44.3% of households use LPG for cooking.

Regardless, vigorous efforts and inter-institutional collaborations are essential to further accelerate progress and ensure a sustainable energy future for all. Data for goal tracking is obtained from national reports and publications which include but are not limited to NEA publications, census reports, economic survey reports, and analysis of Voluntary National Reviews (VNR).

2.4.6 Ministry of Energy, Water Resources, and Irrigation - White Paper 2075

Energy Sector Overview

The energy sector in Nepal has been a focal point for development, with significant progress made in recent years. As of 2018, Nepal's total installed electricity generation capacity stands at 1073 MW, which includes 1016 MW from hydropower, 54 MW from diesel/multi-fuel plants, and 2.68 MW from solar energy. Despite this, the national electricity demand peaks at around 1300 MW, necessitating the import of 450 MW from India to bridge the gap. The Nepal Electricity Authority (NEA) has played a crucial role, providing electricity services across 76 districts[3] and catering to 3,465,822 consumers, with residential users accounting for 94% of total consumption. Industrial and other consumers make up 35.61% and 22.54% of consumption, respectively. To enhance the transmission network, projects are underway to expand the 220 KV and 132 KV transmission lines, with existing lines covering 75 and 2819 circuit kilometers, respectively. Additionally, Nepal aims to increase its per capita electricity consumption to 700 kWh in the next five years and 1500 kWh within ten years, reflecting a significant shift from the current consumption patterns.

Renewable Energy and Alternative Sources

[3] At that time the division of districts were only 76

Renewable energy development is a key priority, with over 55 MW generated from renewable sources, benefiting more than 3.6 million households. The Alternative Energy Promotion Center (AEPC) has been instrumental in promoting mini and micro-hydropower, solar energy, biogas, improved cooking stoves, and wind energy. Notably, over 400,000 domestic biogas plants, 794,276 household solar systems, and 10,654 improved water mills have been installed, contributing to the rural electrification efforts. Renewable energy technologies have also generated approximately 30,000 jobs, and carbon trading from these projects has earned around 1 million rupees through 1.8 million tons of Certified Emission Reductions (CERs).

Transmission and Distribution

Nepal's electricity transmission and distribution infrastructure are undergoing significant upgrades to meet future demand and ensure reliable supply. Current projects include the construction of high-voltage 400 KV East-West transmission lines and cross-border lines with India, such as the Butwal-Gorakhpur line, aimed at enhancing regional energy trade. The NEA's distribution network spans across eight regional offices with 103 distribution centers, managing over 101,531 kilometers of distribution lines at various voltage levels. Efforts are being made to modernize the distribution system by implementing smart meters and smart grid technologies, improving efficiency, and reducing technical losses to below 15% in the next five years.

Challenges and Strategic Initiatives

The energy sector faces several challenges, including managing seasonal variations in hydropower generation, addressing land acquisition issues, and ensuring timely project completion. To overcome these, the government has outlined a strategic roadmap emphasizing public-private partnerships, foreign investments, and regional energy cooperation through frameworks like SAARC, BBIAN, and BIMSTEC. Additionally, policies are being developed to promote the use of electric vehicles, replace traditional energy sources with electricity, and integrate renewable energy projects into the national grid.

Future Prospects

The roadmap for the next decade envisions Nepal becoming energy independent, with plans to develop 3000 MW of new electricity generation capacity within three years, 5000 MW within five years, and 15,000 MW within ten years. Key projects include the Upper Tamakoshi Hydropower Project (456 MW) and province-specific mega projects like the Tamor Reservoir (762 MW) and Dudhkoshi Reservoir (800 MW). The government also aims to provide electricity access to every Nepali household within the next five years, leveraging both grid expansion and off-grid renewable energy solutions.

2.4.7 Energy Sector Vision - 2050

The "Energy Sector Vision 2050" released by the Ministry of Energy, Water Resources, and Irrigation (MoEWRI) outlines ambitious goals for the development of Nepal's energy sector over the next three decades. The vision aims to harness the country's vast hydropower potential, promote renewable energy sources, and ensure energy security and sustainability. By 2050, the plan envisions an installed hydropower capacity of 15,841 MW, increasing from the 1,954 MW in 2020 and 4,253 MW projected for 2030. The per capita electricity consumption is expected to rise dramatically from 104 kWh in 2010 to 955 kWh by 2050.

In the commercial energy sector, the focus is on hydropower development, aiming to not only meet domestic demand but also export surplus electricity to neighboring countries. The vision emphasizes the development of multi-purpose hydropower projects to achieve financial prosperity and economic growth. By 2050, Nepal aims to ensure 100% electrification in various sectors, including agriculture, industry, and transportation. This includes introducing electric trains for freight and intercity transport, increasing the use of electric vehicles, and promoting the use of biofuels like ethanol and biodiesel.

Renewable energy sources are set to play a significant role, with a goal to supply around one-third of the total primary energy demand by 2050. The vision includes widespread adoption of technologies like solar power, biogas, and improved cooking stoves, especially in rural and urban areas. By 2050, all households in Terai are expected to have biogas plants, and micro-hydro installations will be widespread in remote areas. The promotion of energy-efficient technologies across all sectors and the integration of off-grid renewable energy sources into the national grid are also key components of the vision.

This comprehensive plan also addresses the need for legislative and institutional reforms to support the energy sector's growth. The establishment of a National Energy Regulation Commission, the creation of an autonomous rural electrification agency, and the enhancement of infrastructure such as transmission lines and road access are crucial steps identified in the vision. The strategy includes regular updates to policies and regulations to adapt to changing circumstances and the promotion of private sector investment through incentives.

2.4.8 Hydropower Development Policy - 2001 A.D.

Nepal, with its vast water resources and favorable geography, has immense potential for hydropower generation, estimated at 83,000 MW, of which 42,000 MW is feasible. The Hydropower Development Policy, 2058 (2001) aims to capitalize on this potential by creating an investment-friendly, clear, and transparent framework to facilitate both domestic use and export. Key objectives include generating low-cost electricity, extending reliable electric services nationwide, supporting economic activities, and promoting rural electrification. The policy emphasizes strategic initiatives such as attracting private sector participation, implementing diverse hydropower projects, and fostering bilateral and regional cooperation. It also mandates environmental sustainability practices, energy conservation, and rural electrification support. Investment risk management measures include guarantees against nationalization, repatriation of profits for foreign investors, and tax incentives for necessary imports. Institutional arrangements are established for regulatory oversight and skill enhancement. This policy underscores Nepal's commitment to leveraging hydropower for economic growth, improved rural livelihoods, and sustainable energy practices.

Key objectives of the policy include generating electricity at a low cost, ensuring reliable and quality electric services across Nepal, supporting economic activities through electrification, and promoting rural electrification to boost the rural economy. Additionally, the policy aims to develop hydropower as an export commodity, leveraging Nepal's strategic position to meet energy demands in neighboring countries.

To achieve these objectives, the policy outlines several strategies:

1. **Rural Electrification:** Extending hydropower services to rural areas to promote socio-economic equity and support agricultural and industrial development.
2. **Private Sector Participation:** Simplifying procedures to attract private investment and ensuring transparent and investment-friendly policies.
3. **Project Implementation:** Focusing on small, medium, and large hydropower projects that prioritize national interest, environmental protection, and maximum benefits.
4. **Bilateral and Regional Cooperation:** Pursuing cooperative strategies with neighboring countries to support regional economic development through hydropower.

2.4.9 Renewable Energy Subsidy Policy - 2073 B.S.

Nepal, with its vast potential for renewable energy sources such as mini and micro hydropower, solar, biomass, biogas, and wind energy, faces the challenge of reducing its reliance on traditional biomass energy, which still accounts for 85% of the country's total energy consumption. Approximately 28% of Nepalese households lack access to electricity, primarily due to the high costs and logistical difficulties associated with extending the national grid to remote areas. To address these issues, the Government of Nepal (GoN) has introduced the Renewable Energy Subsidy Policy, 2073, which aims to promote the adoption of Renewable Energy Technologies (RETs) as both an immediate and long-term solution to the nation's energy needs.

The policy outlines several strategies to increase access to clean energy, particularly in rural areas, by reducing the upfront costs of RETs and promoting their efficient use. It seeks to enhance service delivery, create employment opportunities, and improve livelihoods, especially for vulnerable and disadvantaged groups. The policy also emphasizes the importance of mobilizing commercial credit and encouraging public-private partnerships to support the growth of the renewable energy market. Key provisions include subsidies covering up to 40% of the costs of various RETs, with the remainder financed through credit and private investment. Special considerations are given to earthquake-affected regions and targeted beneficiary groups such as women-led households and disaster victims. The Central Renewable Energy Fund (CREF) is established to facilitate the disbursement of subsidies and soft loans, thereby encouraging financial institutions to invest in renewable energy projects.

Renewable Energy Subsidy Policy, 2073, aims to achieve universal access to clean, reliable, and affordable renewable energy by 2030, aligning with the United Nations' Sustainable Development Goals. By fostering sustainable energy practices, the policy seeks to significantly reduce energy disparities between urban and rural areas, enhance economic development, and improve the quality of life for all Nepalese citizens.

2.4.10 Plans and Policies - 2080/81

Nepal is committed to ensuring access to energy for all its citizens, enhancing energy security, and promoting sustainable energy development. The government aims to connect electricity to every household within the next two years, providing free electricity to consumers using up to 50 units per month during the rainy season and up to 30 units in winter. This initiative is part of a broader effort to replace cooking gas with electricity, reducing reliance on fossil fuels. The energy policy prioritizes the construction of reservoir-based hydroelectric projects, particularly large-scale ones like the Budhi Gandaki Hydro-electricity Project, which will be constructed using Nepal’s resources. The transmission and distribution systems will be expanded and reinforced to support increased electricity generation, with new infrastructure promoting internal consumption and international transmission lines boosting energy exports.

The government emphasizes clean and renewable energy, promoting an energy mix policy and conducting feasibility studies on hydrogen energy generation. Integrated resource management and preservation activities based on river systems will ensure sustainable energy development. Energy efficiency practices will be encouraged, such as providing concessions on electricity tariffs for irrigation and distributing free water pumps and tube wells to small farmers. International collaboration and investment are crucial, with efforts to attract foreign investment in large-scale hydroelectric projects through innovative financial instruments, including green bonds and concessionary loans. These initiatives aim to achieve the net-zero carbon target by 2045 and enhance Nepal's energy security and sustainability.

Furthermore, the newly formulated **Green Hydrogen Policy** outlines a comprehensive framework aimed at fostering the production, utilization, and promotion of green hydrogen and its co-products. To facilitate this, the nation aims to formulate and regulate necessary laws and incorporate specific provisions for exemptions and facilities that encourage the establishment and investment in green hydrogen industries. Trade and promotion efforts will focus on leveraging green hydrogen to reduce carbon emissions and achieve significant carbon reduction. Environmental standards will be established to ensure safe production, storage, and utilization practices. Additionally, industries will be incentivized to use green hydrogen in the production of chemical fertilizers, thereby integrating sustainable practices into agriculture. The policy also emphasizes the expansion of green hydrogen production and infrastructure, alongside promoting and encouraging studies and research in this field.

2.4.11 National Energy Efficiency Strategy-2075 B.S.

The National Energy Efficiency Strategy 2075, approved by the Government of Nepal on November 19, 2018, outlines a comprehensive approach to address the country's energy challenges by enhancing the development and efficient utilization of renewable energy resources. The strategy is aligned with Nepal's constitutional mandate to ensure reliable and affordable energy supply, aiming to fulfill the basic energy needs of its citizens and support the nation's economic, physical, and social development goals.

Key components of the strategy include the establishment of robust policy, legal, and institutional frameworks to promote energy efficiency across various sectors. The strategy emphasizes the need for public awareness campaigns, energy audits, and the development of national standards for energy efficiency. It also focuses on providing financial and technical support for energy efficiency initiatives, enhancing human resource capabilities, and integrating energy efficiency into the overall energy system. The goal is to double the annual improvement rate of energy efficiency to 1.68% by 2030.

Despite facing challenges such as lack of awareness, insufficient institutional support, and high dependency on energy imports, the strategy identifies significant opportunities. These include the potential for financial returns from energy conservation, reducing trade imbalance, creating employment, and enhancing energy security. The implementation plan involves coordinated efforts at local, provincial, and federal levels, with a strong emphasis on monitoring and evaluation to ensure the strategy's effectiveness and sustainability. Through these measures, the strategy aims to contribute to Nepal's sustainable development, economic growth, and environmental protection.

2.4.12 Environment Friendly Vehicle and Transport Policy - 2014

The Government of Nepal's Environment-friendly Vehicle and Transport Policy (2014) aims to address the critical issues of greenhouse gas (GHG) emissions and deteriorating air quality from the transport sector. Nepal's reliance on imported fuels and vehicles, primarily from India, poses challenges due to differing geographical conditions. The policy targets having over 20% of vehicle fleets environment-friendly by 2020, with a long-term goal of 100% electric Light Duty Vehicle (LDV) sales by 2030. The Global Fuel Economy Initiative (GFEI) aims to reduce CO_2 emissions to 90 g/km and improve fuel economy to 4.4 Lge/100 km by 2030. Despite improvements in fuel economy and CO_2 emissions from 2005 to 2016, actual performance significantly lags behind rated values. Regular servicing could further improve fuel economy and reduce emissions. Projections indicate that by 2030, electric vehicles could comprise 56% of total LDVs, leading to significant fuel cost savings and increased domestic electricity sales. The policy recommends strong promotion of electric mobility, infrastructure development, private sector engagement, and fiscal adjustments to encourage cleaner technologies. Successful implementation depends on consistent measures, supportive fiscal policies, and public awareness, aiming to reduce Nepal's fossil fuel dependence and improve air quality.

2.4.13 Medium Term Expenditure Framework (FY 2080/81-2082/83)

The Medium-Term Expenditure Framework (MTEF) for Nepal, covering fiscal years 2023/24 to 2025/26, outlines the strategic allocation of resources to achieve the country's development goals, including those in the energy sector. The MTEF aims to enhance public financial management by integrating the annual budget with the periodic plans, ensuring alignment with national priorities such as infrastructure development, economic growth, and sustainable energy.

Strategic Objectives for the Energy Sector

The energy sector is a critical component of Nepal's economic development and sustainability goals. The MTEF sets out specific objectives to ensure the sector's growth and stability:

- Sustainable Energy Development: Promoting the development and use of renewable energy sources to achieve long-term energy security and environmental sustainability.
- Infrastructure Investment: Prioritizing investments in energy infrastructure to enhance generation, transmission, and distribution capabilities.
- Public-Private Partnerships: Encouraging collaboration between the public and private sectors to leverage investment and expertise in the energy sector.

Budget Allocation and Planning

The MTEF includes detailed budget estimates and program plans for the energy sector over the next three fiscal years. This structured approach ensures that resources are allocated efficiently to priority projects that drive economic growth and energy sustainability. Key budgetary considerations include:

- Energy Infrastructure Projects: Allocating funds to major infrastructure projects such as hydroelectric plants, solar farms, and wind energy installations.
- Grid Expansion and Modernization: Investing in the expansion and modernization of the national grid to improve reliability and reduce energy losses.
- Research and Development: Funding research and development initiatives to innovate and improve energy technologies and practices.

Challenges and Opportunities in the Energy Sector

The MTEF identifies several challenges and opportunities that impact the energy sector:

- Revenue Generation: Enhancing revenue through improved efficiency and expanded energy production capabilities.
- Institutional Capacity: Strengthening institutional capacity to manage and oversee large-scale energy projects effectively.

- Coordination Among Stakeholders: Promoting better coordination among federal, provincial, and local governments to ensure cohesive and comprehensive energy planning and implementation.
- Sustainable Practices: Emphasizing sustainable energy practices to minimize environmental impacts and ensure long-term viability.

Legal and Institutional Framework

The implementation of the MTEF in the energy sector is supported by robust legal and institutional frameworks, including:

- The Constitution of Nepal: Mandating the preparation of budgets and plans at federal, provincial, and local levels.
- Intergovernmental Fiscal Management Act, 2017: Requiring medium-term expenditure estimates for all government levels.
- Financial Procedure and Fiscal Responsibility Act, 2019: Mandating the preparation of the MTEF based on periodic plans.

These frameworks ensure that the energy sector's financial planning and resource allocation align with national development objectives.

2.4.14 Rural Energy Policy - 2006

The Rural Energy Policy provides a framework to contribute to rural poverty reduction and environmental conservation by ensuring access to clean energy in the rural areas. Some of the key renewable energy related objectives of the policy are:

- Reduce dependency on traditional energy and conserve the environment by increasing access to clean and cost effective energy in the rural areas
- Increase employment and productivity through the development of rural energy resources
- Increase the living standards of the rural population by integrating rural energy with economic activities.

Rural Energy policy is dedicated to the development and use of renewable energy technologies and rural electrification.

2.5 Energy Trilemma Index

The World Energy Trilemma Index evaluates the performance of a nation's energy system based on three key variables: energy security, energy equity, and environmental sustainability.

- **Energy Security:** This variable measures a nation's capacity to meet current and future energy demand reliably and withstand system shocks with minimal disruption. It assesses the management of domestic and external energy sources, as well as the reliability and resilience of energy infrastructure.
- **Energy Equity:** This variable assesses a country's ability to provide universal access to reliable, affordable, and abundant energy. It includes basic access to electricity and clean cooking fuels, prosperity-enabling levels of energy consumption, and affordability of energy.
- **Environmental Sustainability:** Represents the transition of a country's energy system towards mitigating environmental harm and climate change impacts. It focuses on the effects of energy generation, transmission, and distribution by assessing their productivity and efficiency. It also prioritizes areas such as air quality and decarbonization.

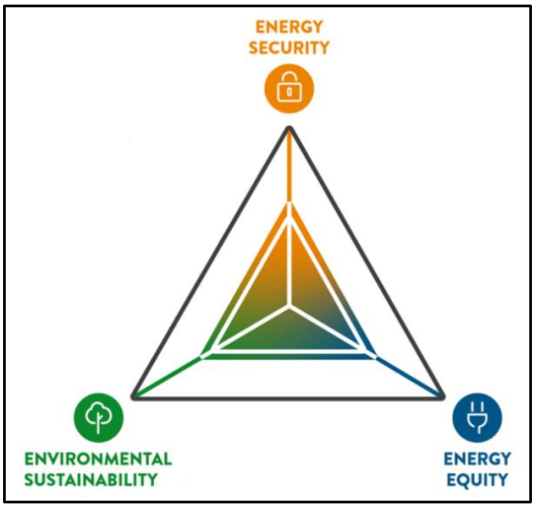

Figure 2.18: Energy Trilemma Index
(Source: World Energy Council, 2022)

2.5.1 Significance of the Trilemma Index

The Energy Trilemma Index, a framework defined by the World Energy Council (WEC), is an official indicator used to assess a country's ability to provide a sustainable energy system across three balanced dimensions: energy security, energy equity (accessibility and affordability), and environmental sustainability. The World Energy Council (WEC) has also placed countries experiencing significant positive or negative changes in their Trilemma Index performance on a “Watch List.” Positive changes include rapid growth of renewable energy, attracting investment from companies to explore new gas resources, and changes in government policies promoting a lower carbon economy. Negative changes can include rapid increases in energy prices, political events creating uncertainty around climate and energy policies, and a country's frequent struggle to meet its own energy demand.

The Index aims to inform policymakers, energy leaders, and the investment sector by providing insights into a country's relative energy performance and highlighting challenges and opportunities for improvement in meeting energy goals. This holistic assessment helps policymakers prioritize actions focused on addressing climate change and challenges within the energy sector.

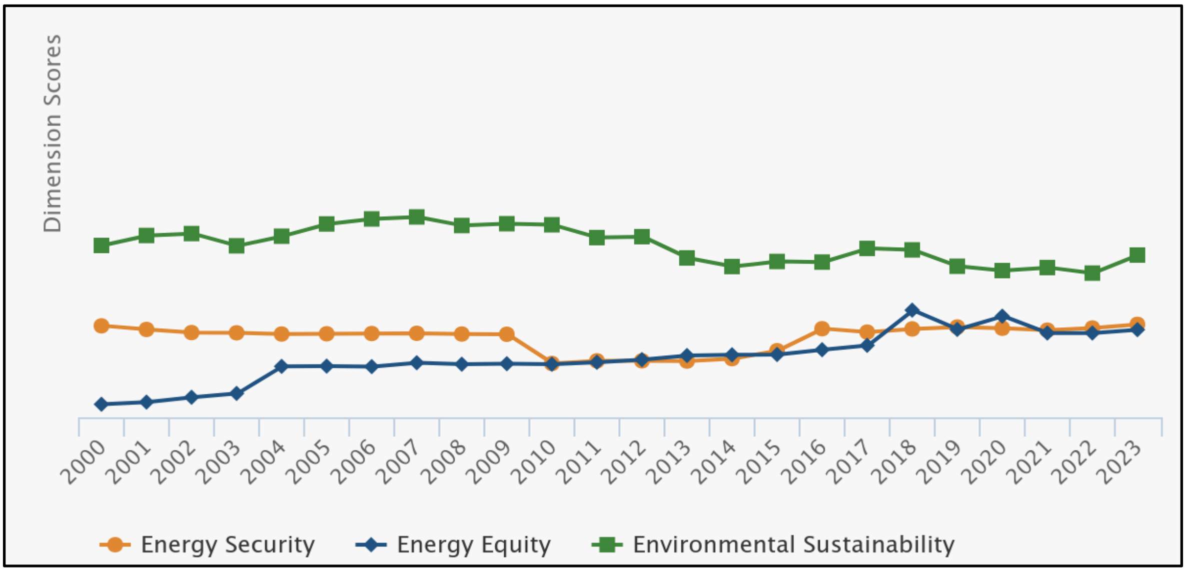

Figure 2.19: Historical Trilemma scores of Nepal

(Source: World Energy Council, 2024)

The top performers overall are Sweden and Denmark, followed by Finland and Switzerland. Nepal scored 32.7 in Energy Security, 30.9 in Energy Equity, and 57.2 in Environmental Sustainability. Nepal has a rank of 91 and an overall score of 40.5, with a balance grade of DDDd.

2.6 Waste-to-Energy

Energy can be generated from organic municipal waste through waste-to-energy technologies. These technologies involve processing waste to produce electricity and/or heat and thus can provide a renewable source of energy to meet increasing energy demands.

According to the Waste Management Baseline Survey report published by NSO in 2021, approximately 6 million tons of waste are collected annually, with organic content compromising around 54%. Only a small percentage of the waste is used for manure and recycling, while a significant portion is dumped, burnt, or left untreated. The collected waste, particularly the organic fraction, holds the potential as a valuable feedstock for energy generation. In FY 2075/76, a total of 15,581.9 metric tons of organic waste was generated in metropolitan cities, sub-metropolitan cities, and municipalities of Nepal. Specific areas like Kathmandu, Lalitpur, and Pokhara show the potential to generate 1,745 MWh, 278 MWh, and 244 MWH of electricity, respectively from waste (Sodari & Nakarmi, 2018).

Another study (by Lohani, et al., 2021) suggests that utilizing 100% of the organic fraction of municipal solid waste (OFMSW) in Kathmandu can generate 130,294 cubic meters of biogas, equivalent to filling 21,045 LPG cylinders per day and saving NRs 515 million. A bio-methanation plant was established in Teku, with the support of the European Commission and the Nepalese government, which has the capacity to convert 3 tons of OFMSW into biogas per day. Additionally, a waste-to-energy plant in Pamara, Dharan sub-metropolitan, processes 30 tons of municipal waste daily, generating bio-CNG and organic fertilizers (AEPC, 2021).

2.7 Geothermal Energy

Nepal has significant geothermal energy potential, primarily located in regions with active tectonic activity such as Sankhuwasabha, Manang, Myagdi, and Mustang districts. Key geothermal sites include Haryana, La Ta, Dana Tatopani, Dhadkhark, Dhima, and Ghorepani Tatopani. Despite these promising locations, Nepal currently lacks large-scale geothermal energy production facilities due to challenges like limited infrastructure, financial constraints, and a shortage of technical expertise. At present, there is no substantial electricity generation from geothermal sources in Nepal.

The current utilization of geothermal energy in Nepal is mainly for local purposes, such as tourism and health benefits, with sites like Singa Tatopani in Myagdi attracting over 60,000 visitors annually for its therapeutic hot springs. However, the future prospects for geothermal energy are promising. The expansion of road networks, such as the North-South Highways, will improve access to remote geothermal sites, facilitating potential applications in agricultural drying, fish farming, greenhouse heating, and biodigestion.

Despite the lack of current large-scale production, feasibility studies and technological advancements indicate a geothermal potential of up to 100 MW in Nepal. The government and local entities are increasingly focusing on this renewable energy source to complement the country's hydropower resources and support energy diversification and sustainability efforts. Proper investments and developments could make geothermal energy a critical component of Nepal's renewable energy mix. (Ranjit, 2015)

2.8 Green Hydrogen Fuel

Nepal's potential in green hydrogen is substantial, given its abundant renewable energy resources, particularly hydropower. The country has an estimated 83,000 MW of hydropower potential, with approximately 22,000 MW currently under development. These projects could support the production of green hydrogen by utilizing surplus hydropower, especially during the wet season. The cost of producing green hydrogen in Nepal is projected to be between $1.17 to $2.55 per kg, significantly lower than the global average of $5.91 to $12.75 per kg.

One key initiative is the Nepal Hydrogen Hub (NHH), which aims to utilize surplus hydropower to produce green hydrogen. This hydrogen can then be stored and used for various applications, including re-electrification during dry seasons, industrial uses, and the production of green ammonia for export. The Koshi basin, with its significant hydropower capacity and strategic location near industrial areas and export markets, has been identified as a prime site for Nepal's first hydrogen hub.

Additionally, Nepal's commitment to international environmental agreements, like the Paris Agreement, further supports its transition towards a low-carbon economy through the adoption of green hydrogen technology. Various stakeholders, including government bodies and academic institutions, are actively working to create a supportive policy and investment environment to foster the development of a green hydrogen economy in Nepal. The country has also launched the "Incubation of Nepal Hydrogen Initiative Program," aimed at promoting research, development, and deployment of green hydrogen technologies. (Department of Mechanical Engineering, School of Engineering, Kathmandu University)

According to Green Hydrogen KU Lab, the Green Hydrogen Lab (GHLab) currently has 2 electrolyzers in the lab which are 5 kW PEM electrolyzer and kW alkaline electrolyzer. Currently, the approximate production capacity of a 5 kW electrolyzer is 1000 liters/hr(83.6 grams per hour) at standard temperature and pressure (STP) and the production capacity of a 1 kW alkaline electrolyzer is 191 liters /hr. (16 grams per hour).The total production capacity of the lab is around 1192 liters/hr at NTP (99.6 grams per hour).

The total hydrogen produced from the lab is 10.98 kg (131500 liters at STP) where 1 kW electrolyzer has been in the lab for the past 2 years and the machine run time indicates it has run for more than 128 hours producing around 2.48 kilograms of hydrogen (24500 liters at STP), whereas the production from the 5 kW electrolyzer has only started in the last 6 months with a total run time of 105 hours producing around 8.5 kg of hydrogen (101,750 liters at STP).

2.9 Wind Energy

Nepal has not yet fully utilized the wind's potential as a clean energy source, despite its abundance. A 2008 AEPC report on the Solar & Wind Energy Resource Assessment in Nepal (SWERA) states that there is a 6074 square kilometer prospective region with a wind power density of more than 300 W/m^2. Nepal has the capacity to produce 3,000 MW of wind energy, assuming that 10% of this area is suitable for wind energy production and that the rate of production is 5 MW per sq. km. Potential places are found in the country's middle and upper mountains, according to the report. The anticipated amount of wind power that can be produced commercially is only 448 MW. Numerous wind-solar hybrid projects, such as a 20 kW power system, have been put into place in various places to supply rural people with electricity.

Chapter 3: Methodology

The progress and completion of Energy Synopsis 2024 has been carried out in three phases as illustrated in Figure 3.1.

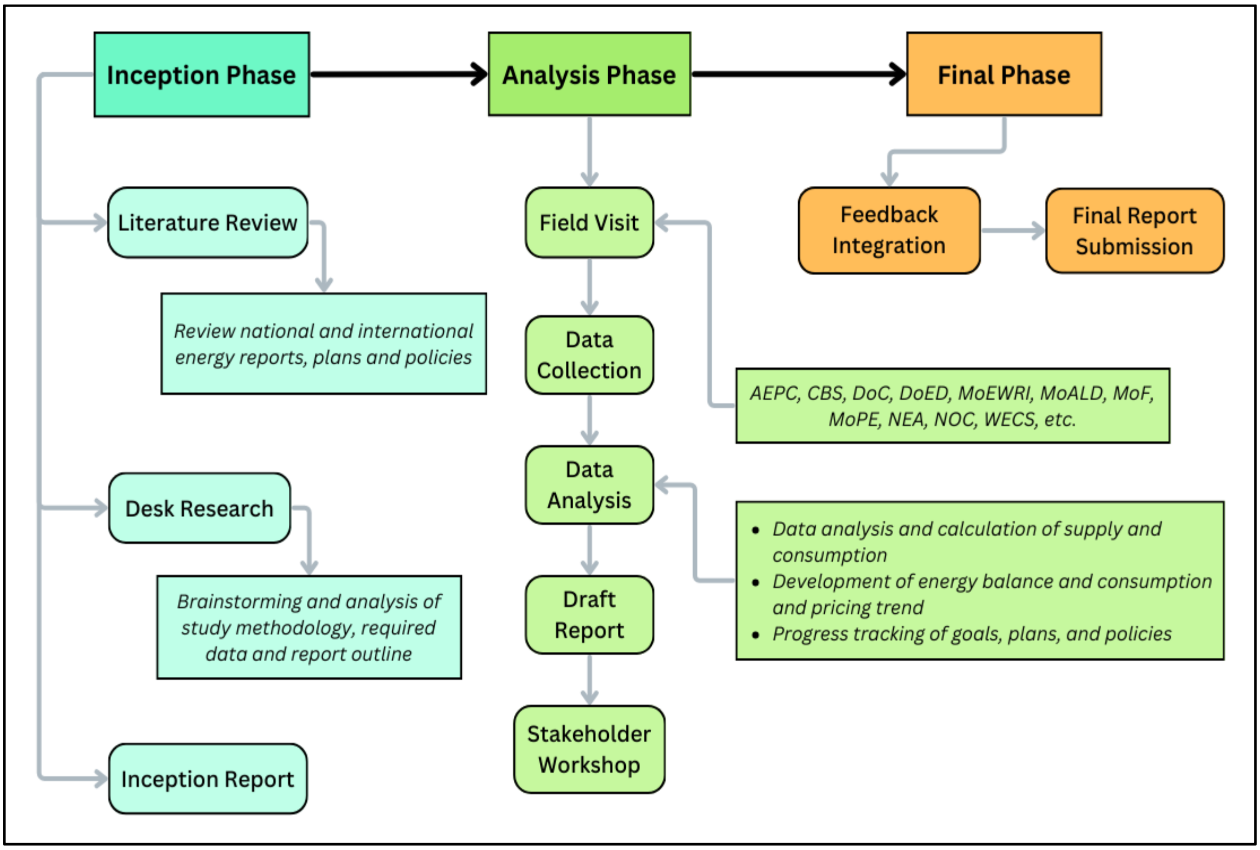

Figure 3.1: Methodology Flowchart

3.1 Inception Phase

The inception phase laid the foundation and outlined the overall structure and format for the entire project process. Literature review and desk research were the major components undertaken during this phase to gather essential information.

- Literature review
  - An extensive review of the past energy synopsis reports was conducted throughout the report preparation duration.
  - International reports such as the World Energy Outlook and related energy reports from various nations were reviewed to gather information about energy trends.
  - Reports on national and international plans and policies were reviewed to assess their impact on the energy sector and identify potential challenges and opportunities.

- Desk research
  - During desk research, a comprehensive analysis of the study's methodology was conducted. The workflow for preparing the synopsis report was then based on the formulated methodology derived from this analysis.
  - The data to be collected for the study was identified as follows:
    - Supply and demand of energy sources, i.e. fuel types
      - Traditional energy sources
        - Fuelwood
        - Agricultural residue
        - Animal residue
        - Other resources such as bagasse
      - Commercial energy sources
        - Coal
        - Petroleum oils and natural gas
        - Electricity
      - Renewable energy sources
        - Solar energy
        - Wind energy
        - Biogas
        - Micro/pico hydropower
        - Other modern renewable energy sources such as waste-to-energy and hydrogen fuel
    - Energy demand and consumption analysis
      - National demand and consumption of energy based on aforementioned fuel types
      - Sectoral consumption analysis
        - Residential

        - Industrial
        - Commercial
        - Agriculture
        - Transportation
        - Construction and mining
    - Provincial analysis of the aforementioned categories
        - Koshi province
        - Madhesh province
        - Bagmati province
        - Gandaki province
        - Lumbini province
        - Karnali province
        - Sudurpaschim province
    - Pricing of energy
- Identification of the sources of data may include but was not limited to:
    - Annual reports and other energy-related publications
    - Data collection from institutions:
        - Alternative Energy Promotion Centre (AEPC)
        - National Statistics Office (NSO) [the then Central Bureau of Statistics (CBS)]
        - Department of Customs (DoC)
        - Department of Electricity Development (DoED)
        - Independent Power Producers' Association Nepal (IPPAN)
        - Ministry for Energy, Water Resources, and Irrigation (MoEWRI)
        - Ministry of Agriculture and Livestock Development (MoALD)
        - Ministry of Finance (MoF)

- Ministry of Forest and Environment (MoFE)
- Ministry of Health and Population (MoHP)
- Nepal Ban Nigam Ltd. (NBNL)
- Nepal Electricity Authority (NEA)
- Nepal Oil Corporation (NOC)
- Solar Electric Manufacturers Association Nepal (SEMAN)
- Water and Energy Commission Secretariat (WECS)

Table 3.1: Data Collection from Institutions

Category	Institutions
Fuelwood, Agriculture and Animal Residue	• Ministry of Agriculture and Livestock Development (MoALD) • Ministry for Energy, Water Resources, and Irrigation (MoEWRI) • Ministry of Forest and Environment (MoFE) • Nepal Ban Nigam Ltd. (NBNL)
Coal and Petroleum Products	• Department of Customs (DoC) • Nepal Oil Corporation (NOC)
Electricity	• Department of Electricity Development (DoED) • Independent Power Producers' Association Nepal (IPPAN) • Ministry for Energy, Water Resources, and Irrigation (MoEWRI) • Nepal Electricity Authority (NEA) • Water and Energy Commission Secretariat (WECS)
Renewable Energy	• Alternative Energy Promotion Centre (AEPC) • Department of Electricity Development (DoED) • Solar Electric Manufacturers Association Nepal (SEMAN) • Water and Energy Commission Secretariat (WECS)
Demographic and Economic Data	• National Statistics Office (NSO) • Ministry of Finance (MoF) • Ministry of Health and Population (MoHP)

➢ Identification of the data variables for the study (which encompassed, but was not restricted to)

  - Traditional energy sources
    - Fuelwood, agriculture residue, animal residue, and bagasse
      - Sources
      - Supply potential

- Commercial energy sources
  - Coal
    - National production
    - Imports
  - Petroleum oils and natural gas
    - Types
    - Imports
    - Sales
  - Electricity
    - National potential and production (including off-grid)
    - Import
    - Export
- Renewable energy sources
  - Solar, wind, biogas, micro/pico hydropower
    - Total potential
    - Number of installations

➢ Preparation of task lists and checklists was prepared for data collection (See Annex)

➢ Brainstorming detailed procedures of data analysis, which may involve, but was not limited to

- National supply and consumption
  - Based on fuel types
  - Based on energy sectors
- Provincial supply and consumption
  - Based on fuel types
  - Based on consumption sectors

➢ The outline for the draft and final report was prepared

3.2 Analysis Phase

The analysis phase of the study consisted of field visits to relevant institutions, data collection, analysis of data, development of consumption and pricing trends, and preparation of a draft report. To analyze the data, interactive workshops, and discussion sessions were conducted with experts and concerned authorities.

- Field visit
  - Institutions shortlisted during the desk research were visited for data query
  - Presentation of data checklist to the institutions
- Data collection
  - Secondary data were collected from various institutions and publications
  - Data was sorted and classified based on the categories established during the desk review phase.
- Result analysis
  - Data analysis and calculation
    - Total energy potential and supply of the energy sources
    - Total energy consumption
      - Consumption based on fuel types
      - Consumption based on sector
  - Development of the energy balance and consumption trends for fiscal year 2079/80, compared with data compiled for 2075/76, 2076/77, 2077/78, and 2078/79
  - Analysis of pricing trends over time
  - Analysis of results against national and international goals, plans and policies

Analysis and conversion formulae were listed in Annex.

- Preparation of draft report
  - The results from the analysis were compiled and presented in a streamlined report format. The draft report was then submitted.
- Workshop with stakeholders
  - A workshop was held with WECS during which the results of the report were discussed.

3.3 Final Phase

In the final phase of the project, the feedback from the stakeholders was integrated into the draft report.

Chapter 4: Energy Outlook of Nepal

4.1 Energy Supply and Generation

Nepal's Energy Supply System is divided into three types based on the source and economy of the energy: traditional, commercial, and modern renewable, as shown in Figure 4.1.

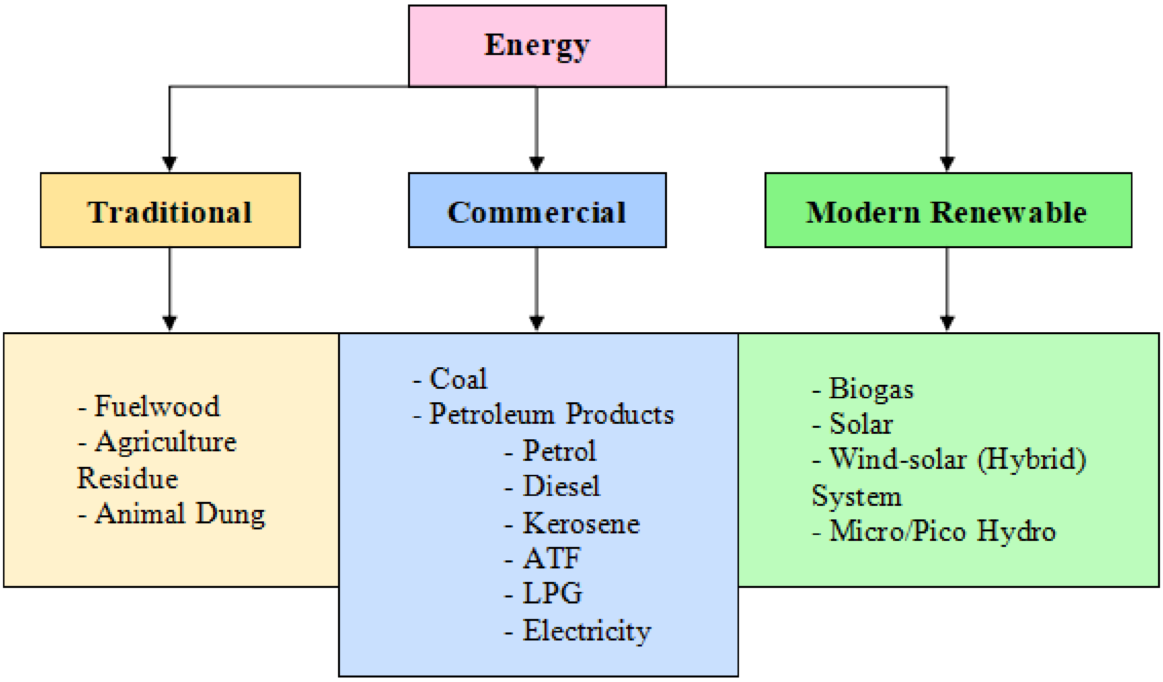

Figure 4.1: Energy resources in Nepal

The traditional energy sources, i.e. firewood, agricultural residues, and animal dung, are low-cost and locally available. The commercial energy sources include electricity, petroleum products, and coal. They are market-driven and more expensive but widely available. The modern renewable energy sources involve solar, wind, biogas, and micro/pico hydropower. These require higher initial investments but are cost-effective in the long term and sustainable.

4.1.1 Traditional Energy Resources

4.1.1.1 Fuelwood

Forests, defined as lands with more than 10% crown cover primarily used for forestry, play a critical role in global ecosystems and human livelihoods. These areas typically have a stand width greater than 100 meters, although they may include small non-forest patches. Even temporarily clear-cut areas intended for replanting are considered part of the forest. Unlike forests, shrubs do not have well-defined stems but share a similar definition.

More than 65% of Nepal's population, especially poorer families, rely on forests for timber, fuelwood, and fodder (FRTC, 2019). Nepal has conducted several national forest inventories to assess and manage its forest resources, with the first in the 1960s, followed by the second in the 1990s, and the third, most comprehensive one, by FRA Nepal between 2010 and 2014 under DFRS (2015). This study revealed the forest's coverage of 5.96 million hectares, equivalent to 40.36% of Nepal's total land area. Additionally, Other Wooded Land (OWL) spans 0.65 million hectares (4.38%), and Other Land covers 8.16 million hectares (55.26%). Within OWL, shrub-covered areas account for 0.12 million hectares (0.79%), and areas with tree crown cover ranging from 5% to 10% cover 0.53 million hectares (3.59%). Altogether, forests and OWL cover 6.61 million hectares, representing 44.74% of the country's total area.

Table 4.1: Forest coverage by province

Province	Total Area (ha)	Forest Area (ha)	Districts Included	Municipalities Covered
Koshi	2,590,500	1,134,250	14	137
Madhesh	966,100	263,630	8	136
Bagmati	2,030,000	1,090,880	13	119
Gandaki	2,150,400	817,290	11	85
Lumbini	2,228,800	974,380	12	109
Karnali	2,798,400	1,183,400	10	79
Sudurpashchim	1,987,400	1,147,110	9	88
Total	14,751,600	6,610,940	77	753

Nepal's forest distribution varies across different physiographic regions. It covers 6.9% of the Terai region, 23.04% of the Churia region, 37.8% of the Middle Mountains, and 32.25% of the High Mountains. 1.03 million hectares of the total forest area are designated protected areas, while 4.93 million hectares fall outside these regions. Protected areas are legally protected and managed to conserve natural resources and biodiversity. Within these areas, 0.79 million hectares of forest are in core areas, and 0.24 million hectares are in buffer zones. Among core areas, the High Mountains have the largest forest coverage at 459,240 hectares (57.95%), while the Middle Mountains have the lowest at 16,669 hectares (2.10%).

Additionally, specific areas of the forests have been designated as community forests. These forests are areas owned and managed by local communities and they hold the rights and responsibilities for sustainably using and benefiting from the forest resources, while promoting conservation and community development. These forests cover nearly half of Nepal's total forest area, making them the second largest management regime after government-managed forests (MOFE, 2020).

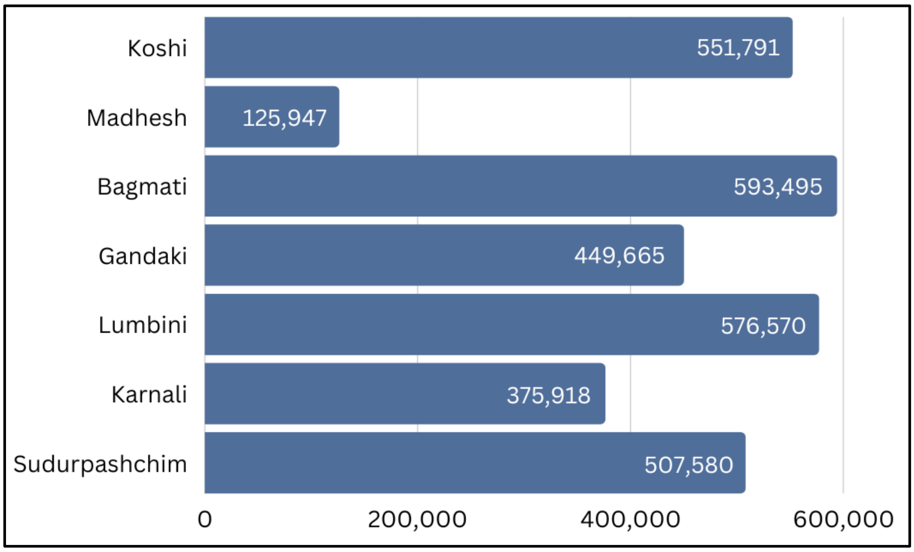

Figure 4.2: Community forest coverage in different provinces (ha)
(Data source: MOFE, 2020)

Among the seven provinces, Bagmati has the largest coverage of community forests, encompassing 593,495 hectares (18.66%). This is followed by Lumbini with 576,570 hectares and Koshi with 551,791 hectares. On the other end of the spectrum, Madhesh has the lowest coverage of community forests, accounting for 125,947 hectares (3.96%). This distribution highlights the significant role community-managed forests play in various regions across Nepal, contributing to local livelihoods and broader conservation efforts.

Sustainable Fuelwood Supply

According to the 2015 report from DFRS, Nepal's total above-ground air-dried biomass is approximately 1,159.65 million tonnes, which is equivalent to 1,054.2 million tonnes of above-ground oven-dried biomass. The High Mountains contribute the highest proportion of this biomass, accounting for 45% of the total. The Middle Mountains, Churia, and Terai regions contribute 27.84%, 20.40%, and 6.74%, respectively.

Table 4.2: Total above-ground air-dried and above-ground oven-dried biomass (in million tonnes)

Physiographic Region	Above-Ground Air-Dried	Above-Ground Oven-Dried
Terai	78.21	71.10
Churia	236.57	215.06
Middle Mountains	322.88	293.52
High Mountains	521.99	474.52
Total	**1,159.65**	**1,054.20**

(DFRS 2015, Energy Synopsis Report 2022)

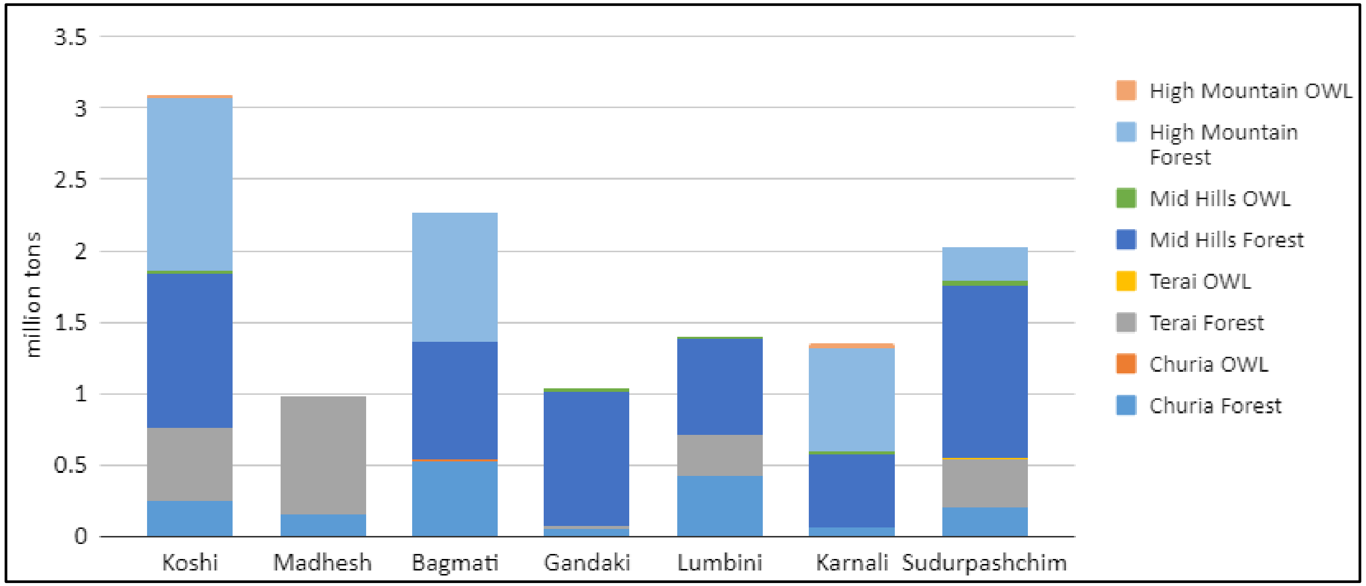

Figure 4.3: Proportion of different provinces in different physiographic regions in sustainable annual wood yields

(DFRS/FRISP, 1999)

Table 4.3: Annual sustainable fuelwood supply and energy by community forests in 2014

Province	Area in (000ha)			Sustainable Wood (million ton)	Energy (GJ)
	Forest	Reachable	Reachable (%)		
Koshi	536.68	420.17	78%	1.58	26,391,873.88
Madhesh	77.64	77.64	100%	0.29	4,876,954.71
Bagmati	374.80	215.32	57%	0.81	13,524,931.69
Gandaki	233.59	85.70	37%	0.32	5,383,219.72
Lumbini	394.88	150.49	38%	0.56	9,452,519.01
Karnali	316.30	120.54	38%	0.45	7,571,648.42
Sudurpashchim	265.09	138.38	52%	0.52	8,691,877.17
Total	**2,198.98**	**1,208.24**		**4.53**	**75,893,024.60**

Nepal has a total of 3,183.25 million hectares of accessible forest area. According to DFRS/FRISP (1999), these forest resources can sustainably provide about 12.16 million tonnes of fuelwood annually, with 11.94 million tonnes from forest areas and 0.22 million tonnes from other wooded lands. The highest contribution to fuelwood comes from the Koshi province (25.4%), followed by Bagmati (18.67%), Sudurpashchim (16.69%), Lumbini (11.43%), Karnali (11.1%), Gandaki (8.63%), and Madhesh (8.06%). The annual energy potential of sustainable fuelwood is estimated to be 203,578,923 GJ.

Furthermore, according to the DFRS (2015) report, Nepal's community forests contribute an annual sustainable fuelwood supply of 4.53 million tons. Leading in this contribution, the Koshi province boasts the highest annual supply of sustainable fuelwood, amounting to 1.58 million tons. Conversely, the Madhesh province provides the lowest supply, contributing only 0.29 million tons per-year.

4.1.1.2 Agricultural Residues

Residues from various agricultural residues can serve as a source of energy production. The calorific value of these residues directly impact the amount of energy that can be generated. Among crops like paddy, wheat, millet and corn, paddy is the most abundant, accounting for more than half of the total share. The estimated residue produced and the total energy potential are shown in Figures 4.4 and 4.5, respectively.

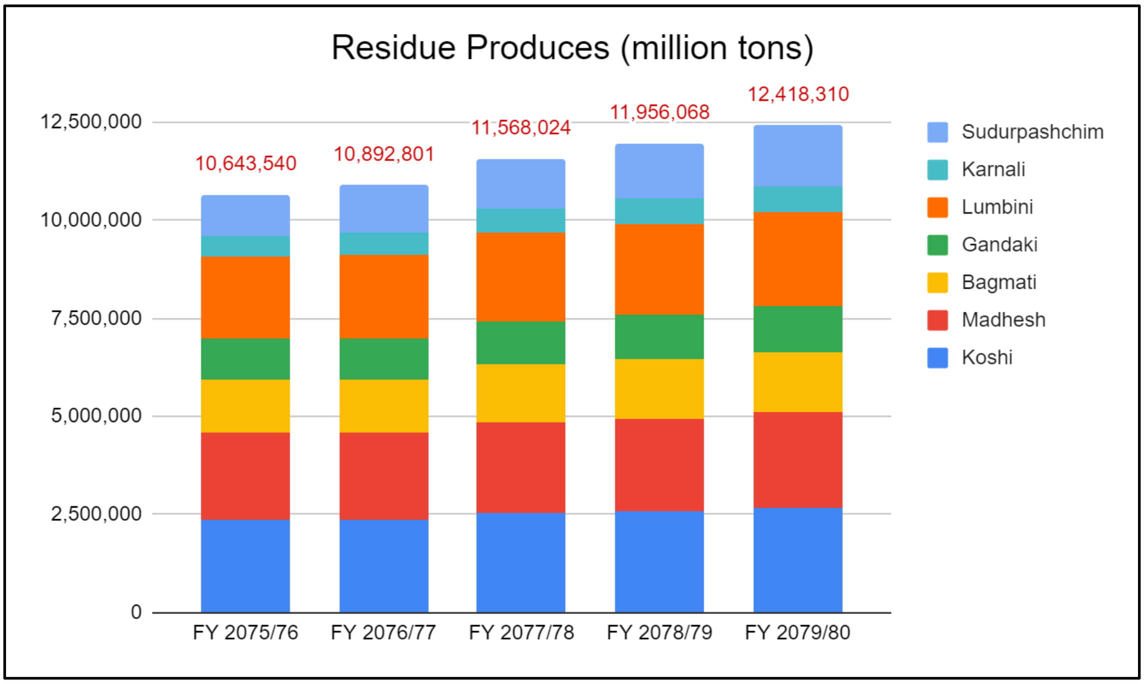

Figure 4.4: Total agricultural residue production up to FY 2079/80
(Source: MoALD 2022)

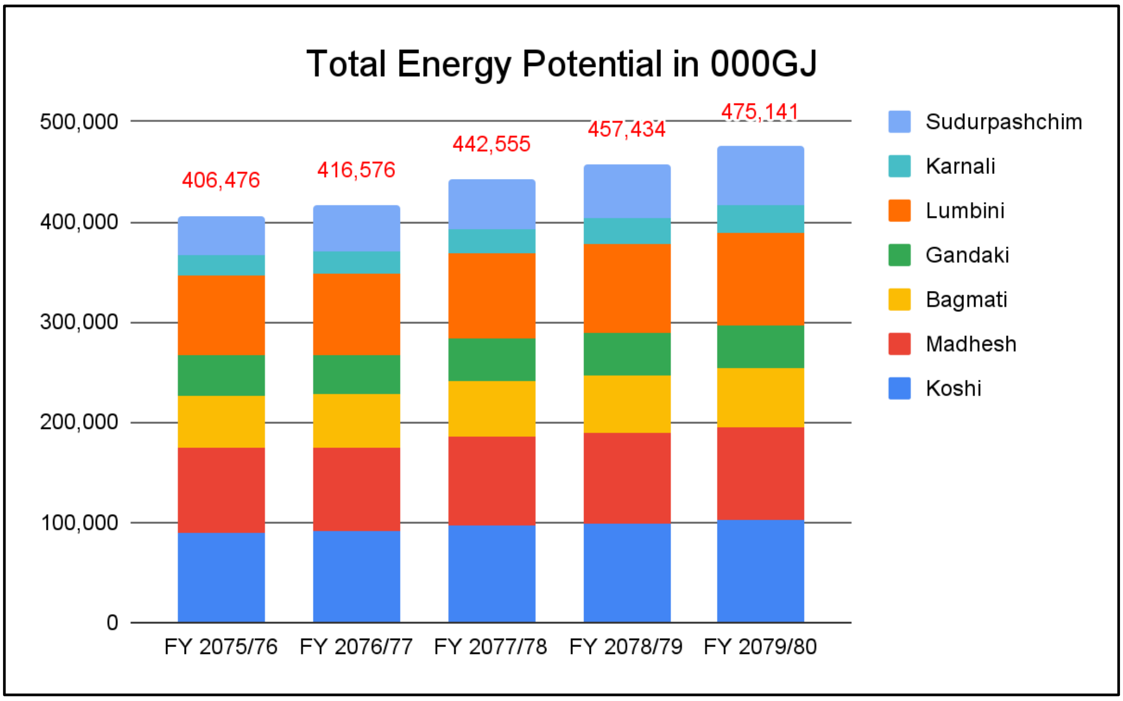

Figure 4.5: Total energy potential from agricultural residue up to FY 2079/80
(Source: MoALD 2022)

4.1.1.3 Animal Dung

The potential supply of animal dung was calculated by considering the populations of cattle and buffalo. According to the WECS 2010 report, the total potential supply of dry dung in 2008/2009 was 15 million tons. A 6.8 million ton of dry dung was yielded in 2019 with the accessibility and collection efficiency of 70% when the population of cattle and buffalo were 7.4 million and 6,9 million respectively. The estimated dung production and the subsequent potential energy are shown in Figures 4.6 and 4.7 respectively.

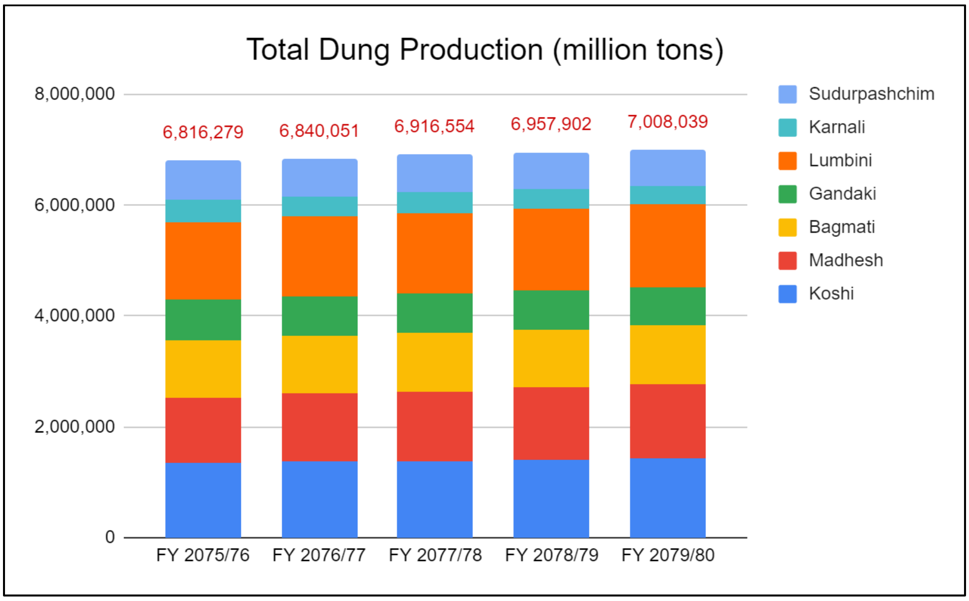

Figure 4.6: Total estimated animal dung production up to FY 2079/80
(Source: Energy Synopsis Report 2023 and MoALD 2022)

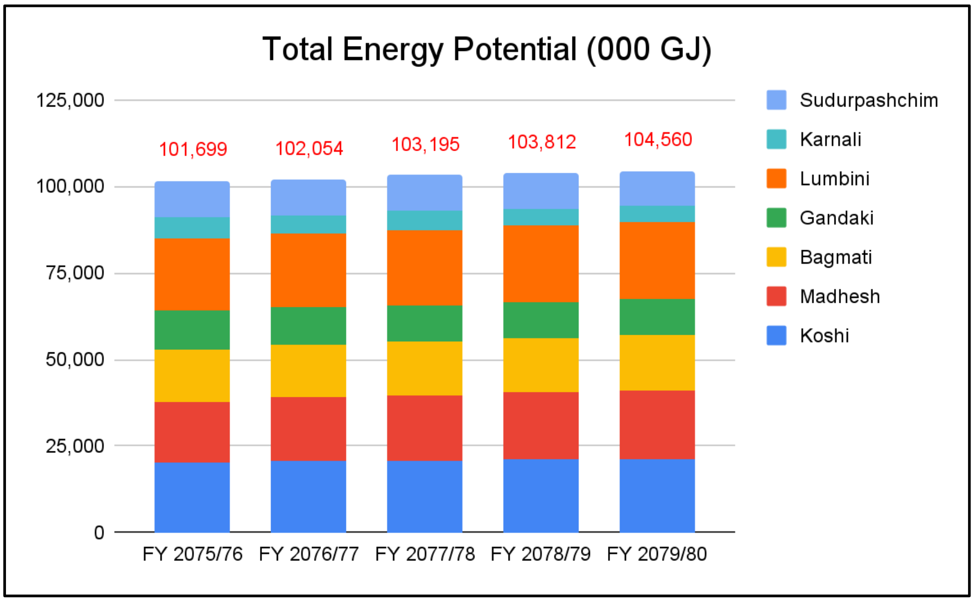

Figure 4.7: Total energy potential from animal dung up to FY 2079/80
(Source: Energy Synopsis Report 2023 and MoALD 2022)

4.1.2 Commercial Energy Resources

4.1.2.1 Coal

Four types of coal are mostly found in Nepal at four different stratigraphic positions. One is quaternary lignite, then there is siwalik coal that if found along the Churia Hill, Eocene coal is found in the Dang-Puritan and the Tosh area of the Dang Valley and the Gondwana coal that are mostly found in the western part of Nepal i.e., Suija, Ajimara and Abidhara.

In FY 2076/77, the country produced 7,250.1 tons of coal. Production increased to 11,303.9 tons in FY 2077/78, then fell to 6,927.04 tons in FY 2078/79. By FY 2079/80 coal production had further declined to 2,948 tons. The brick-manufacturing industry is the largest consumer of coal in Nepal.

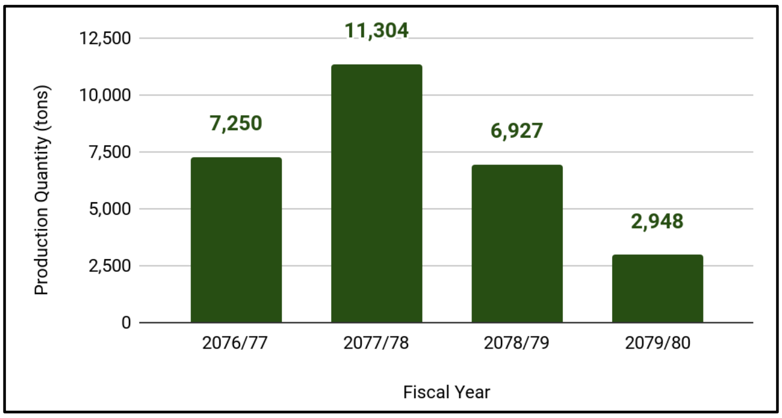

Figure 4.8: National coal production up to 2079/80
(Source: Department of Mines and Geology 2024)

Imports

Coal imports in Nepal have exhibited fluctuations and a declining trend since FY 2077/78, where total imports amounted to 2,001,611 tons. This figure decreased to 1,383,000 tons by FY 2079/80, reflects a diminishing dependence on coal in Nepal.

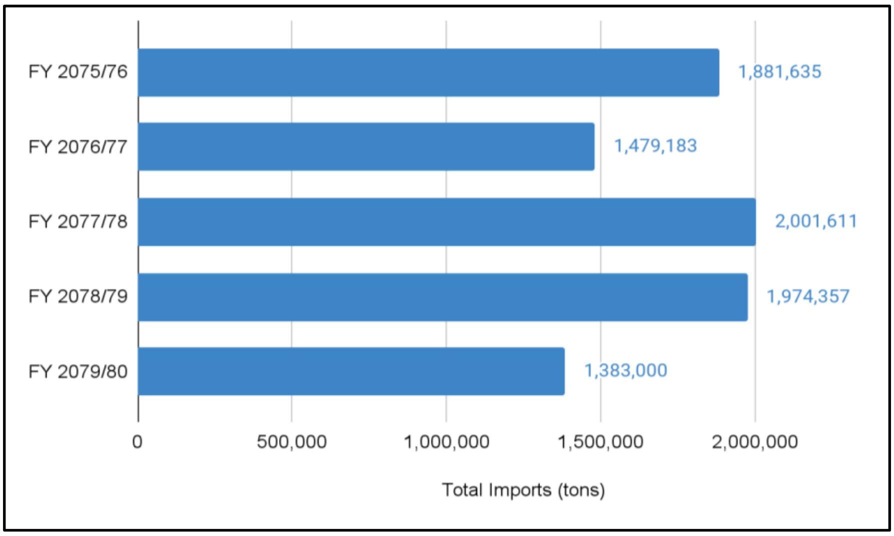

Figure 4.9: Total imports of coal
(Data source: Department of Customs 2080)

4.1.2.2 Petroleum Oils and Natural Gas

Nepal imports its petroleum products primarily through its border with India. Analyzing the current trend, the import of petrol, Diesel and LPG has decreased in 2079/80 to 675kL, 1382kL and 514MT after peaking in 2078/79 at 736kL, 1723kL and 536MT respectively. As for kerosene import, it has been continuously decreasing since 2077/78. Import of ATF has increased to 173kL following the trend of rise since stooping to 77kL in 2077/78.

Table 4.4: Petroleum storage capacity (as of 2080/01/23)

Location	MS	SKO	ATF
Amlekhgunj	3,430	760	-
Bhadrapur	-	-	83
Bhairahawa	519	140	494
BHW Pump	32	-	-
Biratnagar	560	710	302
Dang	-	-	41
Dhangadi	879	70	63
Dipayal	-	-	-
Janakpur	30	70	92
Kathmandu	6,070	760	7,132
Manthali	-	-	28
Nepalgunj	970	140	303
NPJ Pump	32	-	-
Pokhara	1,110	-	157
Simara	-	-	38
Surkhet	-	45	82
Total	**13,632**	**2,695**	**8,815**

(Source: Nepal Oil Corporation 2080)

Imports

Figure 4.10 displays the annual imports of petroleum fuel across various regions for the fiscal years 2075/76 to 2079/80. Each bar represents the total petroleum products imported in a specific year, with segments indicating import through different provinces.

The total import peaked in FY 2078/79 at 736,276 kL and has decreased in FY 2079/80 to 675,492 kL.

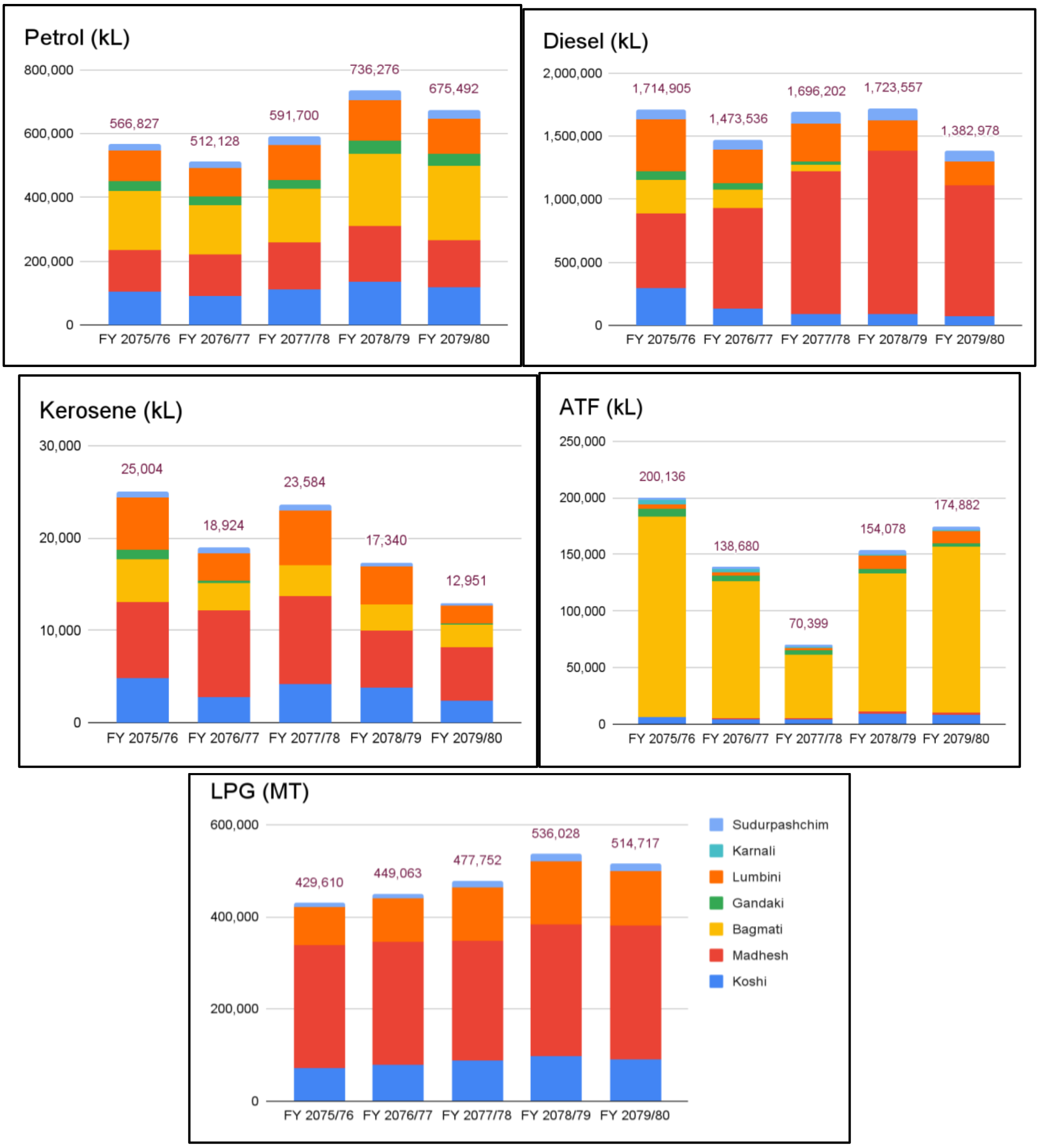

Figure 4.10: Import data of petroleum fuel up to FY 2079/80[4]

(Source: Nepal Oil Corporation, 2080)

The total import of diesel reached its highest in FY 2078/79 at 1,723,557 kL, with a notable decrease in FY 2079/80 to 1,382,978 kL. Similarly, the total import of kerosene reached its highest in FY 2075/76 at 25,004 kL, and decreased in FY 2079/80 to 12,951 kL, indicating the decreasing trend of kerosene. The import of Aviation Turbine Fuel (ATF) reached its

[4] Note: several provinces have no records of imports as those provinces do not import from the neighboring country, and rely on the imports from other provinces.

highest in FY 2075/76 at 2,00,108 kL, with a notable decrease in FY 2077/78 to 12,951 kL which is now on the increasing trend.

Sales

Figure 4.11 represents the sales trend of petroleum fuel in different provinces of Nepal. Each bar represents the total sale of the petroleum products in a specific fiscal year, with segments indicating sale (consumption) by different provinces.

The maximum sales of petrol is in FY 2078/79 which is 7,30,488 kL and minimum is 4,34,830 in FY 2076/77. Sales in Bagmati province is comparatively higher followed by Madhesh, Koshi and Lumbini province. Sales value seems more stable in FY 2078/79 and FY 2079/80.

The sales trend of Diesel shows that the maximum sales is in FY 2078/79 which is 7,30,488 kL and minimum is 4,34,830 in FY 2076/77. Sales in Bagmati province is comparatively higher followed by Madhesh, Koshi and Lumbini province. Overall sales value seems to fluctuate every fiscal year. The highest sales of kerosene occurred in FY 2075/76 at 25,084 kL, and the lowest was in FY 2079/80 at 13,478 kL. Sales in the Bagmati province are comparatively higher, followed by Madhesh, Koshi, and Lumbini provinces. Overall, the sales value fluctuates each fiscal year. Similarly, the highest sales of LPG were recorded in FY 2078/79 at 536,028 MT, while the lowest was in FY 2075/76 at 429,610 MT. Sales in the Madhesh province are notably higher, followed by Bagmati, Koshi, and Lumbini provinces. The overall sales volume exhibits fluctuations across the fiscal years. But, the ATF is drastically changing over a period of time where the maximum sales is in FY 2075/76 and lowest is observed in FY 2077/78.

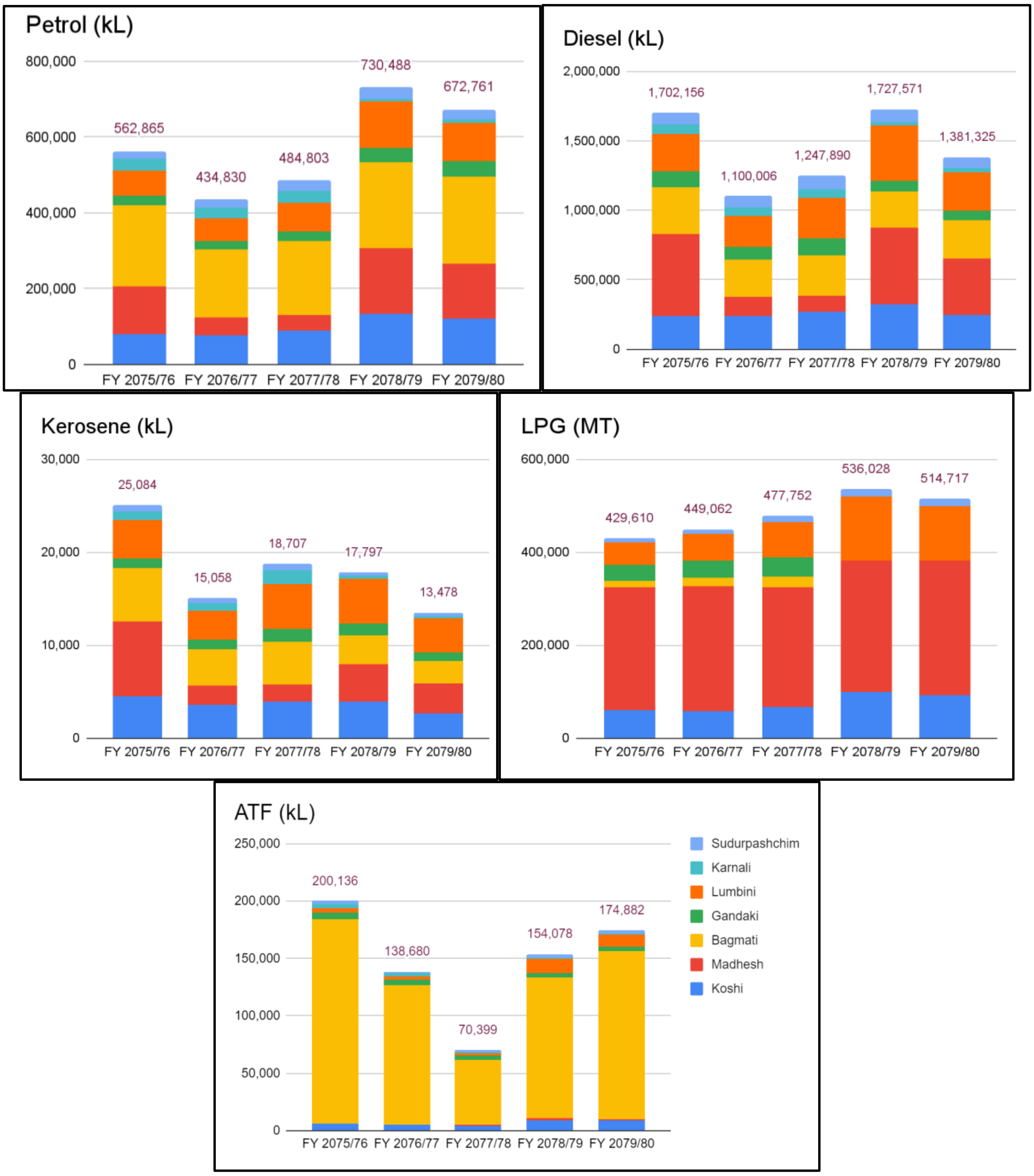

Figure 4.11: Sales of petroleum fuel in provinces up to FY 2079/80[5]

(Source: Nepal Oil Corporation, 2080)

[5] Note: some provinces have no records of sales of LPG as depots handle their sales and NOC lacks data regarding it

4.1.2.3 Electricity

Nepal's gross hydropower potential had been estimated at 72,544 MW [WECS, 2019], predominantly distributed across the Koshi, Gandaki, and Karnali river basins, which account for 94% of this total. Koshi province has the highest potential at 22,619 MW, while Madhesh province has the lowest at 275 MW (Table 4.5).

Table 4.5: Provincial power generation potential

Province	Power Potential (MW)	% of Basin Potential (MW)
Koshi	22,619	31.2%
Madhesh	275	0.4%
Bagmati	10,568	14.6%
Gandaki	14,981	20.7%
Lumbini	2,677	3.7%
Karnali	13,702	18.9%
Sudurpashchim	7,722	10.6%
Total	**72,544**	**100%**

(Source: Hydropower Potential of Nepal 2019, WECS)

In the past FY, Nepal's total generation capacity reached 2,684 MW, augmented by the commissioning of new projects totaling 491 MW. This growth marked a significant milestone for the country, leading to a power surplus during the wet season. Additionally, Nepal exports approximately 452 MW of hydropower to India on a Day-Ahead basis through the Indian Energy Exchange (IEX), highlighting its evolving role in the regional energy market. Domestically, the consumer distribution remained predominantly in favor of residential users, accounting for 92.32% of the total consumers, while industrial and other sectors accounted for 1.31% and 6.37% respectively. According to the ***16th National Plan***, 96.7% of the population has access to electricity through the national grid and 1.3% of the population is electrified via alternative means. This results in 98% of the total population having access to electricity (Figure 4.13).

The hydropower plants under NEA generated 2,930 GWh of electricity. This was a 10.10% decrease from the previous year's record of 3,259 GWh. This was primarily due to reduced river discharge during the dry season. In contrast, energy purchases from Independent Power Producers (IPPs) and NEA subsidiaries increased significantly, with 5,118 GWh and 2,488 GWh respectively, marking substantial year-on-year growth. The total energy imported from India also saw an 18.79% rise, reaching 1,833 GWh. As a result, the total available energy in the system increased by 11.80% to 12,369 GWh. Infrastructure development kept pace with these advancements; the total length of transmission lines of 66 kV and above in operation grew to 5,742 circuit kilometers, and substation capacity expanded to 8,867 MVA. Moreover, NEA aims to achieve 100% electrification within the next two years and further enhance transmission and substation capacities to support ongoing and future development of power generation and distribution.

The total capacity of hydropower, completed, under construction and pipeline, is 11920.31 MW where completed projects are generating 2,538.273 MW, under construction projects aims to generate 5809.637 MW and 3,572.400 MW of power is being planned to generate from pipeline projects.

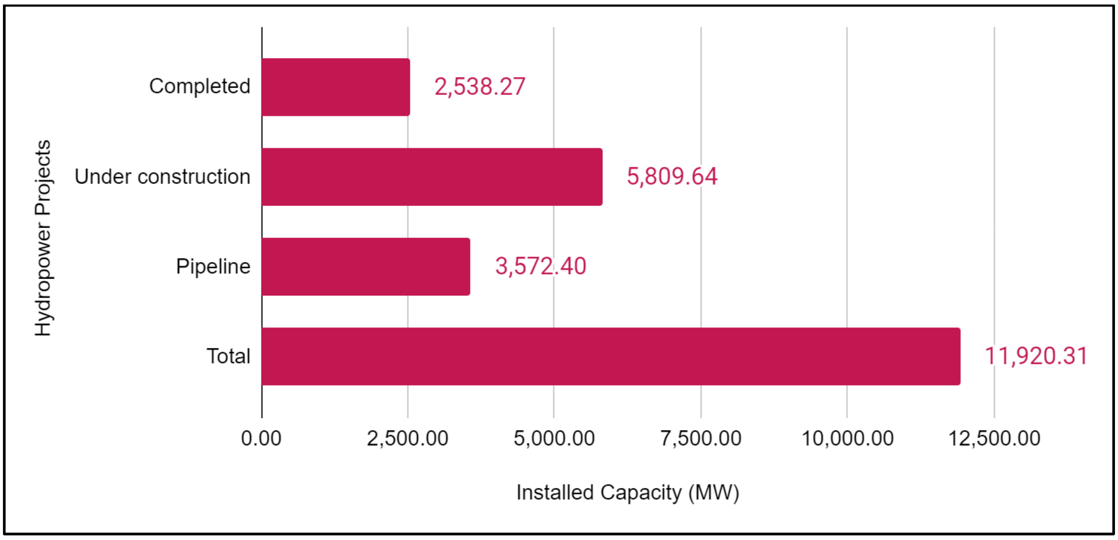

Figure 4.12: Total hydropower projects of Nepal
(Source: NEA, A Year in Review-Fiscal Year 2022/2023)

The energy purchased from Independent Power Producers (IPPs) and NEA's subsidiaries was 5,118 GWh and 2,488 GWh, an increase by 19.41 % and 25.91 % from the figure of 4,286 GWh and 1,976 GWh in FY 2021/22 respectively. In FY 2022/23, the total energy imported from India was 1,833 GWh, up 18.79% from 1,543 GWh in FY 2021/22. Compared to the similar figure of 11,064 GWh in FY 2021/22, the total available energy in the system grew by 11.80% to 12,369 GWh in FY 2022/23. NEA and its subsidiaries contributed 43.80% of the total energy available, while purchases from domestic IPPs and imports from India accounted for 14.82% and 41.38%, respectively.

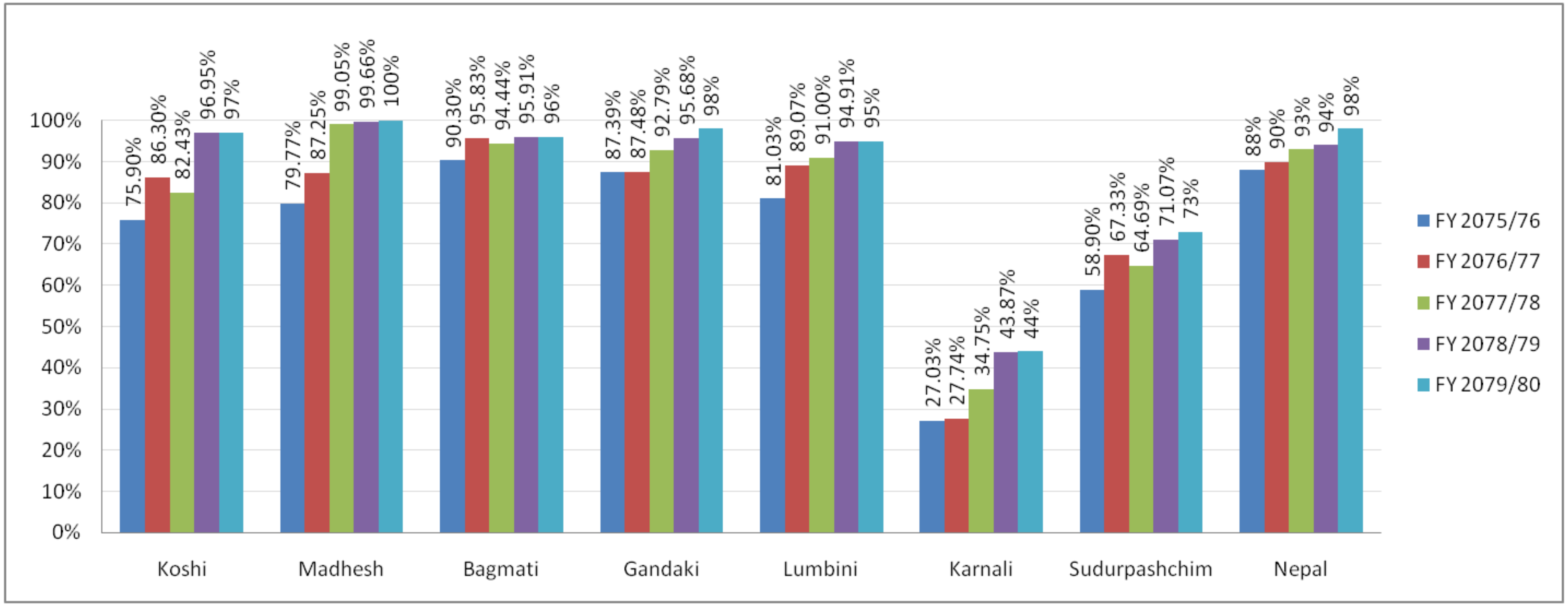

Figure 4.13: Provincial and national electrification status

(Data source: Energy Synopsis Report 2023 and 16th National Plan, 2024)

4.1.3 Modern Renewable and Alternative Energy Resources

Biogas is the largest contributor, providing 256.1 thousand tonnes of oil equivalent, which constitutes the majority share of the renewable energy mix. Solar energy follows, contributing 123.77 thousand tonnes. Micro and pico hydro projects add 13.74 thousand tonnes, while wind energy has the smallest share, contributing just 0.48 thousand tonnes.

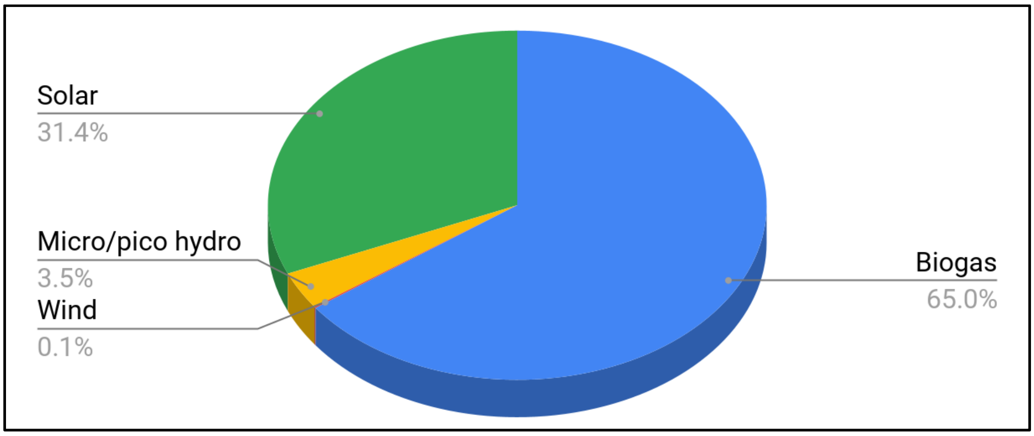

Figure 4.14: Renewable energy for FY 79/80
(Source: AEPC Annual Report 2022/23)

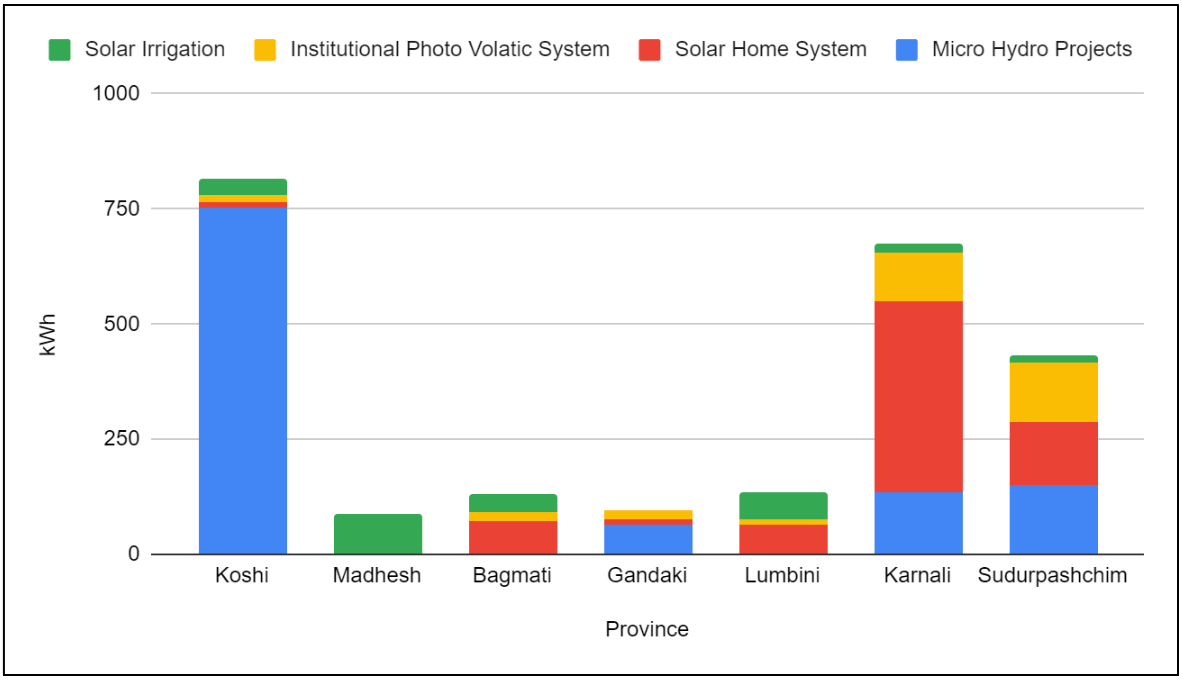

Figure 4.15: Province wise renewable energy production capacity (except biogas)
(Source: AEPC Annual Report 2022/23)

4.1.3.1 Solar Energy

According to Poudyal et al., 2019, the solar energy potential in Nepal is substantial with an average of 300 days per year and approximately 6.8 hours of sunshine per day. This condition showcases a favorable scenario for the generation of energy from utilization of solar radiation.

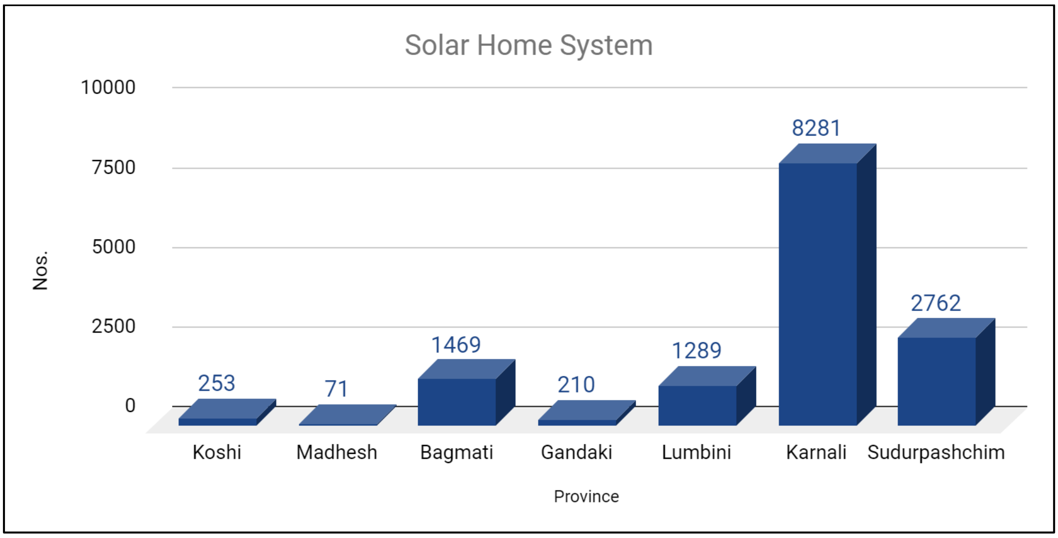

Figure 4.16: Solar home system for FY 2079/80
(Source: AEPC Annual report 2022/23)

Figure 4.16 shows the number of Solar Home Systems (SHS) installations in the seven provinces of Nepal. Karnali accounts for the major area of utilization of SHS. In the remote areas of the province, reliance on erratic grid power and expensive diesel generators can be counterproductive. Thus people are tapping into the benefits of Solar Home Systems in these areas and it accounts for more than a half of total national SHS power generation (57.8%).

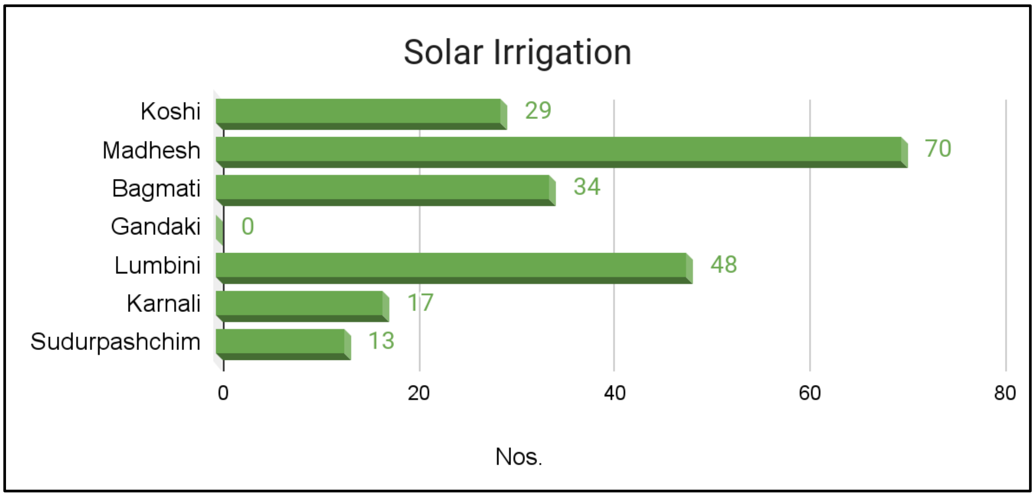

Figure 4.17: Solar irrigation for FY 2079/80[6]

(Source: AEPC Annual report 2022/23)

Solar irrigation in Nepal has revolutionized agriculture by providing reliable and sustainable water supply solutions, especially in remote and off-grid areas. Utilizing the abundantly available sunlight, solar-powered pumps reduce dependency on diesel and grid electricity, enhancing crop yields and improving farmers' livelihoods. The high reliance on this system is observed in the Madhesh province, with a count of 70, as shown in Figure 3.17. This accounts for 33.2% of the total national solar irrigation plants (AEPC, Annual Progress Report, FY 2079/80).

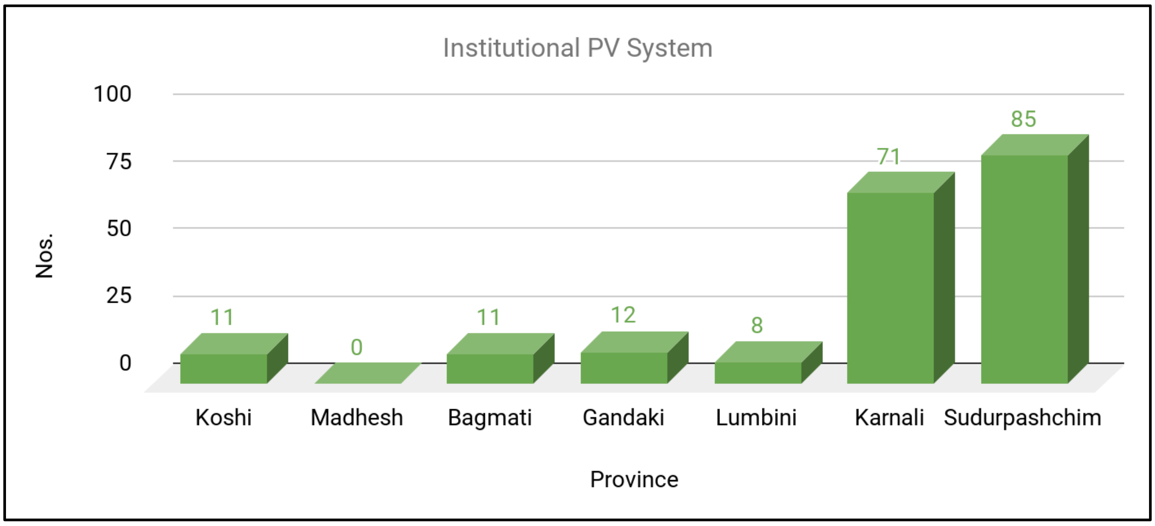

Figure 4.18: Institutional photovoltaic systems for FY 2079/80[7]

(Source: AEPC Annual report 2022/23)

The institutional photovoltaic systems are being implemented in Nepal to supply reliable and sustainable electricity to schools, hospitals, and government offices. The application of these systems are particularly concentrated in the remote and off-grid regions, as evident from the significant number of installations in the western region of the country (Karnali and Sudurpashchim) compared to the eastern region (Figure 4.18). These solar energy solutions decrease reliance on unstable grid power and fossil fuels, ensuring uninterrupted operation and improving service delivery.

4.1.3.2 Wind -Solar Energy

Wind energy generation in Nepal has seen a significant increase in recent fiscal years. During the fiscal year 2078/79, Nepal generated 40 TOE (Tonnes of Oil Equivalent) of wind-solar energy. In the following fiscal year 2079/80, the country added 435 TOE of wind-solar energy generation. This substantial increase brought the total potential of wind-solar energy generation in Nepal to 475 TOE.

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[6] No solar irrigation project implemented by AEPC in Gandaki province in FY 2079/80

[7] No institutional PV systems implemented by AEPC in Madhesh province in FY 2079/80

4.1.3.3 Biogas

Figure 4.19 shows the distribution of biogas production across Nepal's provinces. Bagmati leads with the highest share at 28.1%, followed by Gandaki with 24.2%, and Koshi with 19.6%. Madhesh contributes 11.2%, while Lumbini accounts for 9.8%. Sudurpashchim and Karnali have smaller shares of 4.1% and 3.1% respectively. This distribution highlights that Bagmati, Gandaki, and Koshi are the primary contributors to biogas production, indicating more advanced development and utilization of biogas resources in these regions compared to the relatively lower contributions from Sudurpashchim and Karnali.

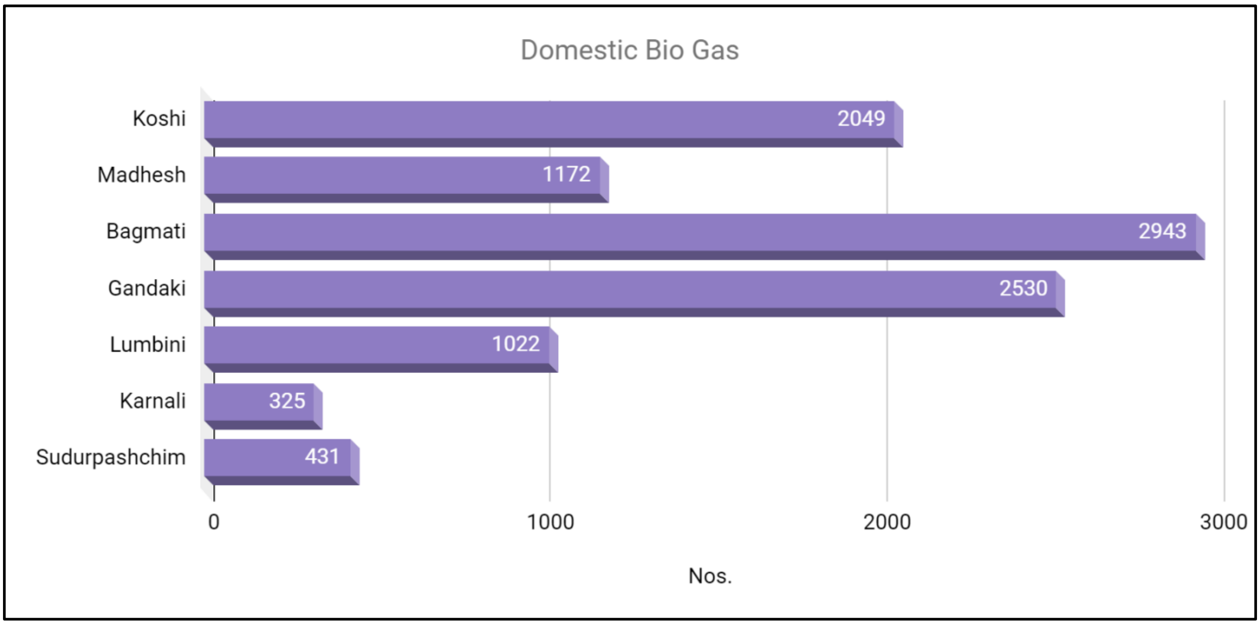

Figure 4.19: Domestic biogas distribution for FY 2079/80
(Source: AEPC Annual report 2022/23)

4.1.3.4 Micro/Pico Hydropower

Figure 4.20 presents the distribution of micro/pico hydropower projects across different regions of Nepal for FY 2079/80. The Koshi region has the highest number of projects, accounting for 68.1% of the total projects. The Sudurpashchim province follows with 13.6% and Karnali province accounts for 12.2% of the total projects. Gandaki holds the smallest share among the provinces with established micro/pico hydropower.

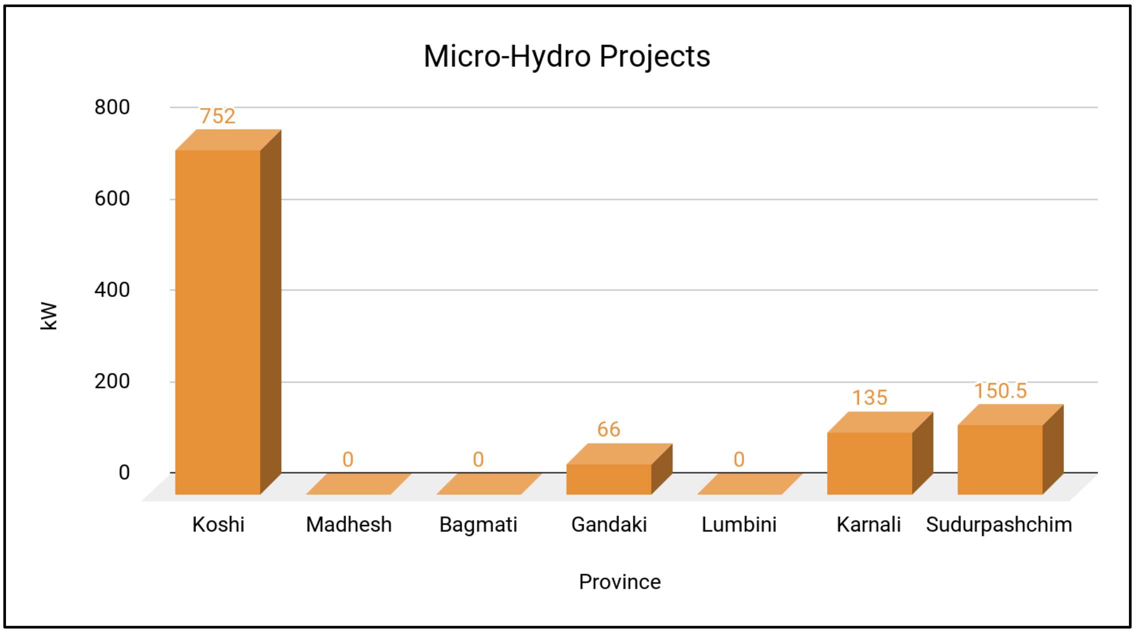

Figure 4.20: Installed capacity of micro/pico hydropower projects for FY 2079/80[8]
(Source: AEPC Annual report 2022/23)

[8] No micro/pico hydropowers implemented by AEPC in Madhesh, Bagmati, and Lumbini province in FY 2079/80

4.2 Energy Consumption

4.2.1 Energy Consumption by Fuel Types

The energy consumption for FY 2079/80 in Nepal totaled to 532.42 PJ (categorized by fuel type). Traditional fuels account for the largest share at 63.87%. Commercial fuels follow, making up 25.80% of the total energy consumption. Grid electricity contributes 7.23%, while renewable energy sources represent 3.10% of the total consumption.

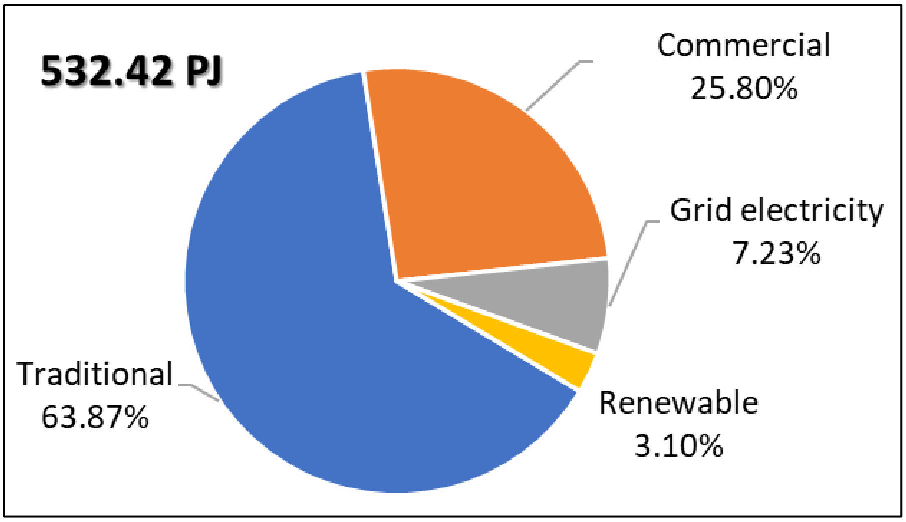

Figure 4.21: Energy consumption for FY 2079/80 by fuel type

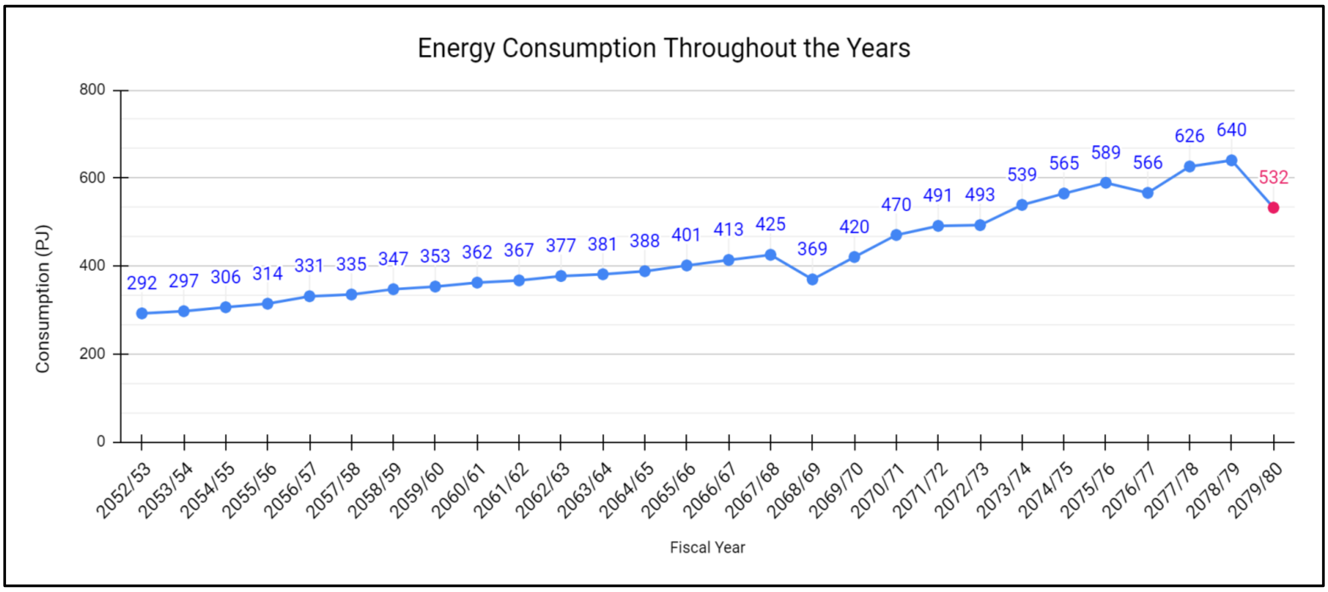

Figure 4.22: Energy consumption trend line[9]

Figure 4.22 shows the trend line of energy consumption of Nepal throughout the years. In recent FY 2079/80 the energy consumption has decreased by 16.81% from FY 2078/79.

[9] Data in graph is presented in rounded format. See Annex B: Table II

Table 4.6 shows the overall energy consumption of Nepal in FY 2079/80 (i.e., 2023).

Table 4.6: Detailed energy consumption of FY 2079/80 (2023)

FY 2079/80					
Category	**Fuel Type**	**Energy (000 GJ)**	**000 TOE**	**GWh**	**% of National Total**
Traditional	Fuelwood	304,625.30	7,275.85	85,295.08	57.22%
	Agricultural residues	25623.22	612.00	7,174.50	4.81%
	Animal dung	9,791.23	233.86	2,741.54	1.84%
	Total	**340,039.74**	**8,121.71**	**95,211.13**	**63.87%**
Commercial	Coal	34,015.89	812.46	9,524.45	6.39%
	Petrol	21,932.01	523.84	6,140.96	4.12%
	Diesel	49,727.70	1,187.73	13,923.76	9.34%
	Kerosene	471.73	11.27	132.08	0.09%
	LPG	23,676.98	565.51	6,629.55	4.45%
	ATF	6,190.82	147.87	1,733.43	1.16%
	Furnace Oil	1,368.71	32.69	383.24	0.26%
	Total	**137,383.84**	**3,281.36**	**38,467.48**	**25.80%**
	Grid Electricity	**38,495.00**	**919.44**	**10,778.60**	**7.23%**
Renewable	Biogas	10,722.27	256.10	3,002.24	2.01%
	Wind/Solar (Hybrid)	20.10	0.48	5.63	0.0038%
	Micro/Pico Hydro	575.06	13.74	161.02	0.11%
	Solar	5,182.00	123.77	1,450.96	0.97%
	Total	**16,499.43**	**394.08**	**4,619.84**	**3.10%**
Total		**532,418.01**	**12,716.59**	**149,077.04**	**100%**

Energy consumption in Nepal is currently on a decline (Table 4.7) due to several interrelated factors. The country's shift towards renewable and alternative energy sources has significantly reduced the reliance on fossil fuels. Renewable energy, particularly hydropower, now plays a crucial role in meeting the energy demands of production and manufacturing, thereby reducing the consumption of coal and petroleum.

Table 4.7: Consumption changes compared to previous FY

Fuel Type	000 GJ		Percentage Change
	2078/79	2079/80	
Traditional	**410,678.59**	**340,039.74**	**-17.20%**
Wood	374,562.95	304,625.30	**-18.67%**
Agriculture Residue	17,965.50	25623.22	**42.62%**
Animal Dung	18,150.14	9,791.23	**-46.05%**
Commercial	**181,406.91**	**137,383.84**	**-24.27%**
Coal	58,148.22	34,015.89	**-41.50%**
Petroleum Products[10]	123,258.69	103,367.96	**-16.14%**
Electricity	**31,766.40**	**38,495.00**	**21.18%**
Renewable	**16113.884**	**16,499.43**	**2.39%**
Total	**639,965.79**	**532,418.01**	**-16.81%**

The global scarcity of coal has led to a sharp increase in coal prices. This has had a direct impact on Nepalese industries that depend heavily on coal, forcing many to close down. The rising cost of coal and subsequent industrial shutdowns have contributed to a decrease in the import of coal and petroleum products, leading to a substantial reduction in overall energy consumption. The industrial sector in Nepal is experiencing a decline in demand and production, resulting in lower consumption of non-renewable fuels like coal and diesel. The shift from petroleum to electricity for transportation further underscores the decreasing reliance on fossil fuels. The energy efficiency of electricity and renewable sources is significantly higher compared to petroleum products and coal. This higher efficiency leads to less wastage of energy during consumption, making renewables a more sustainable and cost-effective option in the long run.With coal no longer being imported at previous levels, the overall energy consumption in Nepal has been decreasing.

As a whole, the decline in energy consumption in Nepal is driven by the transition to renewable energy, the economic impact of rising coal prices, industrial closures, and the increasing adoption of electric vehicles. This multifaceted shift is reducing the country's dependence on non-renewable energy sources and fostering a more sustainable energy landscape.

[10] Percentage changes for individual petroleum products are in Annex H: Table XIX

4.2.2 Energy Consumption by Sector

Figure 4.23 illustrates the sectoral energy consumption share in Nepal. The residential sector dominates energy consumption with 60.75%. The industrial sector follows, consuming 20.91% of the energy. The transportation sector accounts for 10.43%, while the commercial sector uses 5.04%. The agriculture sector accounts for 0.95% and construction and mining sectors accounts for 1.92% of the total energy consumption.

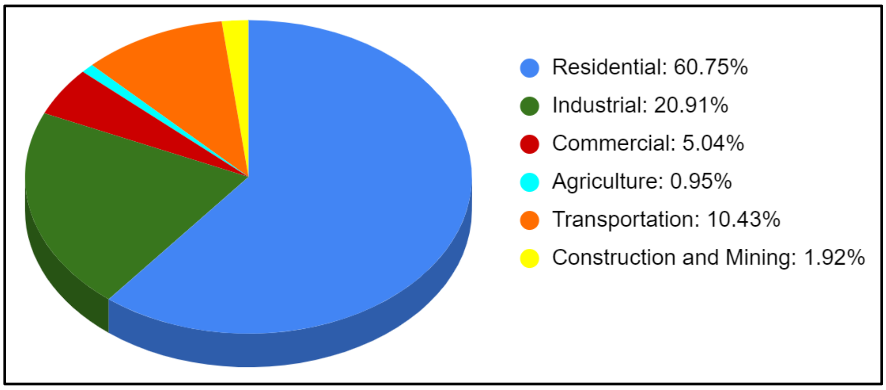

Figure 4.23: Sectoral energy consumption share for FY 2079/80

4.2.2.1 Residential Sector

In the residential sector, the energy mix of Nepal totals 323.46 PJ (Figure 3.24). The largest share is from fuelwood, accounting for 79.52%. Other significant contributions include LPG at 5.62%, electricity at 4.99%, and biogas at 3.31%. Smaller contributions come from agricultural residue (2.75%), animal dung (2.93%), solar (0.68%), micro/pico hydro (0.14%), wind (0.0053%), kerosene (0.03%), and coal (0.01%).

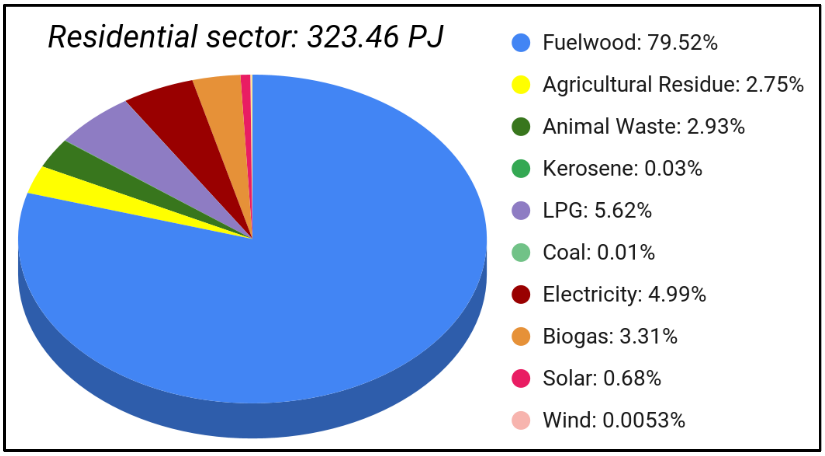

Figure 4.24: Energy consumption of residential sector

4.2.2.2 Commercial Sector

Figure 4.25 illustrates the energy consumption of the commercial sector in Nepal, totaling 26.83 PJ. Fuelwood is the predominant energy source, accounting for 57.44% of the total consumption. LPG is the second-largest contributor at 16.45%, followed by solar at 11.05% and electricity at 9.89%. Other energy sources include agricultural residue (1.40%), animal dung (1.14%), coal (1.34%), petrol (0.65%), and micro/pico hydro (0.43%). Smaller contributions come from kerosene (0.18%), biogas (0.03%), and wind (0.011%).

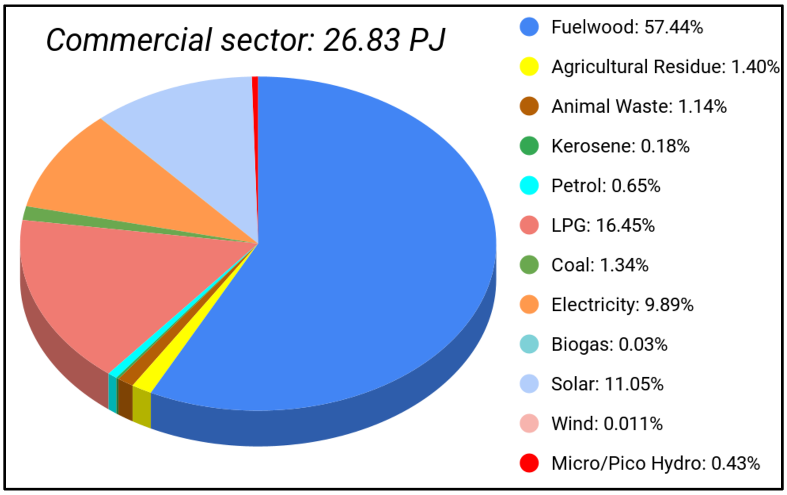

Figure 4.25: Energy consumption of commercial sector

4.2.2.3 Industrial Sector

Figure 4.26 shows the energy consumption mix for the industrial sector in Nepal, totaling 111.30 PJ. Coal is the largest contributor, accounting for 30.21% of the total energy consumption. Fuelwood follows at 28.66%, and electricity constitutes 11.57%. Diesel accounts for 10.46% of the energy mix, while agricultural residue makes up 14.68%. Smaller contributions come from petrol (2.25%), furnace oil (1.23%), LPG (0.69%), and kerosene (0.27%).

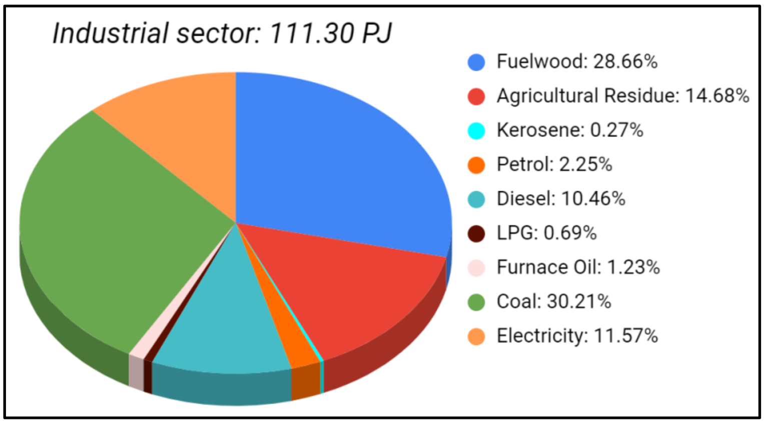

Figure 4.26: Energy consumption of industrial sector

4.2.2.4 Transportation Sector

Figure 4.27 illustrates the energy consumption of the transportation sector in Nepal, totaling 55.55 PJ. Diesel is the dominant energy source, accounting for 54.85% of the total consumption. Petrol follows with 33.95%, and Aviation Turbine Fuel (ATF) contributes 11.14%. Minor contributions come from electricity (0.05%) and LPG (0.0043%).

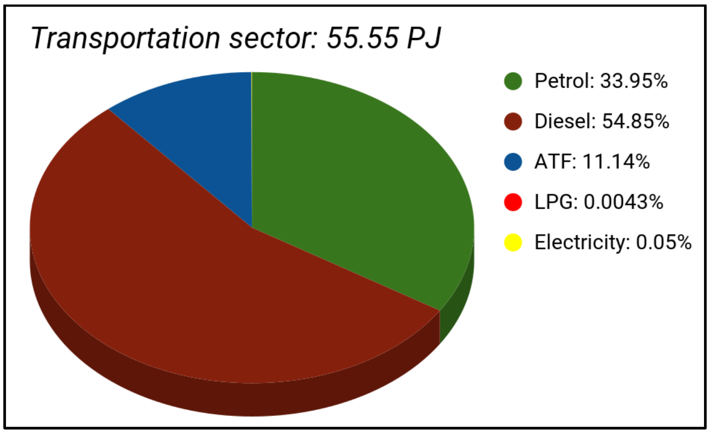

Figure 4.27: Energy consumption of transportation sector

4.2.2.5 Agriculture Sector

Figure 4.28 depicts the energy consumption of the agriculture sector in Nepal, totaling 5.04 PJ. Diesel is the predominant energy source, accounting for 75.77% of the total consumption. Electricity follows with 22.50%, while petrol and solar contribute 1.22% and 0.51%, respectively.

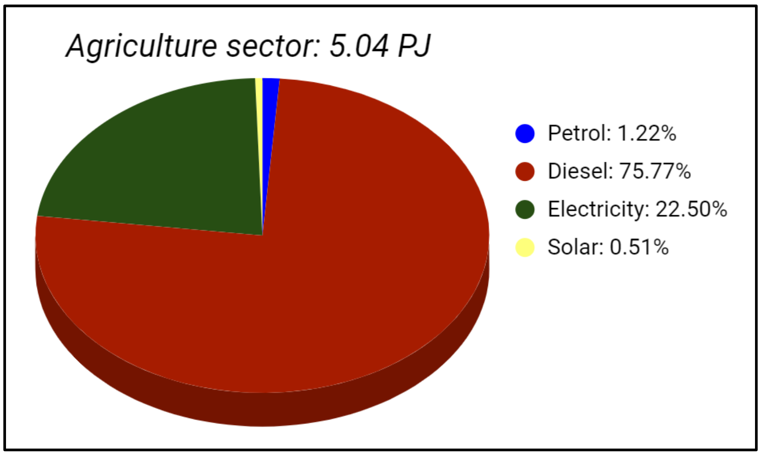

Figure 4.28: Energy consumption of agriculture sector

4.2.2.6 Construction and Mining Sector

Figure 4.29 illustrates the energy consumption of the construction and mining sector in Nepal, totaling 10.22 PJ. Diesel is the primary energy source, accounting for 37.07% of the total consumption. Electricity follows with 55.47%, and LPG contributes 3.15%. Other energy sources include petrol (3.24%), fuelwood (0.89%), kerosene (0.17%), and furnace oil (0.01%).

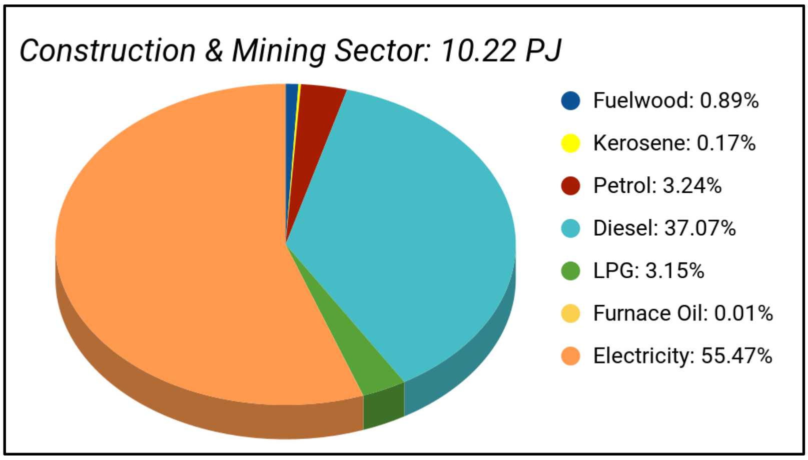

Figure 4.29: Energy consumption of construction and mining sector

Chapter 5: Energy Indicators

5.1 Energy Intensity

Energy intensity is a crucial indicator used to evaluate the energy efficiency of an economy and understand its structural composition. It is defined as the amount of energy consumed per unit of GDP or another measure of economic output. It serves to highlight the cost associated with converting energy into economic value.

A high energy intensity indicates substantial energy consumption to produce a unit of GDP, reflecting high energy conversion costs, commonly seen in industrial economies with energy-intensive manufacturing. Conversely, low energy intensity suggests more efficient energy use with lower costs, typical of economies with significant GDP contributions from less energy-intensive sectors like services and high-tech industries.(European Environment Agency, 2020)

Nepal's energy intensity remained in the range of 0.27 - 0.29 from FY 2075/76 to 2078/79. This value has dropped to 0.11 GJ per 1000 NRs Value Addition in FY 2079/80 due to the drop in energy consumption. While the employment of energy efficient measures as well as shift to efficient energy sources are also responsible, this is more likely as a result of the significant drop of total consumed energy. There have been improvements in energy intensity in the residential sector, with a decrease from 13.3 GJ per capita to 11.09 GJ per capita in FY 2079/80, attributed to improved energy access and the adoption of clean energy technologies. There has been a rise in electricity intensity as well as per capita electricity consumption, showcasing the increasing reliance on electricity as an energy source. The agricultural sector has low energy intensity because it uses human and animal labor, draught animals in particular. The commercial sector gains from efficient electric appliances because the final energy intensity of the country is much lower than the energy intensity. The industrial sector's energy intensity is above the national average especially when it comes to the use of petroleum products and coal. The reduction of the energy intensity could be achieved by transitioning to electrical and more efficient technologies in the industrial segment, as is evident from the case of India; which has demonstrated that it is possible to expand the economy and decrease the economic energy intensity by increasing electricity consumption. Nepal can follow the example by building up its indigenous electricity production.

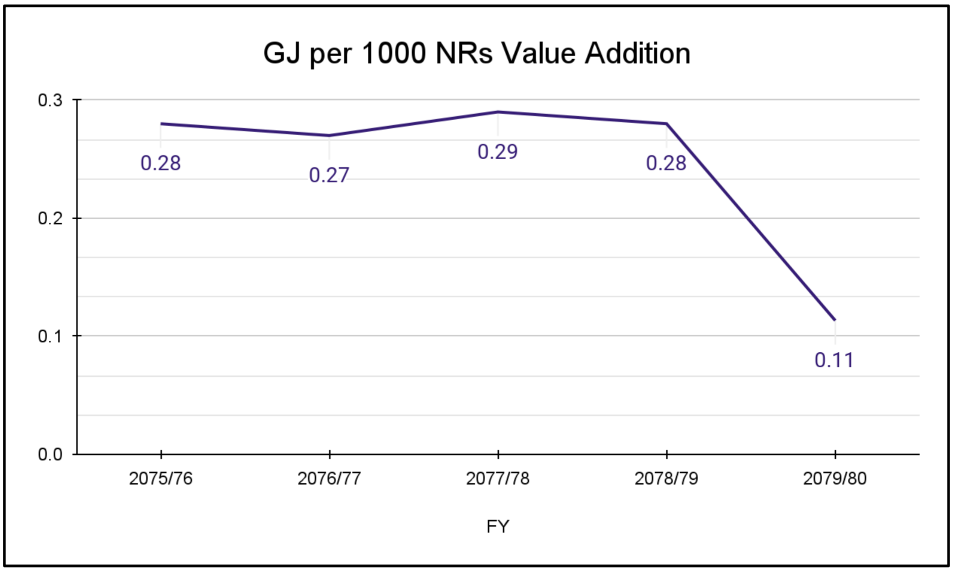

Figure 5.1: Final energy intensity in GJ per 1000 NRs Value Addition

The final energy intensity of FY 2079/80 has decreased considerable compared to the past fiscal years (Figure 5.1). The final energy intensity was obtained as 0.11 GJ per 1000 NRs value addition, which is a substantial decrease compared to previous years' relatively stable values in the range of 0.2s. This decrement is the result of the significant decrease in the Nepal's energy consumption.

Similarly, the per capita energy consumption has also decreased to 18.26 GJ (Figure 5.2).

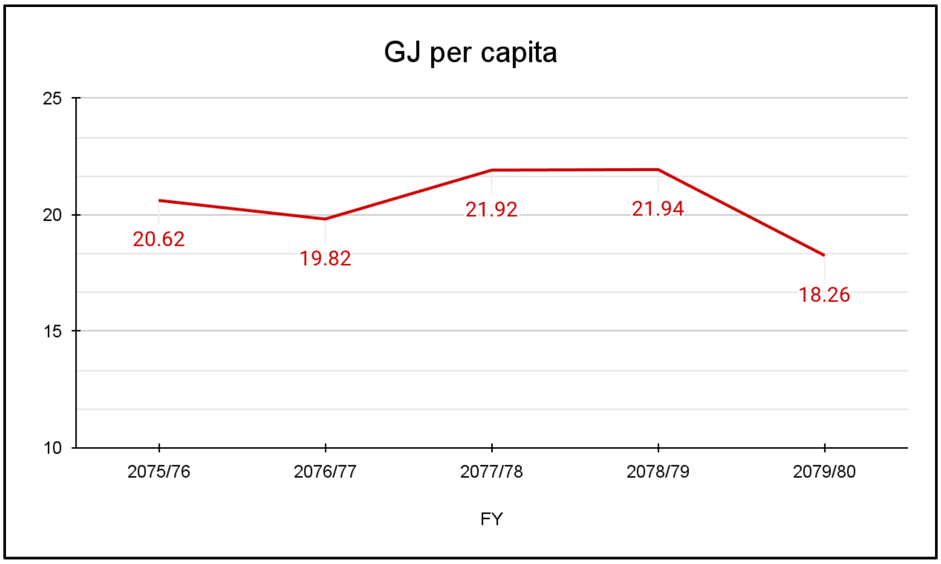

Figure 5.2: Per capita energy consumption

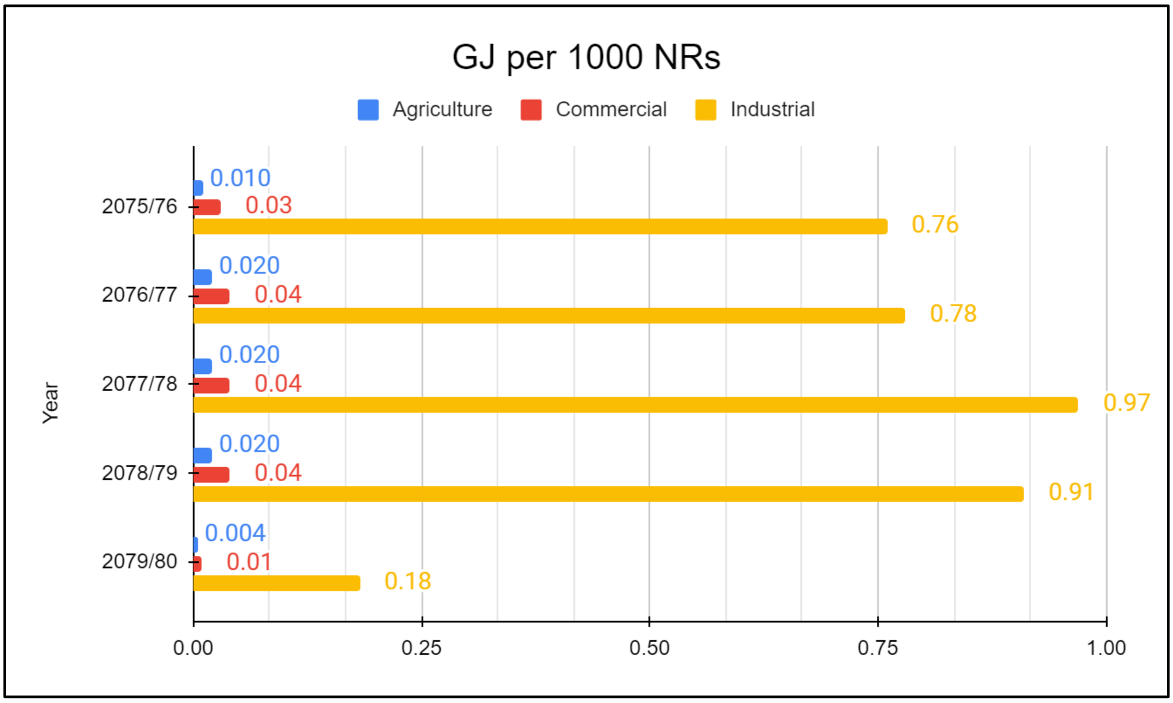

Figure 5.3: Energy intensities for agriculture, industry, and commercial sectors

The energy intensities for the agricultural, industrial, and commercial sectors have also decreased significantly (Figure 5.3).

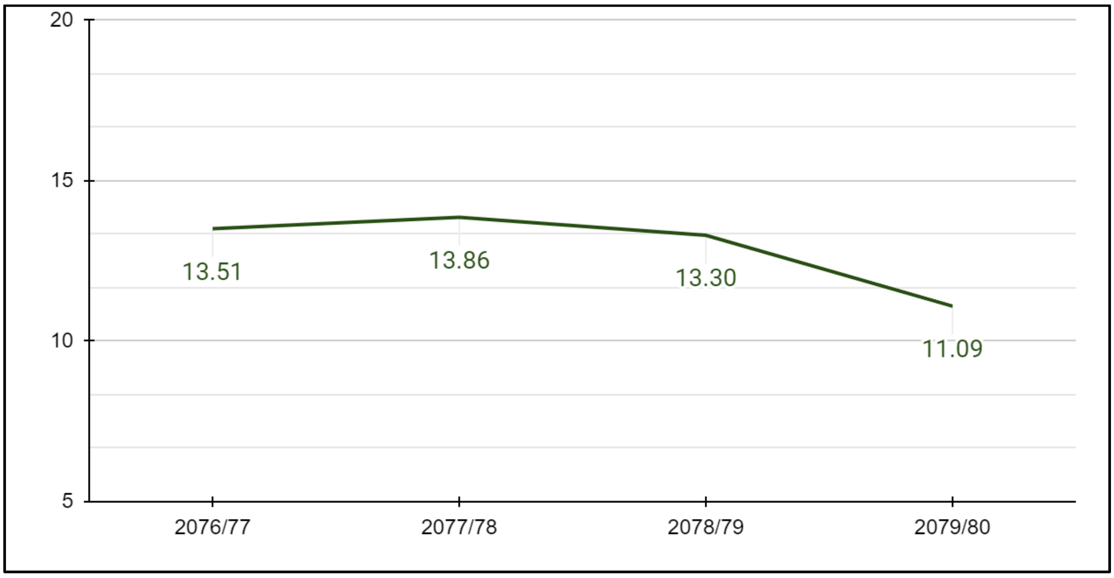

Figure 5.4: Per capita residential energy consumption (GJ per capita)

Following the previous patterns, the per capita residential energy consumption is also observed to have decreased to 11.09 GJ per capita (Figure 5.4).

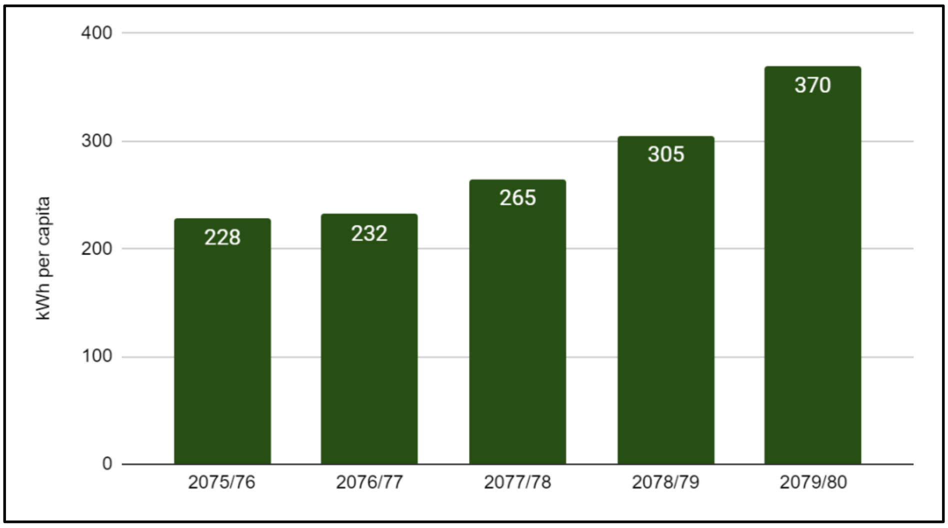

Figure 5.5: Electricity consumption (kWh per capita)

The increasing usage of electricity, however, has led to the increase in the per capita electricity consumption value and subsequently increased the residential electricity consumption per household. The overall electricity consumption of Nepal reached about 370 kWh per capita and is observed to have an increasing trend, likely due to the increasing dependence and utilization of electricity (Figure 5.5).

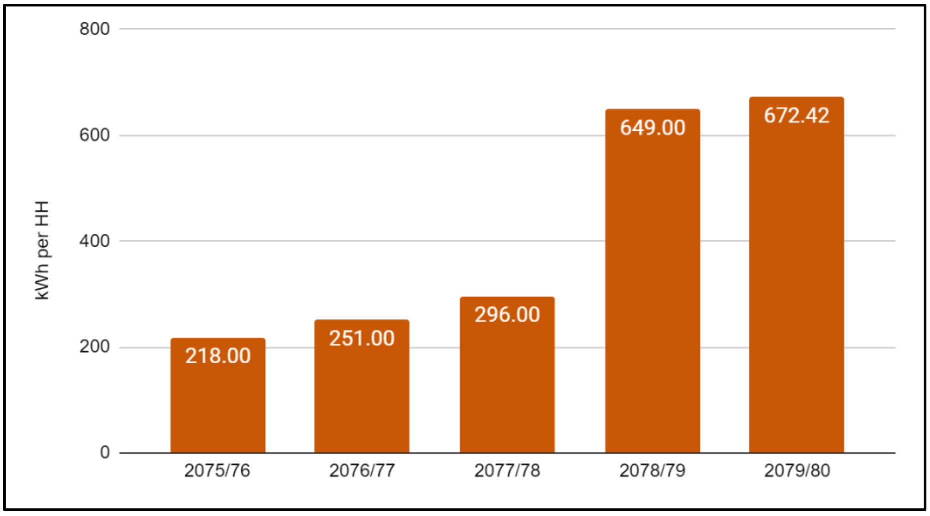

Figure 5.6: Residential electricity consumption (kWh per HH)

The trend of residential electricity intensity has also been growing throughout the past five fiscal years, with a significant increase of 649 kWh in FY 2078/79. This value saw an increase to 672.49 kWh per household in FY 2079/80 (Figure 5.6).

The average electricity price has been decreasing in recent years, while the consumption is increasing. (Note: The per capita electricity consumption mentioned above may differ from the value provided by NEA (in Table 5.1) as NEA calculates its indices based on its electricity sales.)

Table 5.1: Consumer indices for NEA distributed electricity

Parameter	Unit	2075/76	2076/77	2077/78	2078/79	2079/80
Annual Unit sales per consumer	kWh	1420	1342	1425	1606	1658
Average price per kWh	Rs.	10.48	11.57	9.76	9.72	9.66
Per capita sales	kWh	220	218	246.56	295.91	311.87
Distribution Loss	%	11.28	10.28	11.64	10.68	9.76

5.2 Energy Shares

The energy shares of the different categories of energy are shown in Figure 5.7. The traditional biomass energy consists of fuelwood, agri-residue, and animal dung and accounts for 63.87% of total consumption. The total renewable energy comprises biogas, wind/solar (hybrid), micro-hydro, solar, and national grid electricity, and accounts for 9.09% of total consumption. Here, coal and petroleum products and imported electricity are accounted for as imported energy and account for 27.04% of the total consumption.

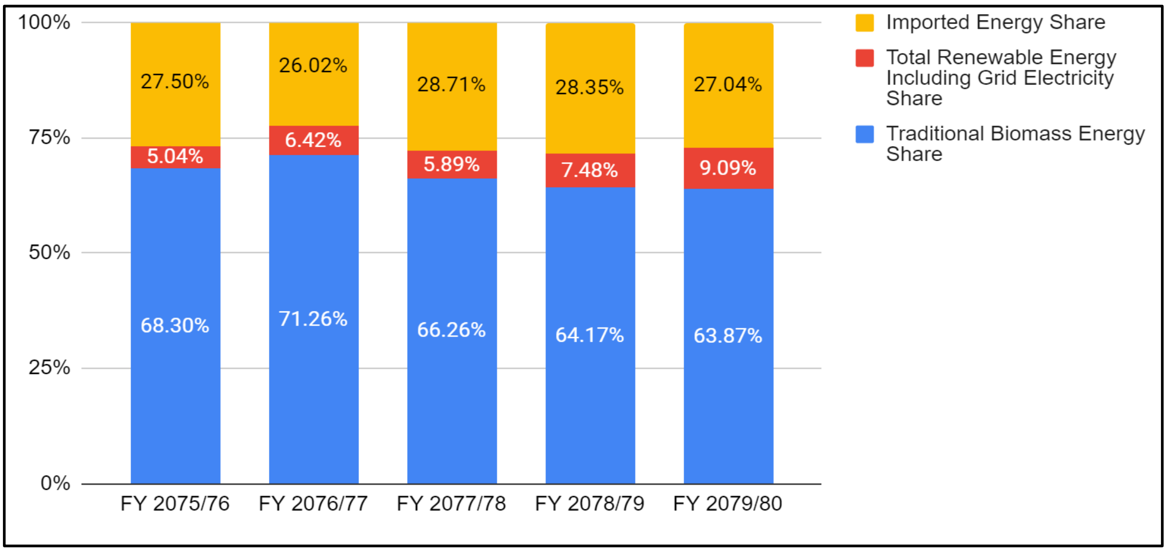

Figure 5.7 Energy shares over the past five fiscal years

5.3 Tracking Progress towards Set Plans and Goals

Monitoring and evaluating the status of energy plans and its goals is crucial for the development of Nepal. It provides checks and balances and helps the country remain on track in terms of energy goals, for instance, the production of renewable energy and the development of energy structures. This makes it easier for Nepal to stay on track, to make necessary changes, and to use resources in the best manner possible. This approach offers tangible proof of the effectiveness of its plans, improves the exchange of information among all parties involved, and guarantees the proper execution of the nation's energy policies, all of which contribute to increased energy security and improved economic performance. Progress of energy related parameters of National plans and goals are discussed here.

5.3.1 Progress in Achieving National Plans and Policies

Nepal is making notable progress under its 15th Five-Year Plan, particularly in increasing energy production and expanding access to electricity. Compared to the base year (2018/19), both access to electricity and per capita electricity consumption have risen significantly. This improvement is largely due to the expansion of transmission and distribution lines. However, while these advancements are commendable, the overall targets have yet to be fully achieved. The progress till date is presented in Table 5.2.

Table 5.2: Progress of 15th five-year plan

(Sources: 15th Five-year plan, NEA, AEPC, and Energy Synopsis Report 2023)

S.N.	Energy Target	Base Year (FY 2018/19)	FY 2021/22	FY 2022/23	Target Year (FY 2023/24)	Achieved Till FY 2023/24
1	Hydropower (Installed Capacity)	1,128 MW	2023 MW	2335.8 MW	5,000 MW	2,538.273 MW
2	Thermal Plant (Installed Capacity)	53.4 MW	53.4 MW	53.4 MW	53.4 MW	53.4 MW
3	Renewable Energy (Installed Capacity)	67.8 MW	-	-	216.6 MW	-
4	Solar Energy (Private Sector Promoted)	N/A	-	-	550 MW	86.9 MW
5	Electricity Leakage	15.32%	-	10.68%	12.32%	12.59%
6	Households Using Electricity for Cooking	0.90%	2.95%	3.99%	20%	< 5%
7	Renewable Energy (Ratio to Total Energy Consumption)*	7%	6.52%	7.48%	12%	9.09%
8	Micro Hydropower (Installed Capacity)	34 MW	35.986 MW	37.734	47 MW	38.8 MW
9	Solar Energy (Installed Capacity)	33 MW	-	-	160 MW	68.38 MW
10	Household Biogas Plants	426,000	433,173	439,547	626,000	449,338
11	Community and Institutional Biogas Plants	247	-	-	747	357
12	Population with Access to Electricity	88%	93%	94%	100%	98%

S.N.	Energy Target	Base Year (FY 2018/19)	FY 2021/22	FY 2022/23	Target Year (FY 2023/24)	Achieved Till FY 2023/24
13	Per Capita Electricity Consumption	245 kWh	265 kWh	305 kWh	700 kWh	370 kWh
14	Transmission Line (66 kV and above)	3,990 circuit km	-	-	8,000 circuit km	5742 circuit km

**Total consumption of renewable energy and grid electricity, except imported electricity*

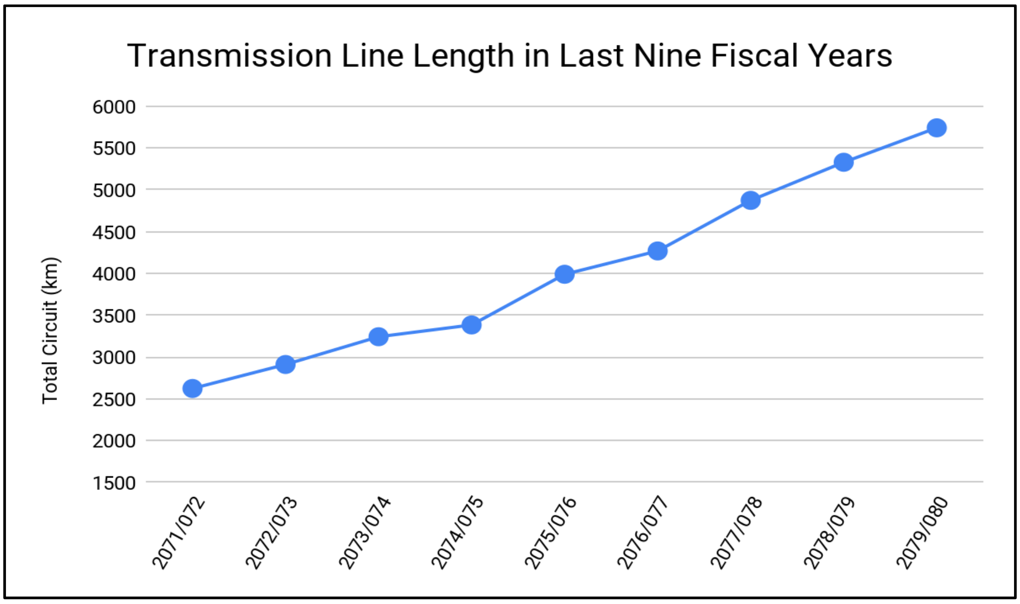

Figure 5.8: Transmission line length in last nine fiscal years
(Source: NEA, Transmission/Project Management Directorate, A Year Book-Fiscal Year 2022/2023)

The total circuit length of transmission lines over the last nine fiscal years, from 2071/72 to 2079/80 is illustrated in Figure 5.8. There has been a steady increase in the transmission line length during this period. From approximately 2,500 km in 2071/72, the length increased gradually each year, reaching about 3,000 km in 2072/73. By 2079/80, the transmission line length had reached around 5,742 km, aligning with the 15th Five year plan.

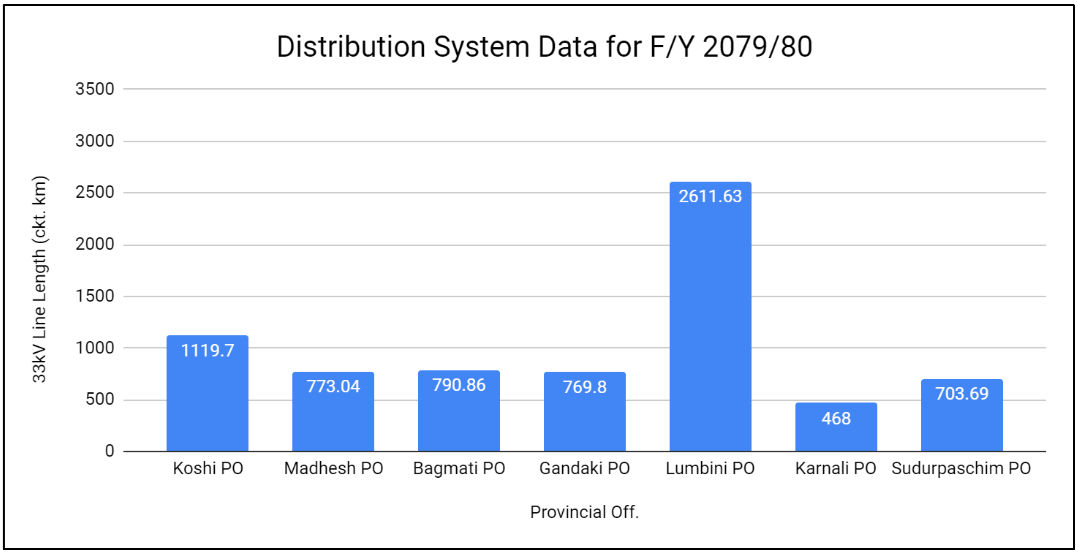

Figure 5.9: Distribution system data for FY 2079/80

(Source: NEA, Generation Directorate, Generation Magazine 15th Issue-Fiscal Year 2022/2023)

The distribution system has significantly taken a leap in Lumbini Province with the installation of a 33 kV line of length 2611.63 km, followed by the Koshi Province with 1119.7 km (Figure 5.9).

5.3.2 Progress in Achieving NDC Goals

Table 5.3: Sector-wise NDC targets and current status

Sectors	2nd NDC Targets/Goals	Present Status
Renewable Energy	15% of the total energy demand comes from clean sources	7.48% out of targeted 15% of energy is supplied from clean energy sources.
Forestry	Maintain 45% of total land area under forest cover	45.31 %
Transport	By 2025, Increase sale of EV to cover 25% of private vehicles sales	-
	By 2030, Increase sale of EV to cover 90% of private vehicles sales	
Residential Sector	Ensuring 25% using electric stoves for primary cooking and install an additional 200,000 household biogas plants.	Up to 2023, 12,015 new domestic biogas plants installed out of targeted 200,000
	Ensure 25% of households use electric stoves as their primary mode of cooking by 2025	
Carbon Neutrality	Achieve carbon neutrality before or by 2045	

(Sources: NDC, WECS, Energy Synopsis 2023)

5.3.2 Progress in Achieving SDG-7 Goals

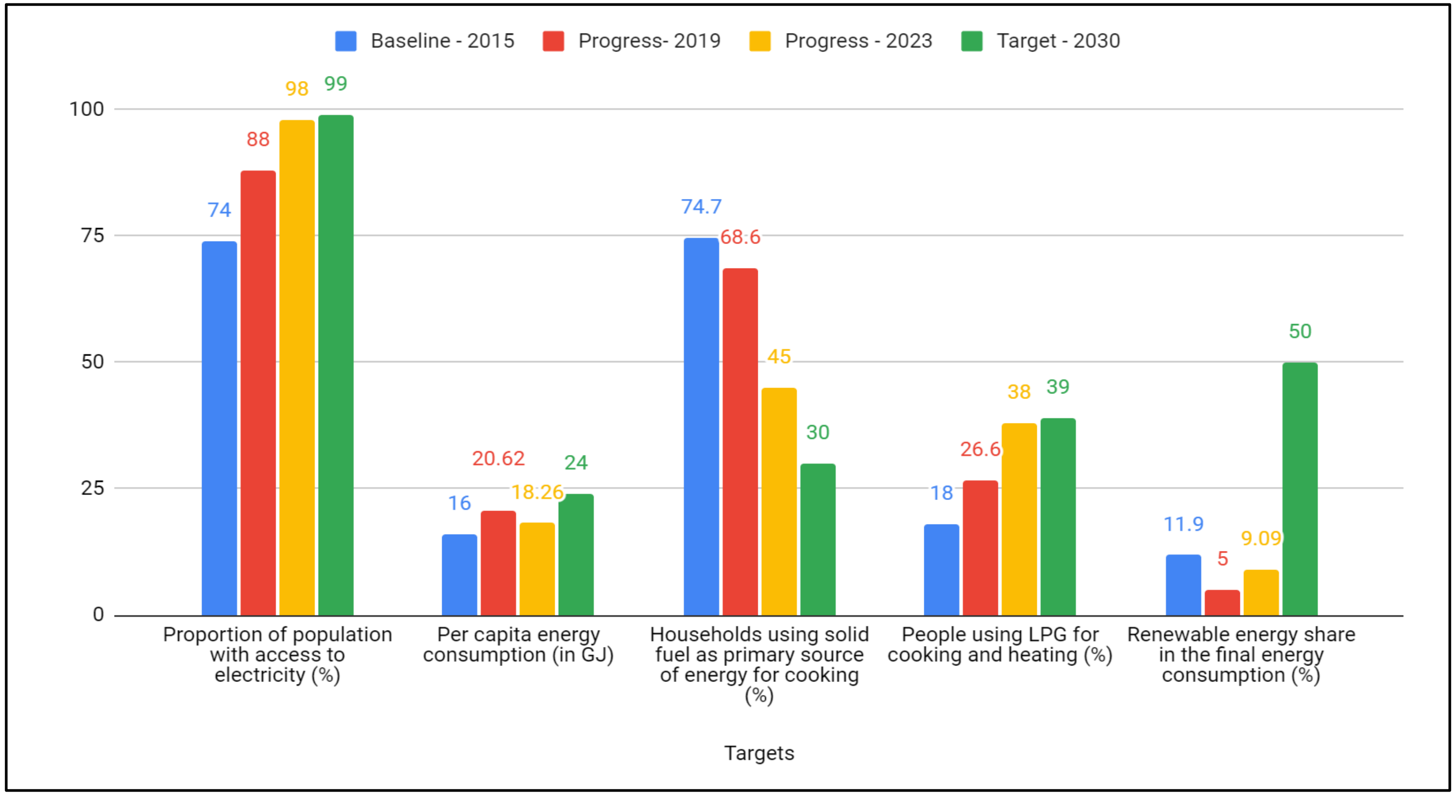

Figure 5.10: Some Important SDG 7 Energy Goals and Progress highlighted

(Source: Energy Synopsis 2023, 16th Plan)

The comparison of the baseline (year 2015), target (year 2030) and progress in years 2019 and 2023 is shown in Figure 5.10. The figure shows that Nepal is nearing the targets set on electrification of the entire population, per capita energy of final consumption and percentage of people using LPG as fuel for cooking and heating. Despite the progress, other areas still require significant time and effort from all levels (public, private, as well as government) to meet the targets by year 2030.

Chapter 6: Commodity Balance and Energy Balance

6.1 Commodity Balance

Commodity balance is generally an aggregate accounting framework that accounts for all the principles surrounding the supply and use of various energy commodities in a country or a region over some period. The balance of commodities informs about the production and imports of commodities, its export, stock change, and quantities consumed for commodities like coal, oil, natural gas, electricity, and renewables. The commodity balance is, therefore, an indispensable component in policy making since it aids the review of energy security and the formulation of strategic plans, ensuring the supply of energy is well-balanced and sustainable. It also gives insight into the economic performance of the energy sector, and therefore becomes relevant for investment decisions. In addition, it interprets market dynamics, aiming to know the dynamics of supply and demands that impact the process of formation for energy prices. The outline of this overall commodity balance is an important tool in understanding the flow of energy and also in supporting the development of more sustainable and secure energy systems.

The data reveals a significant reliance on traditional energy sources, with fuelwood alone accounting for 16,923,627,624 kg of the total energy supply. Other traditional sources, such as agricultural residue and animal dung, also contribute substantially. This heavy dependence on traditional biomass reflects the ongoing challenges in transitioning to modern energy sources in rural and unreachable areas.

Commercial energy sources are primarily driven by petroleum products and coal, with substantial imports supplementing domestic production. Notably, Nepal imports significant quantities of petrol (675,492 kL) and diesel (1,382,978 kL) to meet its energy needs. Renewable energy sources, including biogas, wind, micro/pico hydropower, and solar, are contributing to the energy mix, although at a smaller scale compared to traditional and commercial sources. The utilization side shows that the national consumption is closely aligned with the supply, ensuring a balance between energy availability and usage. Despite minor adjustments and losses, particularly in petrol, the overall energy balance highlights the critical role of both traditional and commercial energy sources in meeting Nepal's energy demands while indicating the potential for increased renewable energy integration.

Table 6.1: Commodity balance of FY 2079/80

	Traditional			Commercial								Renewables			
	Fuelwood	Agricultural Residue	Animal Dung	Petroleum Products						Coal	Electricity	Biogas	Wind	Micro/Pico Hydro	Solar
				Petrol	Diesel	Kerosene	LPG	ATF	Furnace Oil						
Unit	**kg**	**kg**	**kg**	**kL**	**kL**	**kL**	**MT**	**kL**	**kL**	**kg**	**GWh**	**kW**	**kW**	**kW**	**kW**
SUPPLY SIDE															
National Production	439,719,060	670	657,129,522	-	-	-	-	-	-	2,947,600	10,536	340,001	631	18,234	164,320
Imports	16,483,908,564	0	0	675,492	1,382,978	12,951	514,717	173,472	38,339	1,383,000,004	1,833	0	0	0	0
Initial Stock	0	0	0	5,788	0	0	0	3,050	0	0	0	0	0	0	0
Total Supply	**16,923,627,624**	**670**	**657,129,522**	**681,280**	**1,382,978**	**12,951**	**514,717**	**176,522**	**38,339**	**1,385,947,604**	**12,369**	**340,001**	**631**	**18,234**	**164,320**
UTILIZATION SIDE															
National Consumption	**16,923,627,624**	**670**	**657,129,522**	**672,761**	**1,381,325**	**13,478**	**514,717**	**174,882**	**38,339**	**1,385,947,604**	**9,347**	**340,001**	**631**	**18,234**	**164,320**
Exports	0	0	0	0	0	0	0	0	0	0	1,346	0	0	0	0
Final Stock	**0**	**0**	**0**	**8,519**	**1,653**	**0**	**0**	**3,050**	**0**	**0**	**1,676**	**0**	**0**	**0**	**0**
OTHERS															
Changes in Stock	0	0	0	2,731	1,653	0	0	0	0	0	1,676	0	0	0	0
Adjustments (losses, wastes, discrepancies)	0	0	0	0	0	-527	0	-1,410	0	0	0	0	0	0	0

6.2 Energy Balance

Energy balance involves the comprehensive accounting of all energy sources and their utilization within a country. It accounts for the production, import, export, transformation, and consumption of energy in various consumption sectors. The analysis of a country's energy balance is crucial in the assessment of the nation's energy security. It aids in the planning for the country's future energy needs and formulation process of policies. It is a useful tool that helps policymakers identify energy consumption trends, detect areas of inefficiency, and make informed decisions to plan and promote energy efficiency, energy security, and sustainability.

The key highlights of the energy balance of FY 2079/80 are as follows:

- Primary Supply:
  - Traditional sources contribute 340,040 TJ, predominantly from fuelwood (304,625 TJ).
  - Commercial fuels include petrol, diesel, kerosene, LPG, ATF, and furnace oil, coal, and electricity contribute a total of 177,067 TJ.
  - Renewable sources, including biogas, wind, micro/pico hydro, and solar, contribute 16,499 TJ.
  - The total primary supply across all sources is 533,606 TJ.
- Transformation:
  - Electricity generation from commercial sources totals 39,683 TJ.
  - Transmission and distribution (T&D) losses amount to 1,177 TJ.
  - Other losses, including own-use, total 11 TJ.
- Net Supply to Consumers:
  - The total net supply to consumers is 532,418 TJ, reflecting the total energy available for final consumption after accounting for losses.
- Final Consumption:
  - The residential sector consumes the largest share at 323,463 TJ.
  - The industrial sector consumes 111,306 TJ.
  - The commercial sector consumes 26,835 TJ.
  - Agriculture consumes 5,040 TJ.
  - The transportation sector consumes 55,553 TJ.
  - The construction and mining sector consumes 10,222 TJ.

Table 6.2: Energy balance of FY 2079/80

in TJ	Traditional				Commercial										Renewables					Grand Total
					Petroleum Products															
	Fuelwood	Agricultural Residue	Animal Dung	Total Traditional	Petrol	Diesel	Kerosene	LPG	ATF	Furnace Oil	Total Petroleum	Coal	Electricity	Total Commercial	Biogas	Wind	Micro/Pico Hydro	Solar	Total Renewables	
PRIMARY SUPPLY																				
Production	304,625	25,623	9,791	340,040	-	-	-	-	-	-	-	70.7	37,930	38,001	10,722	20	575	5,182	16,499	394,540
Imports	-	-	-	-	22,021	49,787	453.29	23,677	6,141	1,369	103,448	33,945	6,599	143,992	-	-	-	-	-	143,992
Exports	-	-	-	-	-	-	-	-	-	-	0	-	-4,846	-4,846	-	-	-	-	-	-4,846
Stock Changes	-	-	-	-	-89	-60	18	-	50	0	-80	-	-	-80	-	-	-	-	-	-80
Total Primary Supply	**304,625**	**25,623**	**9,791**	**340,040**	**21,932**	**49,728**	**472**	**23,677**	**6,191**	**1,369**	**103,368**	**34,016**	**39,683**	**177,067**	**10,722**	**20**	**575**	**5,182**	**16,499**	**533,606**
TRANSFORMATION																				
Inputs	-	-	-	-	-	-	-	-	-	-	-	-	-39,683	-39,683	-	-	-	-	-	-39,683
Electricity Generation	-	-	-	-	-	-	-	-	-	-	-	-	39,683	39,683	-	-	-	-	-	39,683
T&D Losses	-	-	-	-	-	-	-	-	-	-	-	-	-1,177	-1,177	-	-	-	-	-	-1,177
Other Losses, Own-use etc.	-	-	-	-	-	-	-	-	-	-	-	-	-11	-11	-	-	-	-	-	-11
Net Supply to Consumers	**304,625**	**25,623**	**9,791**	**340,040**	**21,932**	**49,728**	**472**	**23,677**	**6,191**	**1,369**	**103,368**	**34,016**	**38,495**	**175,879**	**10,722**	**20**	**575**	**5,182**	**16,499**	**532,418**
FINAL CONSUMPTION																				
Residential	257,226	8,909	9,486	275,621	0	0	111	18,174	0	0	18,285	35	16,139	34,459	10,714	17	460	2,192	13,383	323,463
Industrial	31,894	16,337	0	48,232	2,502	11,646	296	765	0	1,369	16,579	33,622	12,874	63,074	0	0	0	0	0	111,306
Commercial	15,414	377	305	16,096	175	0	47	4,413	0	0	4,636	359	2,653	7,648	9	3	115	2,964	3,091	26,835
Agriculture	0	0	0	0	61	3,819	0	0	0	0	3,880	0	1,134	5,014	0	0	0	26	26	5,040
Transportation	0	0	0	0	18,862	30,473	0	2	6,191	0	55,528	0	25	55,553	0	0	0	0	0	55,553
Construction and Mining	91	0	0	91	331	3,789	18	322	0	-	4,460	0	5,670	10,130	0	0	0	0	0	10,222
Total	**304,625**	**25,623**	**9,791**	**340,040**	**21,932**	**49,728**	**472**	**23,677**	**6,191**	**1,369**	**103,368**	**34,016**	**38,495**	**175,879**	**10,722**	**20**	**575**	**5,182**	**16,499**	**532,418**

Chapter 7: Energy Pricing Trend

7.1 Trend in Pricing of Petroleum Products and Natural Gas

Figure 7.1 shows the petroleum fuel pricing over the latter part of FY 2078/79 to FY 2079/80. Petrol, diesel/kerosene shows similar trend and less fluctuation. LPG has a sudden increase from 2078.12.23 to 2079.02.23 and the flat line indicates the stabilization of LPG prices. The price of ATF shows a massive fluctuation over a period of time but has shown a decreasing trend towards the end.

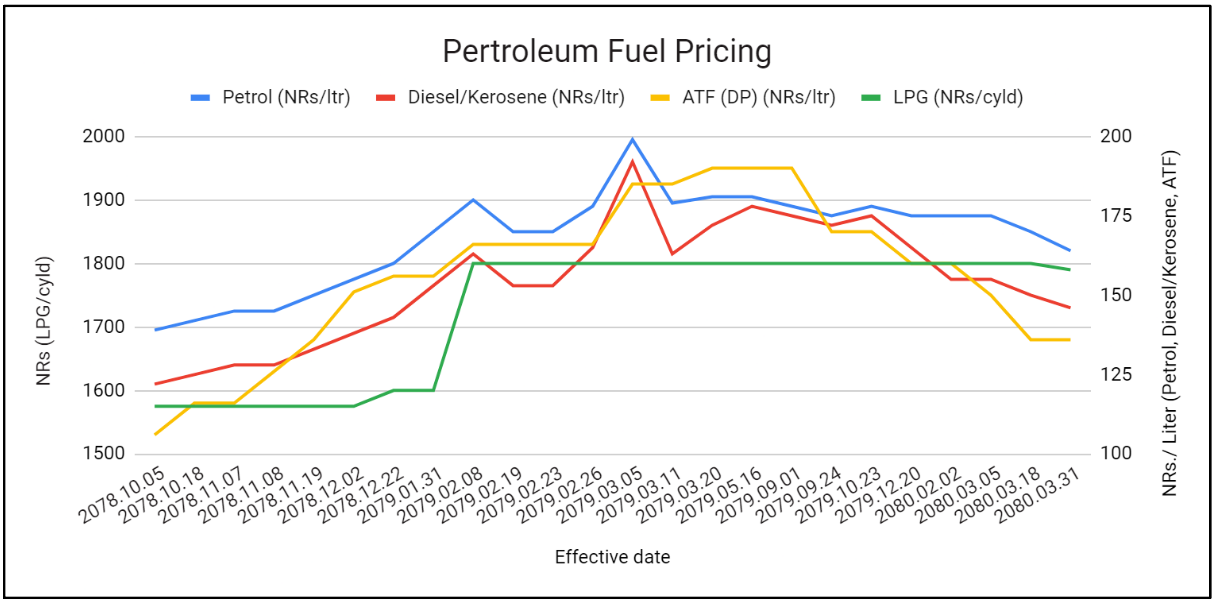

Figure 7.1: Petroleum fuel pricing trend

(Source: Nepal Oil Corporation, 2024)

There is an increase in the price of petrol, diesel/kerosene and ATF during the period, likely due to the global oil market which is in increasing trend. During early to mid 2079 there are the peak prices of all fuel types that suggests the period of high fuel costs. The subsequent decline is seen after the peak demand which is due to the government policy of shifting toward renewable and alternative sources of energy. Also, LPG prices remain relatively stable in comparison to other fuels, showing the dynamic pricing of other fuels in a given period of time.

7.2 Trend in Pricing of Electricity

The domestic tariff rates for single phase low voltage (230 V), three phase low voltage (400 V), and three phase medium voltage (33/11 kV) are shown in tables 7.1, 7.2 and 7.3, respectively.

Table 7.1: Single phase low voltage (230 V)

kWh (Monthly)	5 Ampere		15 Ampere		30 Ampere		60 Ampere	
	Monthly Minimum Charge (NRs.)	Energy Charge (NRs.)/kWh	Monthly Minimum Charge (NRs.)	Energy Charge (NRs.)/kWh	Monthly Minimum Charge (NRs.)	Energy Charge (NRs.)/kWh	Monthly Minimum Charge (NRs.)	Energy Charge (NRs.)/kWh
0-20	30.00	0.00	50.00	4.00	75.00	5.00	125.00	6.00
21-30	50.00	6.50	75.00	6.50	100.00	6.50	125.00	6.50
31-50	50.00	8.00	75.00	8.00	100.00	8.00	125.00	8.00
51-100	75.00	9.50	100.00	9.50	125.00	9.50	150.00	9.50
101-250	100.00	9.50	125.00	9.50	150.00	9.50	200.00	9.50
Above 251	150.00	11.00	175.00	11.00	200.00	11.00	250.00	11.00

Note: If 5 Ampere consumers use more than 20 units, they have to pay NRs. 3.00 per unit

(Source: NEA, A Year in Review-Fiscal Year 2022/2023)

Table 7.2: Three phase low voltage (400V)

kWh (Monthly)	Up to 10 kVA			Above 10 kVA		
	Monthly Minimum Charge (NRs.)	Month	Energy Charge (NRs.)/kWh	Monthly Minimum Charge (NRs.)	Month	Energy Charge (NRs.)/kWh
All Consumers	1100.00	Ashad-Kartik	10.50	1800	Ashad-Kartik	10.50
		Marg-Jestha	11.5		Marg-Jestha	11.5

(Source: NEA, A Year in Review-Fiscal Year 2022/2023)

Table 7.3: Three phase medium voltage (33/11 kV)

kWh (Monthly)	Monthly Minimum Charge (NRs.)	Month	Energy Charge (NRs.)/kWh
All Consumers	10000.00	Ashad-Kartik	10.50
		Marg-Jestha	11.00

(Source: NEA, A Year in Review-Fiscal Year 2022/2023)

Chapter 8: Provincial Energy Outlook

8.1 Koshi Province

8.1.1 Energy Supply and Consumption Scenario

Electricity

- Consumer Base and Distribution Centers:
  - The Koshi Provincial Office serves 977,100 consumers across 24 Distribution Centers spread across 14 districts.
  - The majority of these consumers (approximately 89.89%) fall into the domestic category.
- Connected Load (FY 2079/80) :
  - In the fiscal year 2079/80, the office recorded an increase in connected load, reaching 271 MVA (megavolt-amperes).
- Energy Sales and Revenue:
  - Annual energy sales amounted to 1,552.54 GWh, marking an 11.19% rise from the previous fiscal year.
  - These sales represent 16.59% of NEA's total energy sales.
  - The gross annual revenue stood at NRs. 14.47 billion, accounting for approximately 16.0% of NEA's total revenue.
  - Overall, there was an increase of 10.52% in sales revenue compared to the previous fiscal year.
- Distribution Loss and Revenue Collection:
  - The Provincial Office successfully reduced its distribution loss from 11.72% in the prior year to 10.38%.
  - During this year, 41,998 consumer lines were disconnected due to outstanding dues amounting to NRs. 548.56 million.
  - The collective efforts of all Distribution Centers, revenue collection improved to 97.00%.

Renewable Energy

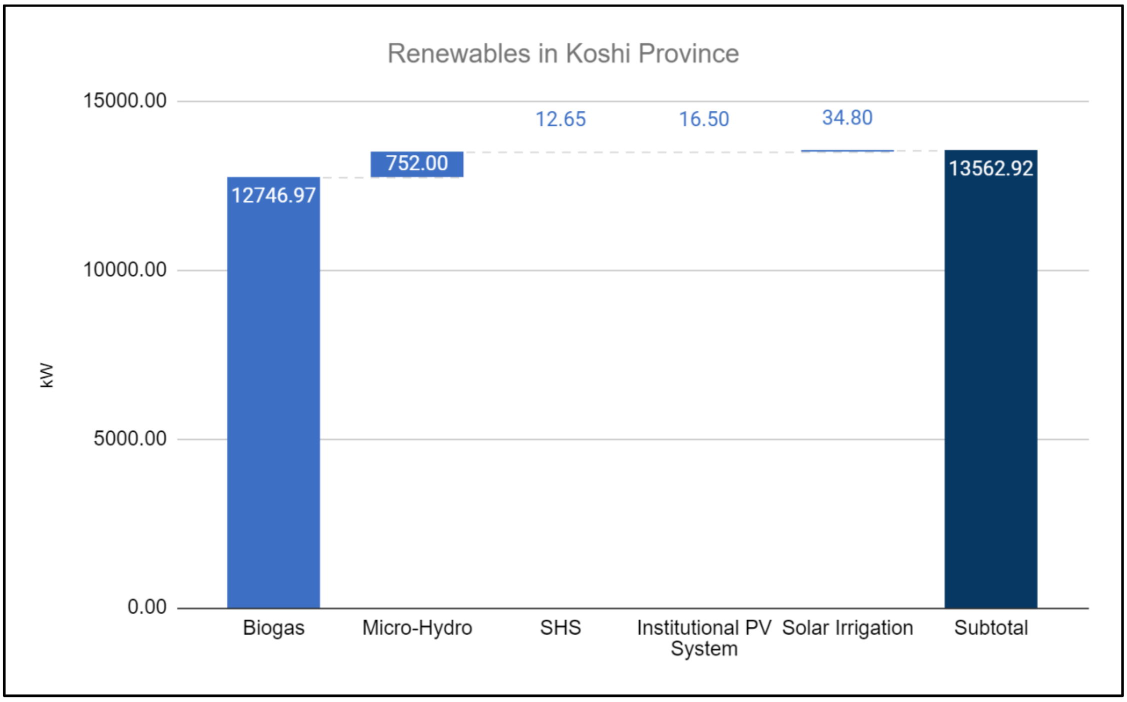

Figure 8.1: Renewables in Koshi Province (kW)

Figure 8.1 shows the usages of renewable energy resources in the Koshi Province in FY 2079/80.

Petroleum Fuels

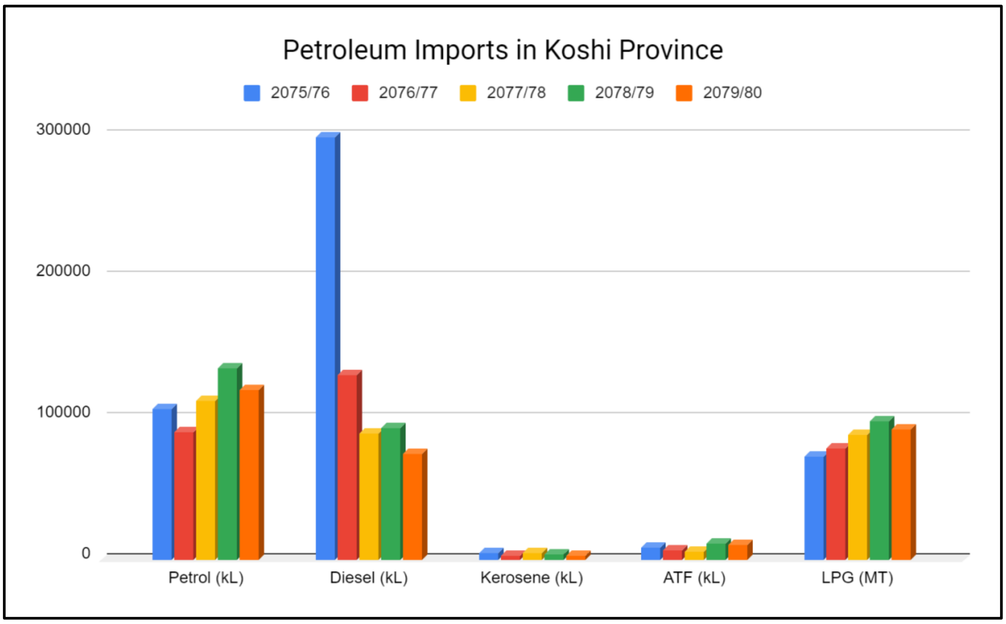

Figure 8.2: Koshi Province Petroleum Imports

Figure 8.2 and Figure 8.3 showcase the recent trends of petroleum product imports and sales in Koshi Province (FY 2075/76 - FY 2079/80). Compared to the previous FY, FY 2079/80 there has been a decrease in the imports and consumption of petroleum products.

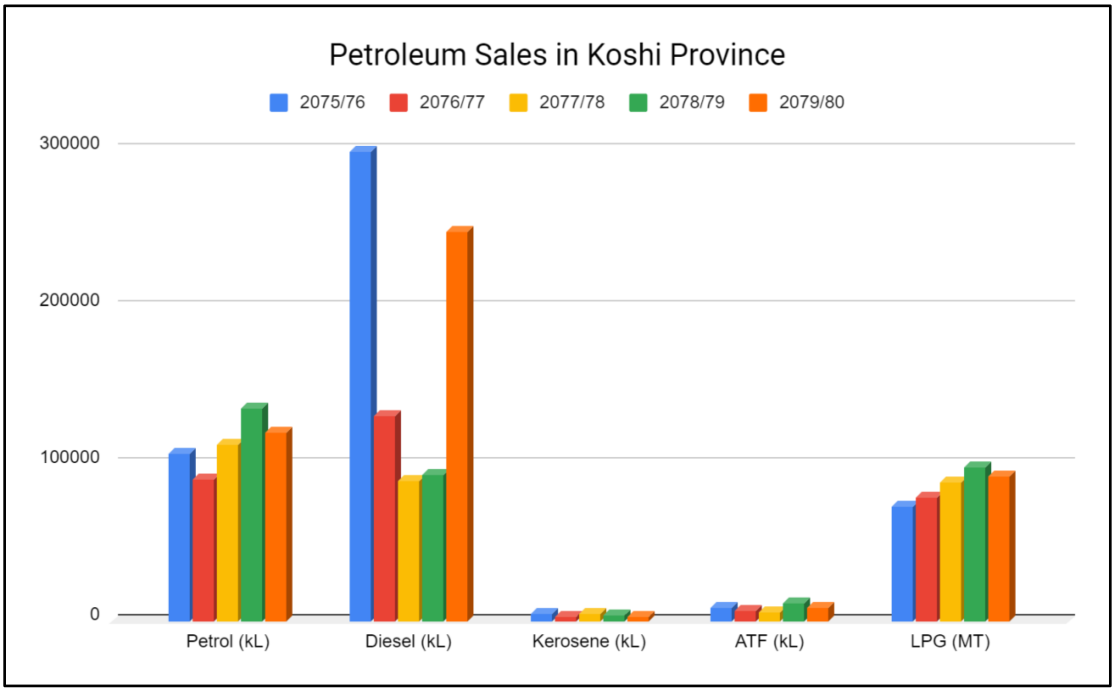

Figure 8.3: Koshi Province Petroleum Sales

The total energy consumption of the Koshi province was estimated at 73,835 TJ in 2019 [WECS, 2021].

8.2 Madhesh Province

8.2.1 Energy Supply and Consumption Scenario

Electricity

- Consumers and Distribution Centers:
  - The Madhesh Provincial Office of NEA serves 1,059,669 consumers through 23 Distribution Centers across 8 districts.
  - Approximately 89.13% of these consumers are domestic.
- Connected Load (FY 2079/80):
  - In FY 2079/80, Madhesh Provincial NEA office saw an increase in connected load, reaching 348 MVA.
- Energy Sales:
  - Annual energy sales was 2,017 GWh, with an increase of 5.47% from the previous fiscal year which accounts for 21.56% of NEA's total energy sales.
- Revenue:
  - The gross annual revenue of NRs. 18.04 billion, represents 19.94% of NEA's total revenue.
  - The sales revenue increased by 4.18% compared to the previous fiscal year.
- Distribution Loss and Revenue Collection:
  - The Madhesh Provincial Office reduced its distribution loss to 13.79% from 14.17% the previous year.
  - 28,923 consumer lines, with dues of NRs. 1,293.18 million were disconnected.
  - Due to the combined efforts of all Distribution Centers, revenue collection improved to 90.51%.

Renewable Energy

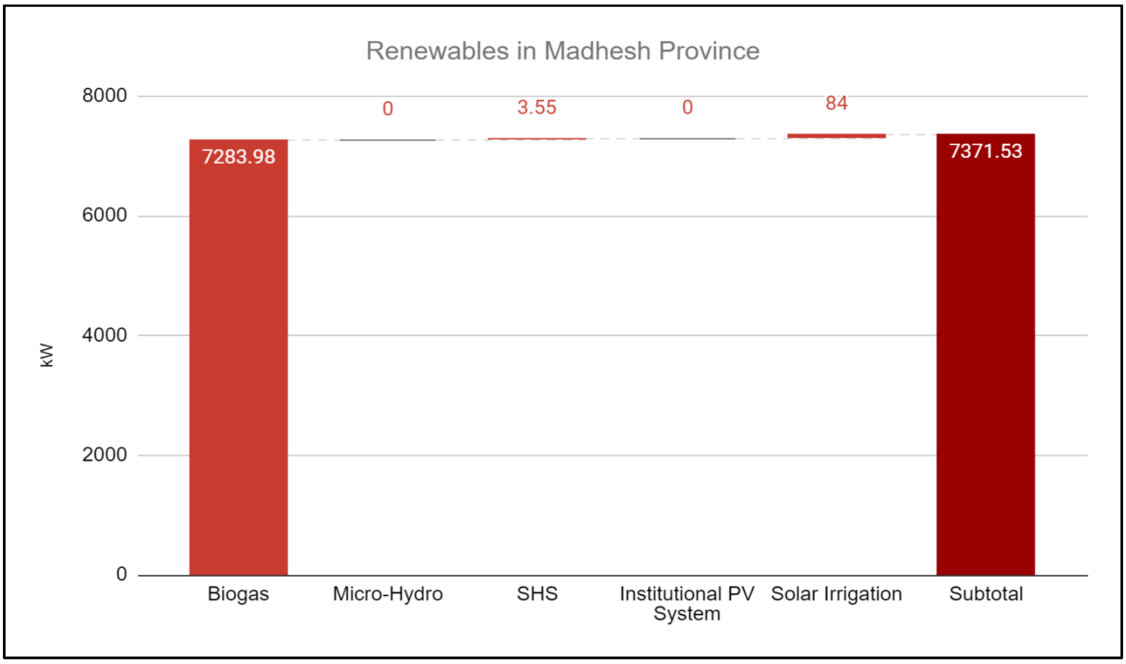

Figure 8.4: Renewables in Madhesh province (kW)

Figure 8.4 shows the usages of renewable energy resources in the Madhesh province in FY 2079/80.*(Note: '0' indicates no installations from AEPC in FY 2079/80.)*

Petroleum Fuels

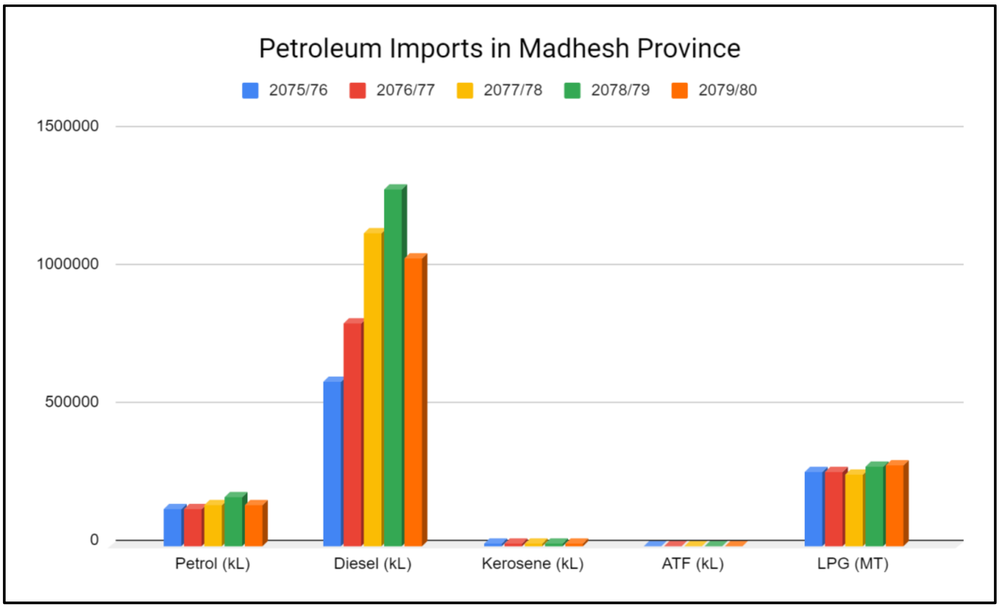

Figure 8.5: Madhesh Province Petroleum Imports

Figure 8.5 and Figure 8.6 showcases the recent trends of petroleum product imports and sales in Madhesh Province (FY 2075/76 - FY 2079/80). Compared to the previous FY, FY 2079/80 there has been a decrease in the imports and consumption of petroleum products. (Note: Madhesh province started importing and selling ATF in FY 2079/80.)

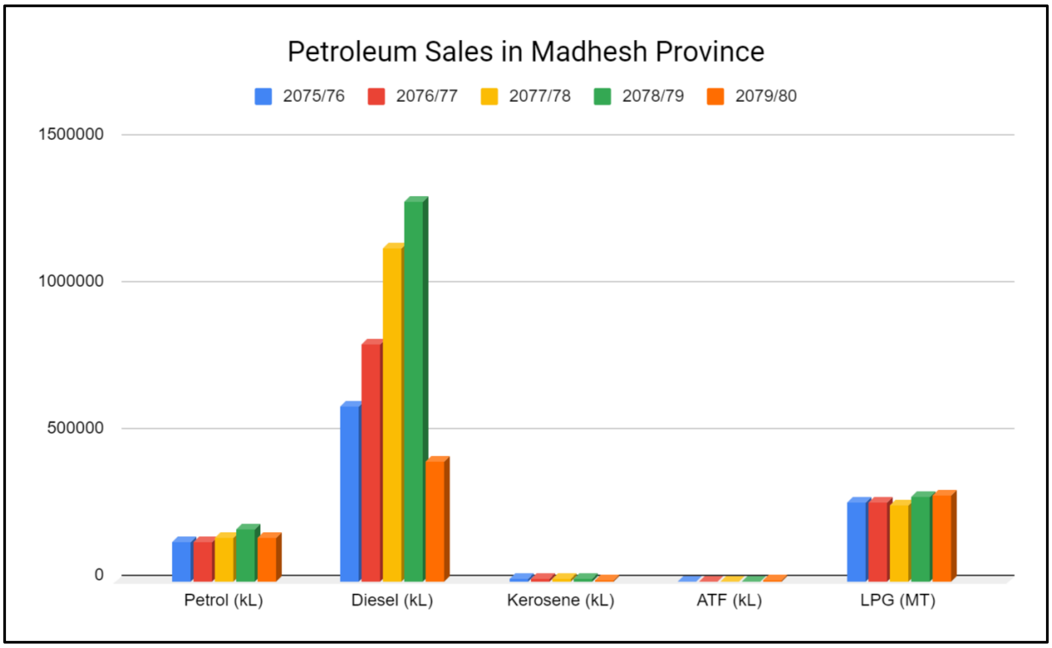

Figure 8.6: Madhesh Province Petroleum Sales

The total energy consumption of the Madhesh province was reported at 63,174 TJ in 2019 [WECS, 2021].

8.3 Bagmati Province

8.3.1 Energy Supply and Consumption Scenario

Electricity

- Consumer Base and Distribution Centers:
  - The Bagmati Provincial Office of NEA serves 1,190,991 consumers through 26 Distribution Centers across 13 districts.
  - Approximately 95.61% of these consumers are served via Kathmandu, and 90.82% are served via Hetauda.
  - The majority of consumers fall into the domestic category.
- Connected Load and Fiscal Year 2079/80:
  - In the fiscal year 2079/80, the office recorded an increase in connected load:
    - Kathmandu: 154 MVA
    - Hetauda: 72 MVA
- Energy Sales and Revenue:
  - Annual energy sales amounted to 2,838 GWh, accounting for 30.33% of NEA's total energy sales.
  - The gross annual revenue was NRs. 30.18 billion, representing about 33.37% of NEA's total revenue.
  - There was an 8.96% overall increase in sales revenue from Kathmandu and 1.88% from Hetauda compared to the previous fiscal year.

Renewable Energy

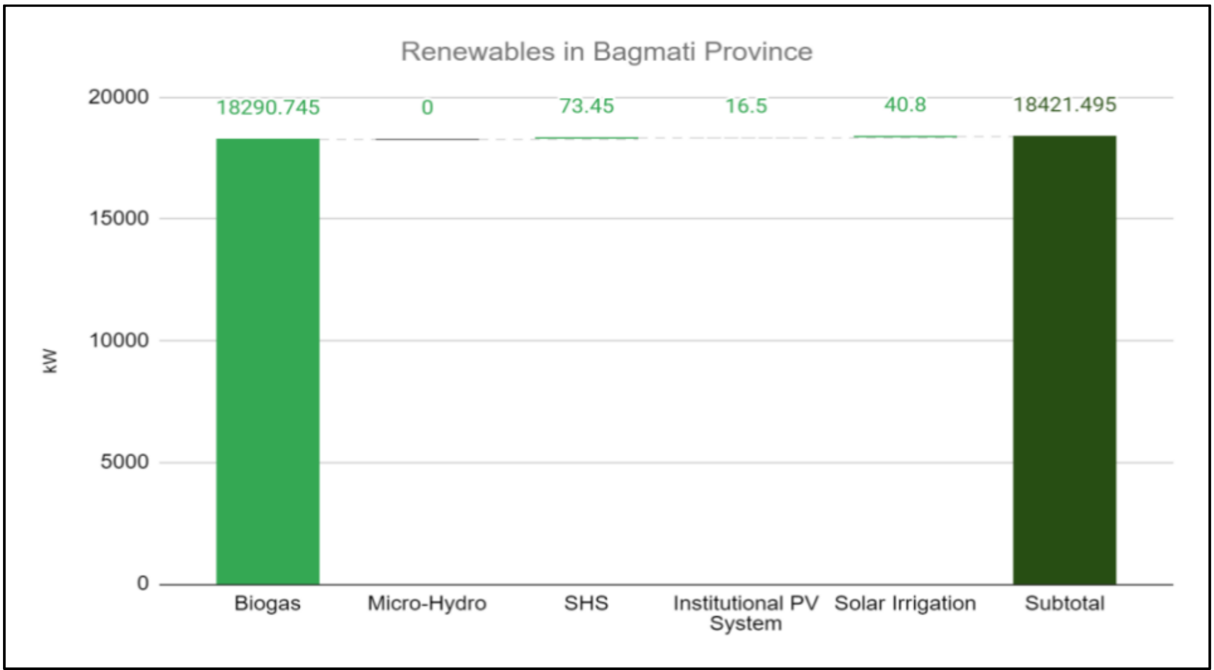

Figure 8.7: Renewables in Bagmati province (kW)

Figure 8.7 shows the usages of renewable energy resources in the Bagmati province in FY 2079/80.*(Note: '0' indicates no installations from AEPC in FY 2079/80.)*

Petroleum Fuels

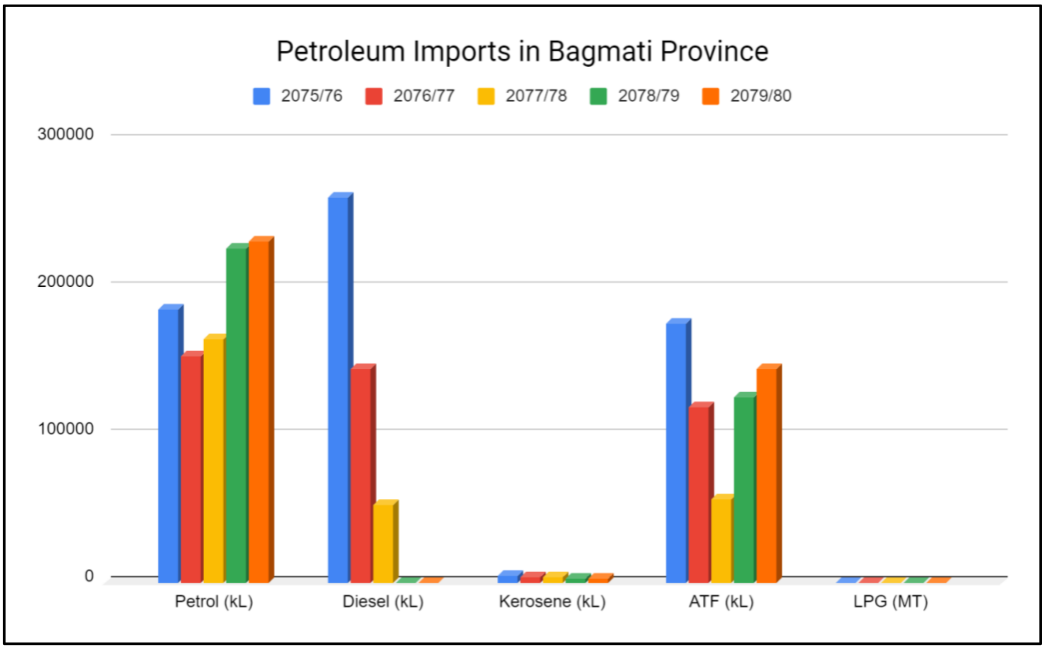

Figure 8.8: Bagmati Province Petroleum Imports

Figure 8.8 and Figure 8.9 showcases the recent trends of petroleum product imports and sales in Bagmati Province (FY 2075/76 - FY 2079/80). Compared to the previous FY, FY 2079/80 there has been a decrease in the imports and consumption of petroleum products. (Note: the import data of LPG is not available as the province does not import it from the neighboring county and relies on other provinces. Similarly, the sales data is also absent as it depends on the LPG depot's, whose data is not available with NOC.)

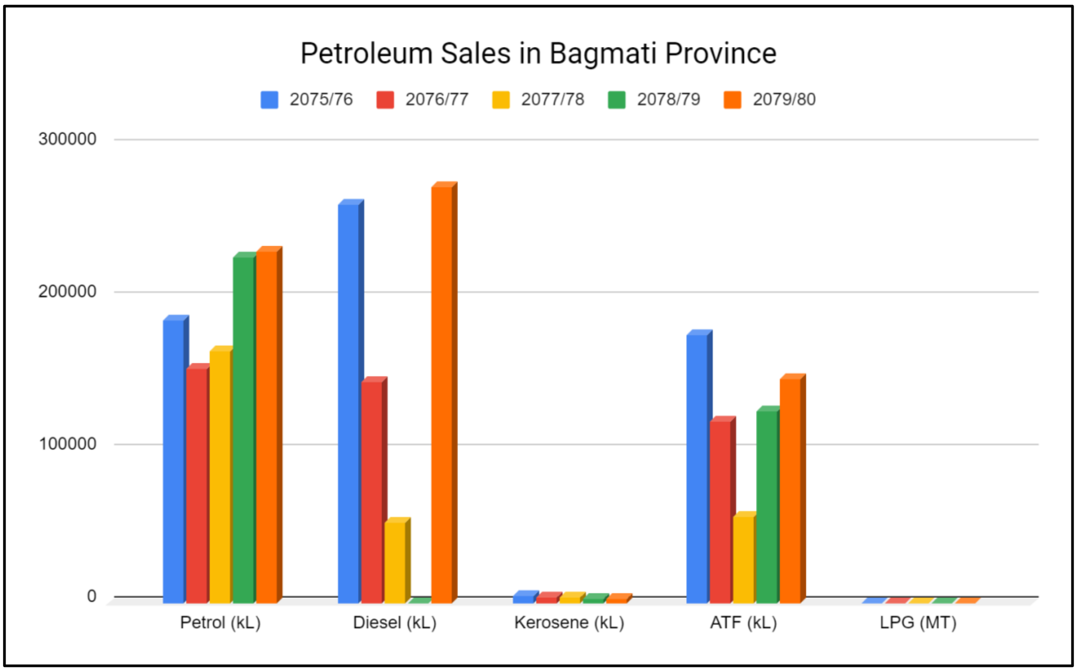

Figure 8.9: Bagmati Province Petroleum Sales

The total energy consumption of the Bagmati province was reported at 83,535 TJ in 2021 [WECS, 2022].

8.4 Gandaki Province

8.4.1 Energy Supply and Consumption Scenario

Electricity

- Consumer Base and Distribution Centers:
    - The Gandaki Provincial Office of NEA serves 480,862 consumers through 13 Distribution Centers across 11 districts.
    - Approximately 95.27% of these consumers are domestic.
- Connected Load and Fiscal Year 2079/80:
    - In the fiscal year 2079/80, the office recorded an increase in connected load, reaching 128 MVA.
- Energy Sales and Revenue:
    - Annual energy sales amounts 632 GWh, a 6.38% increase from the previous fiscal year and this sales represent 6.75% of NEA's total energy sales
    - The gross annual revenue was NRs. 6.13 billion, accounting for about 6.78% of NEA's total revenue.
    - There was a 7.37% overall increase in sales revenue compared to the previous fiscal year.
- Distribution Loss and Revenue Collection:
    - The Provincial Office reduced its distribution loss to 8.47% from 9.10% the previous year.
    - During this year, 12,902 consumer lines, with dues totaling NRs. 214.17 million were disconnected.
    - The combined efforts of all Distribution Centers, revenue collection improved to 99.63%.

Renewable Energy

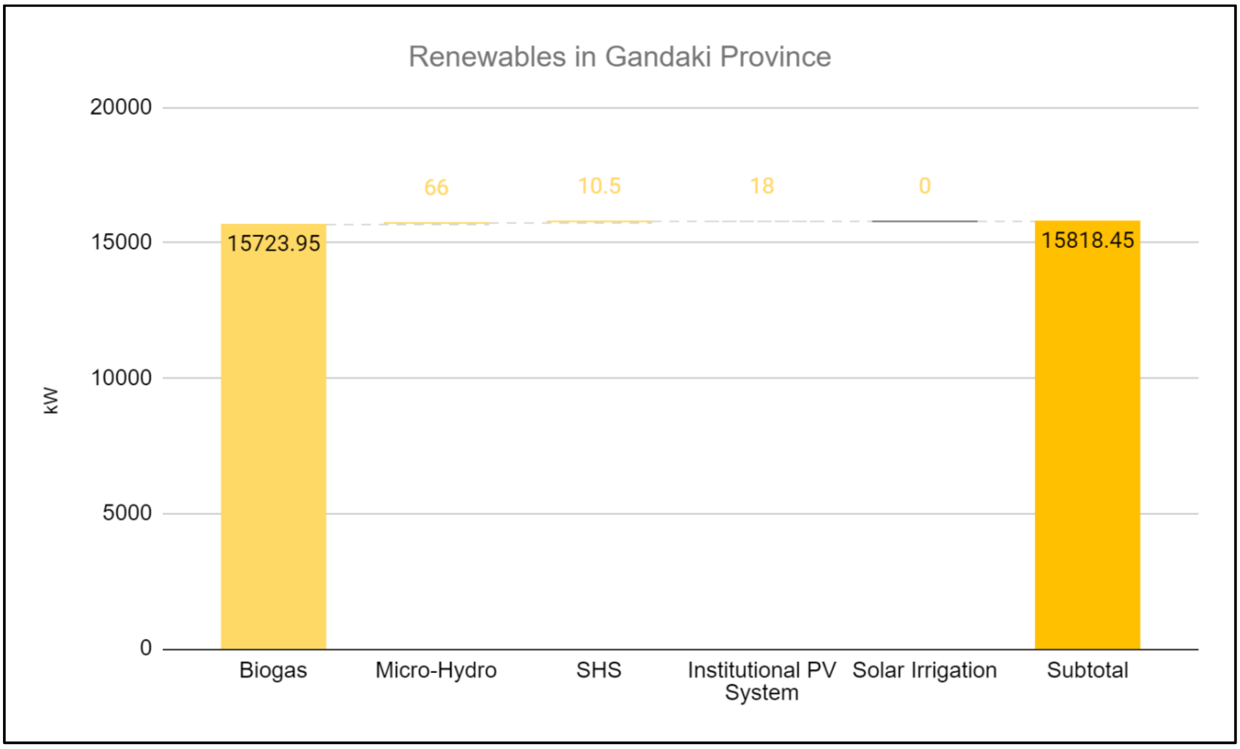

Figure 8.10: Renewables in Gandaki province (kW)

Figure 8.10 shows the usages of renewable energy resources in the Gandaki province in FY 2079/80.*(Note: '0' indicates no installations from AEPC in FY 2079/80.)*

Petroleum Fuels

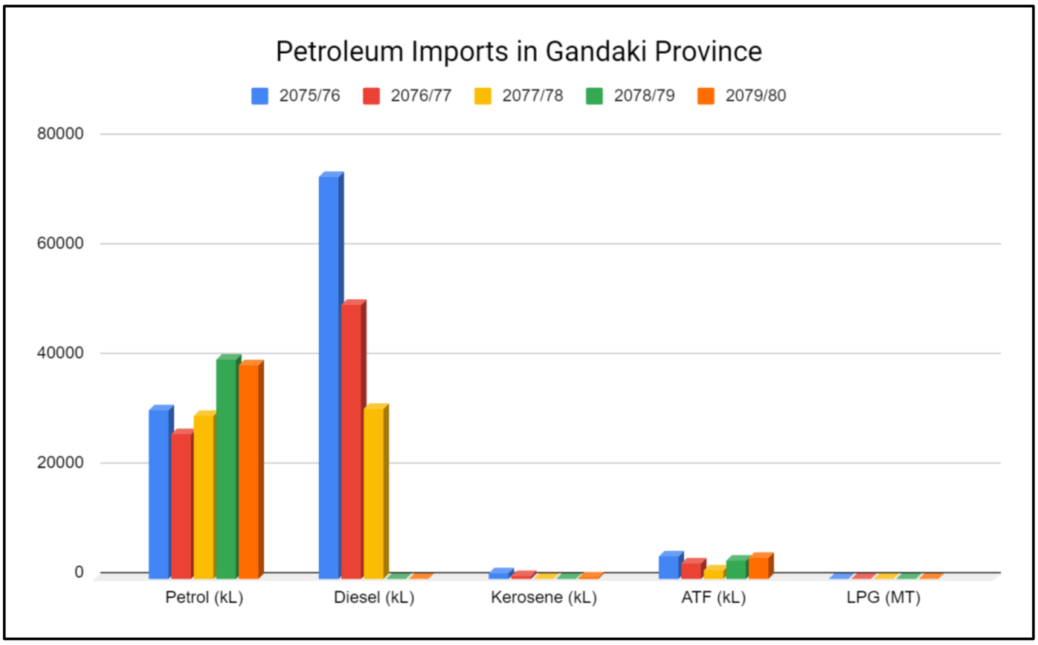

Figure 8.11: Gandaki Province Petroleum Imports

Figure 8.11 and Figure 8.12 showcases the recent trends of petroleum product imports and sales in Gandaki Province (FY 2075/76 - FY 2079/80). Compared to the previous FY, FY

2079/80 there has been a decrease in the imports and consumption of petroleum products. (Note: the import data of LPG is not available as the province does not import it from the neighboring county and relies on other provinces. Similarly, the sales data is also absent as it depends on the LPG depot's, whose data is not available with NOC.)

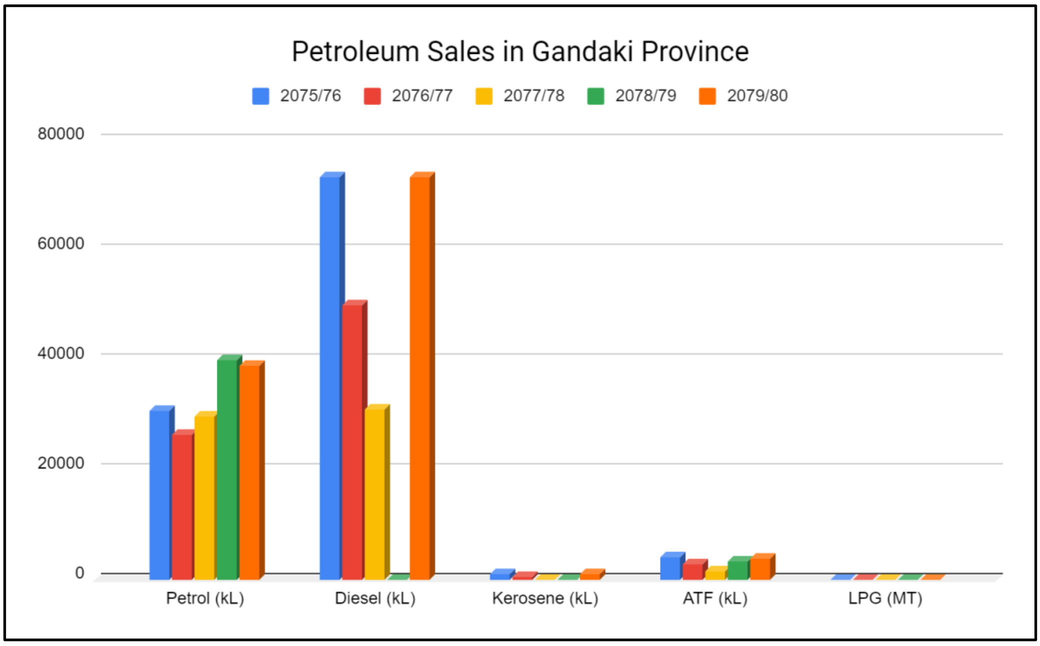

Figure 8.12: Gandaki Province Petroleum Sales

The total energy consumption of the Gandaki province was reported at 46,462 TJ in 2022 [WECS, 2024].

8.5 Lumbini Province

8.5.1 Energy Supply and Consumption Scenario

Electricity

- Consumer Base and Distribution Centers:
    - The Lumbini Provincial Office of NEA serves 947,311 consumers through 21 Distribution Centers across twelve districts.
    - Approximately 94.45% of these consumers are served via Butwal, and 92.36% are served via Nepalgunj.
    - The majority of consumers fall into the domestic category.
- Connected Load and Fiscal Year 2079/80:
    - In the fiscal year 2079/80, the office reported an increase in connected load:
        - Butwal: 174 MVA
        - Nepalgunj: 192 MVA
- Energy Sales and Revenue:
    - Annual energy sales reached 1917 GWh, accounting for 20.49% of NEA's total energy sales.
    - The gross annual revenue was NRs. 18.09 billion, representing about 20.02% of NEA's total revenue.
    - There was a 13.19% increase in sales revenue from Butwal Office and 11.61% from Nepalgunj office compared to the previous fiscal year.
- Distribution Loss and Revenue Collection:
    - Distribution losses were reduced to 8.48% from 12.83% (Butwal) and 8.6% from 9.81% (Nepalgunj) in the prior fiscal year.
    - This year, 35,548 consumer lines with outstanding dues of NRs. 1,541.44 million were disconnected.

Renewable Energy

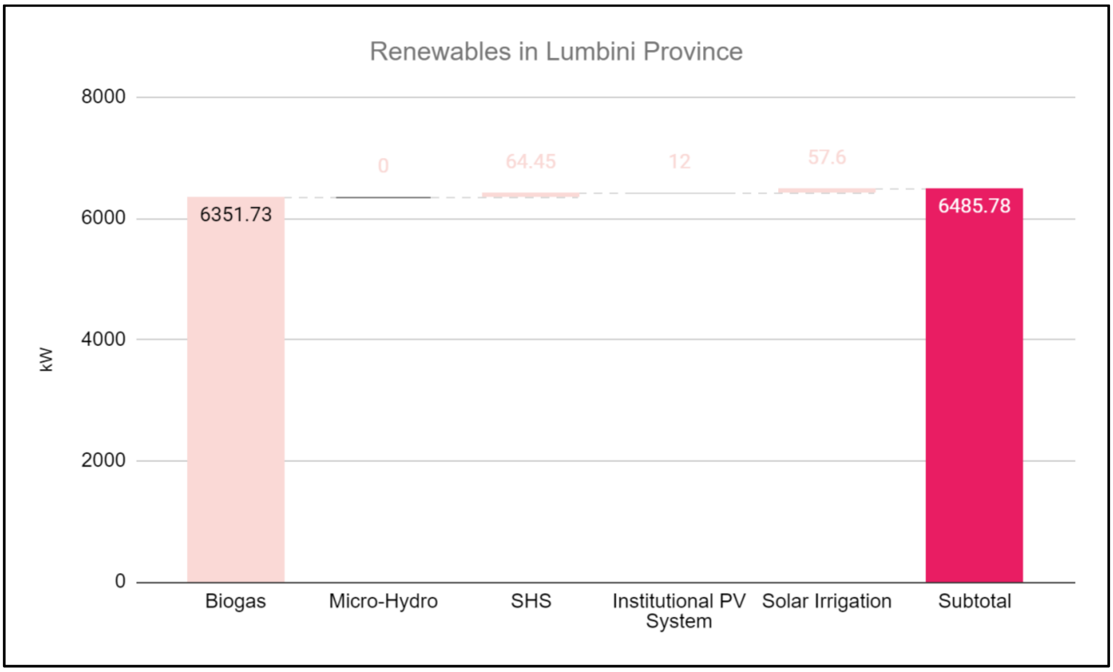

Figure 8.13: Renewables in Lumbini province (kW)

Figure 8.13 shows the usages of renewable energy resources in the Lumbini province in FY 2079/80.*(Note: '0' indicates no installations from AEPC in FY 2079/80.)*

Petroleum Fuels

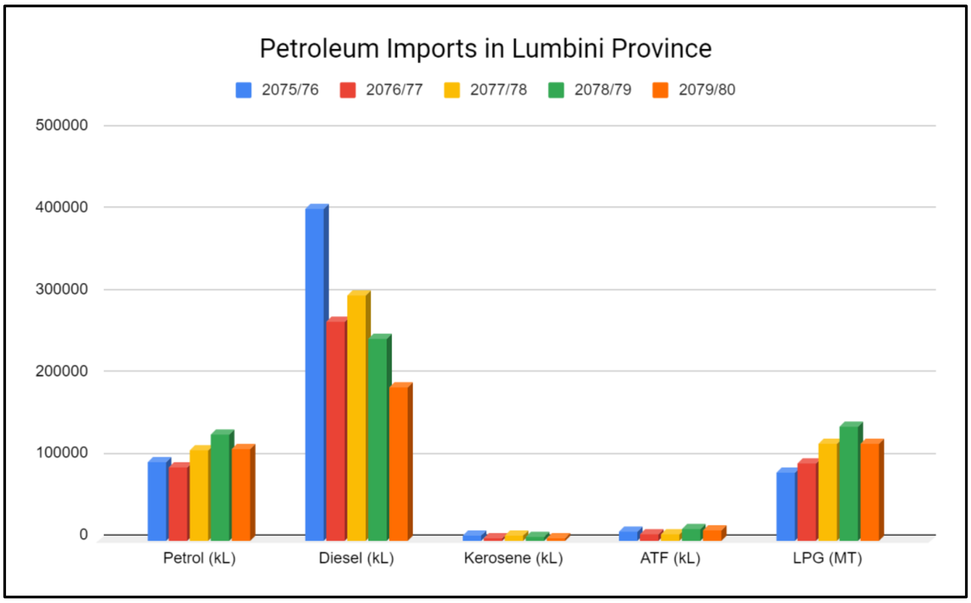

Figure 8.14: Lumbini Province Petroleum Imports

Figure 8.14 and Figure 8.15 showcases the recent trends of petroleum product imports and sales in Lumbini Province (FY 2075/76 - FY 2079/80). Compared to the previous FY, FY 2079/80 there has been a decrease in the imports and consumption of petroleum products.

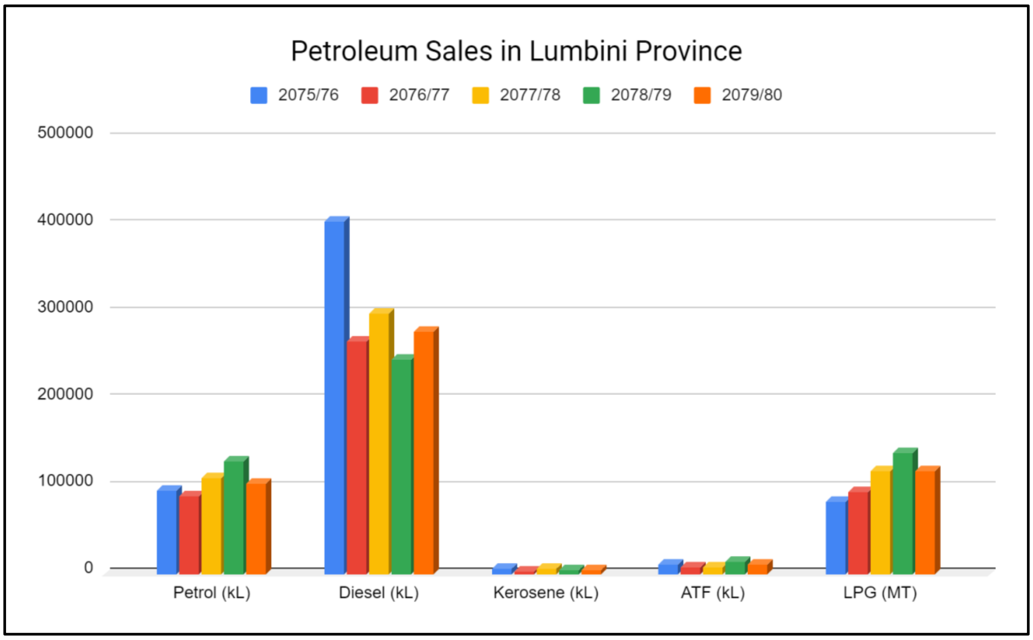

Figure 8.15: Lumbini Province Petroleum Sales

The total energy consumption of the Lumbini province was reported at 77,259 TJ in 2022 [WECS, 2024].

8.6 Karnali Province

8.6.1 Energy Supply and Consumption Scenario

Electricity

- Consumer Base and Distribution Centers:
    - The Karnali Provincial Office of NEA serves 139,073 consumers through 10 Distribution Centers across 10 districts.
    - Approximately 96.01% of these consumers are domestic.
- Connected Load and Fiscal Year 2079/80:
    - In the fiscal year 2079/80, the office recorded an increase in connected load, reaching 36 MVA.
- Energy Sales and Revenue:
    - Annual energy sales were 73 GWh, an 8.91% increase from the previous fiscal year.
    - These sales contributed to 0.79% of NEA’s total energy sales.
    - The gross annual revenue was NRs. 713 million, which is about 0.79% of NEA’s total revenue.
    - There was a 7.73% overall increase in sales revenue compared to the previous fiscal year.
- Distribution Loss and Revenue Collection:
    - The Provincial Office’s distribution loss increased to 16.20% from 6.97% the previous year.
    - During this year, 2,571 consumer lines, with dues totaling NRs. 45.94 million were disconnected.
    - The combined efforts of all Distribution Centers, revenue collection improved to 97.08%.

Renewable Energy

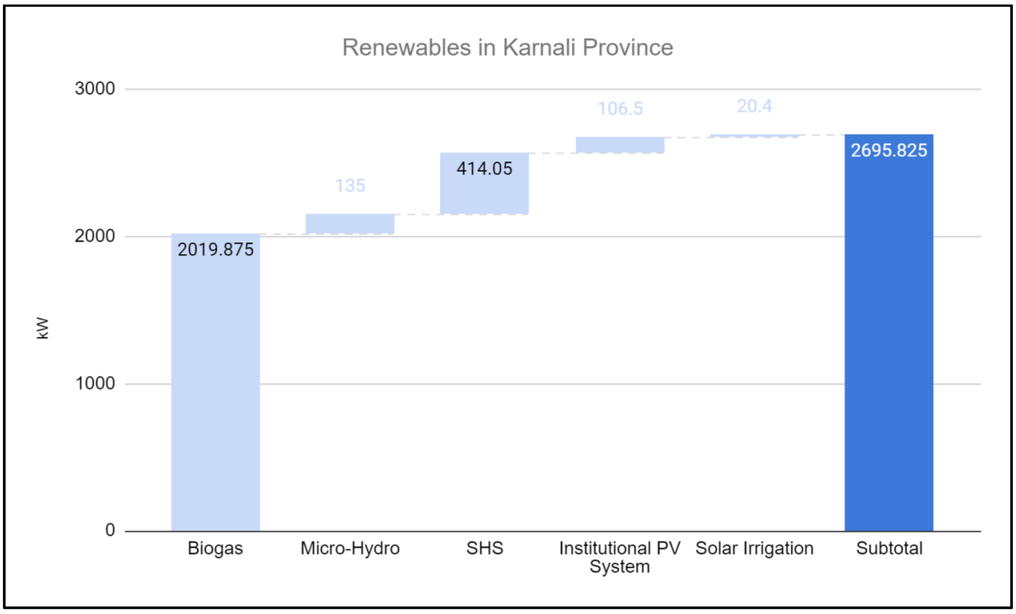

Figure 8.16: Renewables in Karnali province (kW)

Figure 8.16 shows the usages of renewable energy resources in the Karnali province in FY 2079/80.

Petroleum Fuels

Figure 8.17 showcases the recent trends of petroleum product sales in Karnali Province (FY 2075/76 - FY 2079/80).

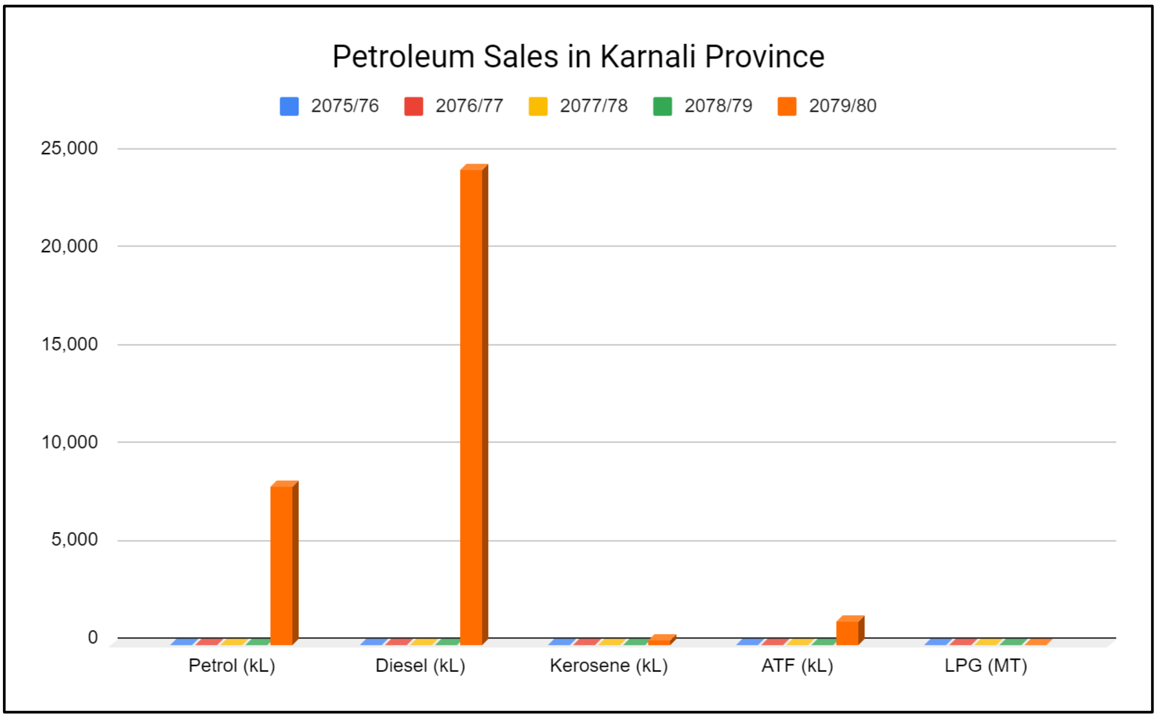

Figure 8.17: Karnali Province Petroleum Sales

Compared to the previous FY, the FY 2079/80 there has been an increase in the consumption of petrol, diesel, and ATF. The import, however, is non-existent as the petroleum products are imported from India and the Karnali province does not share its border with the neighboring country. (Note: the sales data of LPG is absent as it depends on the LPG depots whose data is not available with NOC.)

The total energy consumption of the Karnali province was reported at 19,594 TJ in 2022 [WECS, 2024].

8.7 Sudurpashchim Province

8.7.1 Energy Supply and Consumption Scenario

Electricity

- Consumer Base and Distribution Centers:
  - The Sudurpashchim Provincial Office of NEA serves 339,352 consumers through 12 Distribution Centers across 9 districts.
  - Approximately 93.17% of these consumers are domestic.
- Connected Load and Fiscal Year 2079/80:
  - In the fiscal year 2079/80, the office saw an increase in connected load, reaching 54 MVA.
  - 73% of the population are connected to the electricity grid.
- Energy Sales and Revenue:
  - Annual energy sales totaled 327 GWh, marking a 1.38% increase from the previous fiscal year.
  - These sales contributed to 3.50% of NEA's total energy sales.
  - The gross annual revenue was NRs. 2.80 billion, which is about 3.10% of NEA's total revenue.
  - However, there was an overall decrease in sales revenue by 1.38% compared to the previous fiscal year.
- Distribution Loss and Revenue Collection:
  - The Provincial Office reduced its distribution loss to 10.99% from 13.30% the previous year.
  - During this year, 8,992 consumer lines, with dues amounting to NRs. 212.83 million were disconnected.
  - The concerted efforts of all Distribution Centers, revenue collection improved to 100.10%.

Renewable Energy

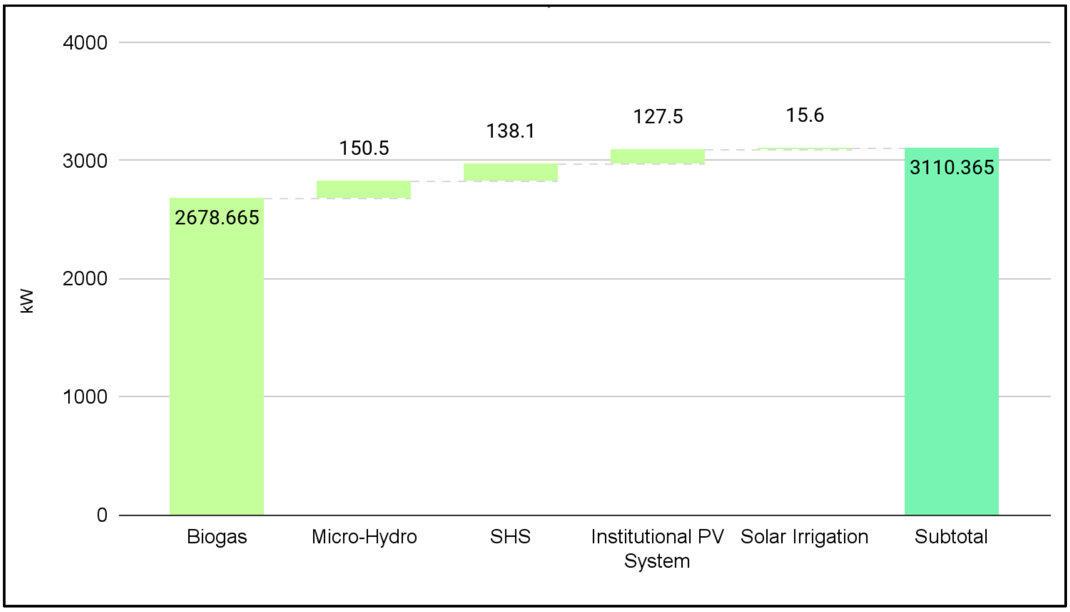

Figure 8.18: Renewables in Sudurpashchim province (kW)

Figure 8.18 shows the usages of renewable energy resources in the Sudurpashchim province in FY 2079/80.

Petroleum Fuels

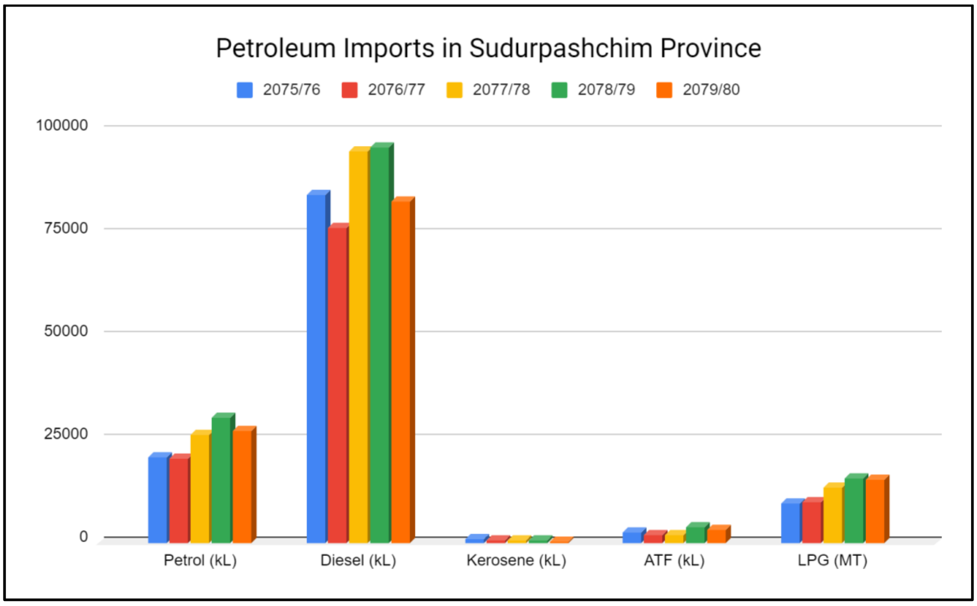

Figure 8.19: Sudurpashchim Province Petroleum Imports

Figure 8.19 and Figure 8.20 showcases the recent trends of petroleum product imports and sales in Sudurpashchim Province (FY 2075/76 - FY 2079/80). Compared to the previous FY, FY 2079/80 there has been a decrease in the imports and consumption of petroleum products.

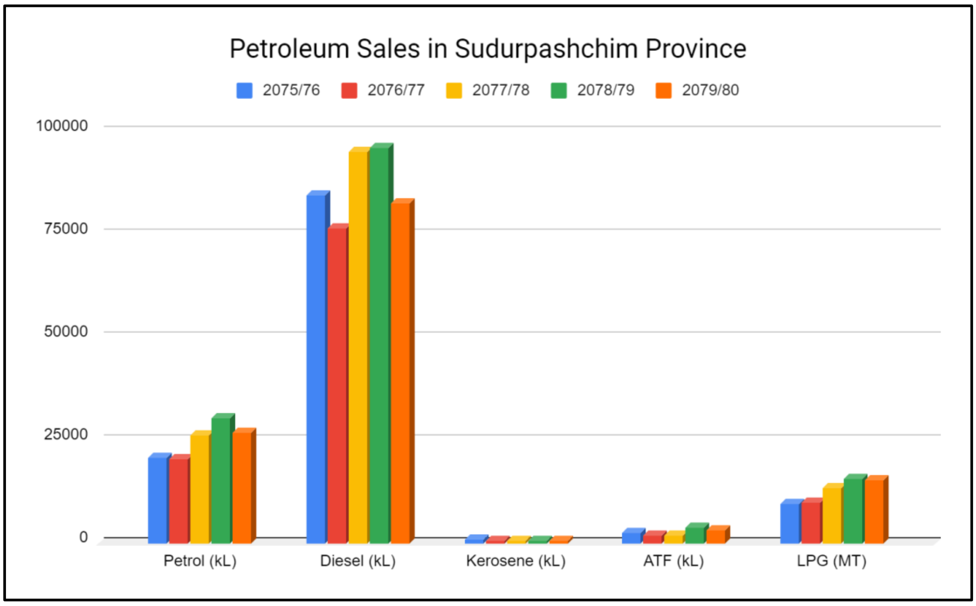

Figure 8.20: Sudurpashchim Province Petroleum Sales

The total energy consumption of the Sudurpashchim province was reported at 36,906 TJ in 2022[WECS,2024].

Chapter 9: Conclusion

An energy synopsis report provides insights into the country's supply and consumption trends of energy and energy resources. The energy situation of Nepal in FY 2079/80, displayed a decrease of 16.81% in the overall consumption of energy. The final energy consumption totaled to 532.42 PJ.

The traditional energy resources along with coal and petroleum products were observed to have decreased by 17.2% and 24.27%, respectively (totaling 340 PJ and 137.4 PJ, respectively). The contribution of electricity showed a increase of 21.18%, amounting to 38.5 PJ (7.23% of the total consumption). The utilization of renewable resources was also observed to have increased by 2.39% compared to the previous FY(2078/79).

The import of coal decreased from 1,974,357 tons in FY 2078/79 to 1,383,000 tons. Similarly, the national production of coal was also observed to have reduced from 6,927 tons to 2,948 tons, showcasing the decreasing dependence of Nepal on coal. Similarly, there was a decreasing trend in the overall import and sales of petroleum fuels (compared to FY 2078/79):

- Percentage changes in imports of:
    - Petrol: -8.61%
    - Diesel: -21.93%
    - Kerosene: -28.98%
    - ATF: 9.89%
    - LPG: -4.06%
- Percentage changes in sales of:
    - Petrol: -8.23%
    - Diesel: -22.27%
    - Kerosene: -27.61%
    - ATF: 12.65%
    - LPG: -4.06%

The total consumption of petroleum products amounted to 103.4 PJ.

Despite the decrease in the imports of coal and petroleum fuels, these resources are still the major driving factors of the nation's economy and international relations.

The electricity sector saw a significant increase in internal sales (9,358 GWh) as well as exports (1,346 GWh). 98% of the population now has access to electricity in which 96.7% is from grid connected electricity whereas 1.3% other isolated off-grid system (Solar, Wind, Mircohydro)., and the per capita electricity consumption was 370 kWh. A total of 5,742 circuit km of transmission lines of 66 kV and above has been constructed. Additionally, the renewable energy resources totaled to 16.5 PJ, which accounted for 3.10% of the total consumption. Biogas was the major energy source with 10.7 PJ followed by solar (5.2 PJ), micro/pico hydro (0.6 PJ), and wind/solar hybrid system (0.02 PJ). Despite the low contribution to the total consumption, at the current time, there has been a slow, yet growing, trend in the utilization of these resources, directing the nation towards a reliable and sustainable future.

In FY 2079/80, the Koshi province recorded electricity sales of 1,552.54 GWh and a gross annual revenue of NRs. 14.47 billion. The total energy consumption was 73,835 TJ, with the industrial sector consuming the most at 32,961 TJ. The annual electricity sales in the Madhesh province reached 914 GWh, accounting for 9.83% of NEA's total energy sales, with a gross annual revenue of NRs. 9.57 billion. Distribution losses reduced to 8.75%.

The Bagmati province accounts for 36.86% of the national total GDP. The electricity sales reached 2,838 GWh in the fiscal year 2079/80, and the gross annual revenue was NRs. 30.18 billion. Annual electricity sales in the Gandaki province amounted to 632 GWh, a 6.38% increase from the previous fiscal year, with a gross annual revenue of NRs. 6.13 billion. Distribution losses were reduced to 8.47%.

Similarly, electricity sales in Lumbini province reached 1917 GWh, accounting for 20.49% of NEA's total energy sales, with a gross annual revenue of NRs. 18.09 billion. Distribution losses reduced to 8.48%. In Karnali province, the annual electricity sales were 73 GWh, an 8.91% increase from the previous fiscal year, with a gross annual revenue of NRs. 713 million. Distribution losses increased to 16.20%. And in the Sudurpashchim province, annual electricity sales reached 327 GWh, with a gross annual revenue of NRs. 2.80 billion, and distribution losses were reduced to 10.99%.

Chapter 10: Recommendations

1. **Recommendation for classification of energy resources**

General classification of energy resources on the basis of renewable energy and non-renewable energy is as follows.

Renewable Resources	Non-renewable Resources
➢ Fuelwood ➢ Agri-residue ➢ Animal dung ➢ Hydro electricity ➢ Biogas ➢ Solar ➢ Wind-solar (hybrid system) ➢ Micro-hydro	➢ Coal ➢ Petrol ➢ Diesel ➢ Kerosene ➢ ATF ➢ LPG ➢ Imported electricity*

*(*India relies on mixed sources to produce electricity)*

It is recommended to modify the current energy classification system as follows.

Traditional Resources	Commercial Resources	Renewable Resources
➢ Fuelwood ➢ Agri-residue ➢ Animal dung	➢ Coal ➢ Petrol ➢ Diesel ➢ Kerosene ➢ ATF ➢ LPG ➢ Imported electricity*	➢ Hydro electricity ➢ Biogas ➢ Micro-hydro ➢ Solar ➢ Wind/solar (hybrid system)

*(*India relies on mixed sources to produce electricity)*

Energy consumption according to new classification is shown in Figure 10.1 and Table 10.1.

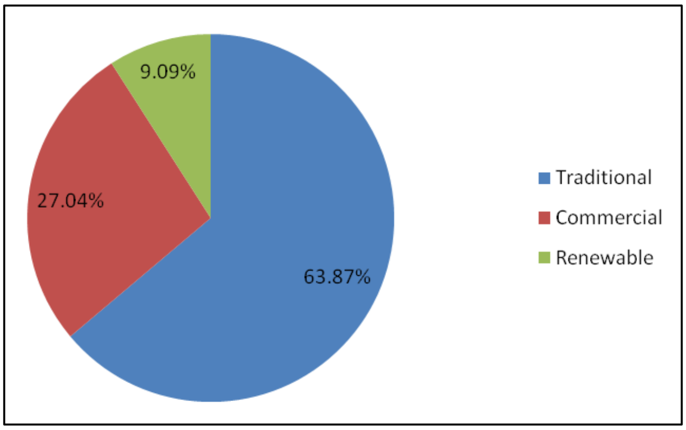

Figure 10.1: Energy consumption share for 532.42 PJ according to new classification

Table 10.1: Consumption table based on new classification

FY 2079/80					
Category	**Fuel Type**	**Energy (000 GJ)**	**000 TOE**	**GWh**	**% of National Total**
Traditional	Fuelwood	304,625.30	7,275.85	85,295.08	57.22%
	Agricultural residues	25623.22	612.00	7,174.50	4.81%
	Animal dung	9,791.23	233.86	2,741.54	1.84%
	Total	**340,039.74**	**8,121.71**	**95,211.13**	**63.87%**
Commercial	Coal	34,015.89	812.46	9,524.45	6.39%
	Petrol	21,932.01	523.84	6,140.96	4.12%
	Diesel	49,727.70	1,187.73	13,923.76	9.34%
	Kerosene	471.73	11.27	132.08	0.09%
	LPG	23,676.98	565.51	6,629.55	4.45%
	ATF	6,190.82	147.87	1,733.43	1.16%
	Furnace Oil	1,368.71	32.69	383.24	0.26%
	Total	**137,383.84**	**3,281.36**	**38,467.48**	**25.80%**
	Imported Electricity	**6599**	**157.61**	**1,847.67**	**1.24%**
Renewable	Hydro Electricity	31896.2	761.83	8,930.93	5.99%
	Biogas	10,722.27	256.10	3,002.24	2.01%
	Wind/Solar (Hybrid)	20.10	0.48	5.63	0.0038%
	Micro/Pico Hydro	575.06	13.74	161.02	0.11%
	Solar	5,182.00	123.77	1,450.96	0.97%
	Total	**48,395.60**	**1,155.91**	**13,550.77**	**9.09%**
Total		**532,418.02**	**12,716.59**	**149,077.05**	**100%**

2. Recommendation for databases

Some of the recommendations that can be done in order to make the energy database are:

(i) The data for sales of LPG was not available via the NOC for a couple of provinces, leading to some discrepancies in provincial consumption. It is suggested to contact the existing and operating LPG depots in order to obtain accurate data of sales in each of the seven provinces.

(ii) A detailed information on the energy consumption data should be kept by the institutions like:

a. *Nepal Ban Nigam:*

WECS and Nepal Ban Nigam should conduct a collaborative study on the different types of woods found in Nepal, quantity used for fuel and their calorific values.

Sample format:

Province	Types and Categories of Fuelwood	Quantity (in Kg or Tons)	Calorific Values of fuelwood (kcal/kg)
-	-	-	-

b. *Ministry of Agriculture and Livestock Development:*

Studies regarding dung production of different types of cattle and their utilization factors for fuel should be conducted to obtain accurate data for the estimation of energy produced using quantity and quality of dung.

Sample format:

Province	Types of Livestock	Quantity of Dung Production	Calorific Values of dried dung (kcal/kg)
-	-	-	-

It is also recommended that studies regarding the bagasse and other crops be conducted to find the quantity of residue produced, quantity used for fuel, and their respective calorific values.

Sample format:

<table>
<tr><th>Province</th><th colspan="2">Types of Crops and its Waste</th><th>Quantity of Crops (kg or tons)</th><th>Calorific Values of Dried crops (kcal/kg)</th></tr>
<tr><td rowspan="2">-</td><td rowspan="2">Crop A</td><td>Waste Sub Crop A1</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td>Waste Sub Crop A2</td></tr>
</table>

c. *Alternative Energy Promotion Center (AEPC):*

AEPC should conduct studies and maintain data in terms of energy along with the number of installations.

Sample format:

Fiscal Year	Province	Districts	IWM	MHP	SHS	LBG	DBG	MICS	ISPS	Solar Irrigation
	-	-	(in kW)	(in kW)	(in kW)	(in kW)	(in kW)	(in kW)	(in kW)	(in kW)
		-								

Similarly, a detailed record of installations that are under operation and installations that have ceased operation should be maintained.

Sample format:

FY	Province	Districts	Types of energy production	Nos. in Operation	Nos. Not in Operation	Total Power Generation (kW)
		(District 1 contains all the information of the given energy production and it follows to all the districts)	IWM			
			MHP			
			SHS			
			LBG			
			DBG			
			MICS			
			ISPS			
			Solar Irrigation			

(iii) The Department of Customs should introduce specific codes for energy-related commodities to enhance transparency and accuracy in assessing energy flows. This will facilitate data collection and verification of energy supply sources.

(iv) Regular energy analysis should be conducted for the nation and its seven provinces to obtain an accurate representation of total and sectoral energy supply and consumption patterns. This will enable informed decision-making and effective energy planning at various levels.

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ANNEX

A. GDP Composition

Table I: GDP Composition of Different Sectors

FY	Agriculture	Industrial	Service
2019/20	25.16%	13.66%	61.18%
2020/21	24.90%	13.69%	61.41%
2021/22	23.95%	14.29%	61.76%
2022/23	24.10%	13.50%	62.40%

Table II: Province-wise GDP composition

Province	GDP
Koshi	15.8%
Madhesh	13.1%
Bagmati	36.9%
Lumbini	14.2%
Gandaki	9%
Karnali	4.1%
Sudurpashchim	7%

(Source: Economic Survey 2022/23)

B. Energy Consumption

Table III: Consumption throughout the years

Fiscal Year	Consumption in PJ
2052/53	292
2053/54	297
2054/55	306
2055/56	314
2056/57	331
2057/58	335
2058/59	347
2059/60	353
2060/61	362

Fiscal Year	Consumption in PJ
2061/62	367
2062/63	377
2063/64	381
2064/65	388
2065/66	401
2066/67	413
2067/68	425
2068/69	369
2069/70	420
2070/71	470
2071/72	491
2072/73	493
2073/74	539
2074/75	565
2075/76	589
2076/77	566
2077/78	626
2078/79	639.97
2079/80	532.42

(Source: Energy Synopsis Report 2023 and calculations)

C. Provincial Energy Consumption by Sector and Fuel Type

Table IV: Annual Energy consumption in Koshi Province by Sector and Fuel Type (TJ) in 2019

	Renewables							Non renewables							Total (in TJ)
	Conventional renewables					New Renewables									
	Traditional biomass			Modern biomass											
	Firewood	Agricultural Residue	Animal dung	Biogas	Bio briquettes	Solar	Electricity	Petrol	Diesel	Kerosene	Furnace Oil	Aviation turbine fuel	LPG	Coal	
Agriculture	-	-	-	-	-	0.09	0.08		534	-	-	-	-	-	534
Commercial	885	-	-	0.07	0.03	0	617	-	-	-	-	-	642	-	2,144
Industry	2,300	6,915	-	-	-	-	2,823	-	4,136	-	1,162	-	4	15,620	32,961
Residential	24,261	42	826	60.2	0.43	9.88	1,792	-	-	40	-	-	3,127	3.8	30,163
Transport	-	-	-	-	-	-	10	1,858	5,017	-	-	563	-	-	7,448
Construction and mining	13	-	-	-	-	-	2	16	462	89	-	-	2	-	585
Total	**27,458**	**6,957**	**826**	**60**	**0.47**	**10**	**5,245**	**1,874**	**10,150**	**129**	**1,162**	**563**	**3,776**	**15,624**	**73,835**

(Source: WECS 2020)

Table V : Annual Energy Consumption in Madhesh Province by Sector and Fuel Type (TJ) in 2019

	Renewables							Nonrenewable							Total (in TJ)
	Conventional renewable					New Renewables									
	Traditional biomass			Modern biomass											
	Fuelwood	Agricultural Residue	Animal dung	Biogas	Bio briquettes	SolarPV	Grid Electricity	Petrol	Diesel	Kerosene	Furnace Oil	Aviation Turbine fuel	LPG	Coal	
Agriculture	-	-	-	-		0.3	0.16	26	764	-	-	-	-	-	790
Commercial	3.59	-	-	0.22		-	1,869	-	-	-	-	-	305	-	2,178
Industry	975	824	-	-		-	1,511	-	1,254	-	3,645	-	59	6,632	14,900
Residential	20,880	5,101	6,777	27.99	20.84	7.45	2,057	-	-	151	-	-	4,220	5.56	39,248
Transport	-	-	-	-		-	129	2,984	2,638	-	-	62	-	-	5,812
Construction and mining	-	-	-	-		-	23	-	187	4	-	-	54	-	267
Total	**21,859**	**5,925**	**6,777**	**28**	**20.84**	**8**	**5,588**	**3,009**	**4,842**	**155**	**3,645**	**62**	**4,638**	**6,638**	**63,174**

(Source: WECS 2020)

Table VI: Annual Energy consumption in Bagmati Province by sectors and fuel types in 2021 (TJ)

Fuel type	Agriculture	Commercial	Industrial	Residential	Transportation	Construction and mining	Total (in TJ)
Traditional fuels (Renewable)							
Fuelwood	-	114	6,912	20,302	-	11	**27,340**
Animal Dung	-	-		3	-	-	**3**
Agriculture Residue	-	-	1,039	2,005	-	-	**3,043**
Modern fuels (Renewable)							
Biogas	-	-	-	335	-	-	**335**
Briquette	-	15	0	7	-	-	**22**
New-Renewables							
Electricity	55	2,179	2,139	4,635	14	12	**9,033**
Solar PV	6	-	-	25	-	-	**31**
Solar Thermal	-	10	-	189	-	-	**199**
Non-Renewables							
Coal	-	286	2,261	0	-	-	**2,547**
Kerosene	-	-	529	0.4	-	0	**529**
LPG	-	3,455	93	7,799	15	64	**11,427**
Diesel	677	-	10,257	-	6,217	676	**17,827**
Gasoline	1	-	1,110	-	4,791	89	**5,990**
Furnace oil	-	-	3,508	-	-	9	**3,518**
Aviation Fuel	-	-	-	-	1,689	-	**1,689**
Total	**739**	**6,059**	**27,848**	**35,300**	**12,726**	**861**	**83,535**

(Source: WECS 2022)

Table VII: Annual Energy Consumption in Gandaki Province by Sector and Fuel Type in 2022

	Renewables							Non - renewables							Total (in TJ)
	Conventional renewable					New Renewables									
	Traditional biomass			Modern biomass											
	Fuelwood	Agricultural Residue	Animal dung	Biogas	Bio briquettes	Solar	Grid Electricity	Petrol	Diesel	Kerosene	Furnace Oil	Aviation turbine fuel	LPG	Coal	
Agriculture	-	-	-	-		0.01	11.88	3.24	1,132.77	-	-	-	-	-	1,147.90
Commercial	2,946.96	106.76	92.9	-		61.65	610.51	-	-	-	-	-	194.98	50.09	4,063.84
Industry	1,954.69	3,843.25	-	-		-	626.28	644.01	7,047.91	-	2,281.34	-	29.84	1,608.21	18,035.52
Residential	16,013.01	26	-	323.89	-	6.16	999.23	-	-	3.19	-	-	1,964.15	1.48	19,337.10
Transport	-	-	-	-		-	0.05	1,025.18	1,698.27	-	-	435.12	-	-	3,158.61
Construction and mining	-	-	-	-		-	24.02	15.35	592.19	0.01	-	-	87.55	-	719.12
Total	**20,914.65**	**3,976.01**	**92.9**	**323.89**	**-**	**67.81**	**2,271.97**	**1,687.79**	**10,471.13**	**3.2**	**2,281.34**	**435.12**	**2,276.51**	**1,659.78**	**46,462.08**

(Source: WECS 2023)

Table VIII: Annual Energy Consumption in Lumbini Province by Sector and Fuel Type in 2022

	Renewables							Nonrenewable							Total (in TJ)
	Conventional renewable					New Renewables									
	Traditional biomass			Modern biomass											
	Fuelwood	Agricultural Residue	Animal dung	Biogas	Bio briquettes	Solar	Grid Electricity	Petrol	Diesel	Kerosene	Furnace Oil	Aviation turbine fuel	LPG	Coal	
Agriculture	-	-	-	-		0.56	49.5	105.36	5,129.18	-	-	-	-	-	5,284.61
Commercial	3,602.55	247.87	146.03	3.28		108.64	785.58	-	-	-	-	-	445.67	13.62	5,353.25
Industry	4,706.35	2,879.38	-	-		-	2,760.54	4.89	9,675.11	-	1,413.47	-	717.52	6,314.01	28,471.27
Residential	20,748.83	178.13	120.53	2,212.79	7.3	19.23	1,881.42	-	-	6.01	-	-	3,681.15	23.49	28,878.88
Transport	-	-	-	-		-	0.23	3,468.43	3,107.44	-	-	217.67	-	-	6,793.78
Construction and mining	-	-	-	-		-	55.23	5.9	2,272.23	3.85	0.03	-	139.8	-	2,477.04
Total	**29,057.73**	**3,305.38**	**266.56**	**2,216.07**	**7.3**	**128.43**	**5,532.51**	**3,584.59**	**20,183.96**	**9.86**	**1,413.50**	**217.67**	**4,984.16**	**6,351.12**	**77,258.83**

(Source: WECS 2023)

Table IX: Energy Consumption in Karnali Province by Sector and Fuel Type in 2022

	Renewables							Non-renewable							Total (in TJ)
	Conventional renewable					New Renewables									
	Traditional biomass			Modern biomass											
	Fuelwood	Agricultural Residue	Animal Dung	Biogas	Bio briquettes	Solar	Grid Electricity	Petrol	Diesel	Kerosene	Furnace Oil	Aviation turbine fuel	LPG	Coal	
Agriculture	-	-	-	-		0.04	1.64	0.03	243.76	-	-	-	-	-	245.46
Commercial	633.1	9.49	5.54	-		339.02	56.41	-	-	0.02	-	-	60.07	0.52	1,104.16
Industry	86.68	8.45	-	-		-	18.06	35.53	158.08	17.5	-	-	0.99	48.07	373.35
Residential	16,332.00	21.65	-	3.33	0.23	26.62	140.78	-	-	0.78	-	-	241.83	0.08	16,767.30
Transport	-	-	-	-		-	0.03	280.86	469.96	-	-	139.95	-	-	890.8
Construction and mining	-	-	-	-		-	1.76	8.88	199.02	-	-	-	3.66	-	213.32
Total	**17,051.78**	**39.58**	**5.54**	**3.33**	**0.23**	**365.68**	**218.68**	**325.3**	**1,070.81**	**18.3**	**-**	**139.95**	**306.54**	**48.67**	**19,594.39**

(Source: WECS 2023)

Table X: Annual Energy Consumption in Sudurpashchim Province by Sector and Fuel Type in 2022

	Renewables							Non-renewable							Total (in TJ)
	Conventional renewable					New Renewables									
	Traditional biomass			Modern biomass											
	Fuelwood	Agricultural Residue	Animal dung	Biogas	Bio briquettes	Solar	Grid Electricity	Petrol	Diesel	Kerosene	Furnace Oil	Aviation turbine fuel	LPG	Coal	
Commercial	378.9	44.19	4.01	-		388.19	331.61	-	-	-	-	-	113.62	1.87	1,262.39
Industry	730.81	3,026.49	-	-		-	121.08	186.77	1,144.48	13.86	-	-	1.58	506.7	5,731.77
Residential	23,884.80	1,044.79	8.93	1,035.43	0.07	17.62	549.84	-	-	8.43	-	-	508.91	0.07	27,058.89
Transport	-	-	-	-		-	1.07	579.17	564.45	-	-	89.51	-	-	1,234.20
Construction and mining	-	-	-	-		-	7.99	127.15	413.53	25.49	-	-	31.2	-	605.36
Total	**24,994.51**	**4,115.47**	**12.94**	**1,035.43**	**0.07**	**406.17**	**1029.97**	**910.28**	**3,100.03**	**47.78**	**-**	**89.51**	**655.3**	**508.64**	**36,906.09**

(Source: WECS 2023)

D. Fuelwood

Table XI: Sustainable fuelwood supply and energy in 2014

Province	Area in 000ha						Sustainable Wood (Million T) From Reachable			Energy (GJ)
	Forest		OWL		OL					
	Total	Reachable	Total	Reachable	Total	Reachable	Forest	OWL	Total	
Koshi	1,034.17	809.65	100.17	78.42	1,476.72	1,476.72	3.04	0.05	3.09	51,759,239
Madhesh	260.76	260.76	2.87	2.87	695.34	695.34	0.98	0.00	0.98	16,411,934
Bagmati	1,046.21	601.05	44.67	25.66	939.43	939.43	2.25	0.02	2.27	38,048,744
Gandaki	739.60	271.36	99.55	36.52	1,429.16	1,429.16	1.02	0.03	1.05	17,465,405
Lumbini	968.37	369.04	49.22	18.76	963.27	963.27	1.38	0.01	1.39	23,396,583
Karnali	902.82	344.06	215.52	82.13	1,828.31	1,828.31	1.29	0.06	1.35	22,557,306
Sudurpashchim	1,010.21	527.33	135.90	70.94	831.26	831.26	1.98	0.05	2.03	33,939,709
Total	**5,962.14**	**3,183.25**	**647.90**	**315.30**	**8,163.49**	**8,163.49**	**11.94**	**0.22**	**12.16**	**203,578,920**

(DFRS/FRISP, 1999)

E. Agriculture Residue

Table XII: Total agriculture residue produced (million tons)

Province	FY 2075/76	FY 2076/77	FY 2077/78	FY 2078/79	FY 2079/80
Koshi	2,358,762	2,385,173	2,532,781	2,599,591	2,686,601
Madhesh	2,241,037	2,199,426	2,339,566	2,358,539	2,407,803
Bagmati	1,348,355	1,366,068	1,448,861	1,488,267	1,538,520
Gandaki	1,044,170	1,047,836	1,109,032	1,128,671	1,161,102
Lumbini	2,065,559	2,104,198	2,237,234	2,307,339	2,393,176
Karnali	532,004	576,345	611,023	652,143	691,653
Sudurpashchim	1,053,653	1,213,755	1,289,527	1,421,519	1,539,456
Total	**10,643,540**	**10,892,801**	**11,568,024**	**11,956,068**	**12,418,310**

(Extrapolated data from Energy Synopsis Report 20223)

Table XIII: Total energy potential from agriculture residue (000 GJ)

Province	FY 2075/76	FY 2076/77	FY 2077/78	FY 2078/79	FY 2079/80
Koshi	89,914	91,007	96,689	99,239	102,561
Madhesh	85,276	83,835	89,169	89,892	91,770
Bagmati	51,819	52,570	55,795	57,313	59,248
Gandaki	39,369	39,485	41,850	42,591	43,815
Lumbini	79,184	80,744	85,848	88,538	91,832
Karnali	20,735	22,495	23,860	25,466	27,009
Sudurpashchim	40,179	46,440	49,344	54,395	58,908
Total	**406,476**	**416,576**	**442,555**	**457,434**	**475,084**

(Extrapolated data from Energy Synopsis Report 2022, 2023)

F. Animal Waste

Table XIV: Total animal dung produced (million tons)

Province	FY 2075/76	FY 2076/77	FY 2077/78	FY 2078/79	FY 2079/80
Koshi	1,351,458	1,373,824	1,387,369	1,406,795	1,424,751
Madhesh	1,182,948	1,242,857	1,255,812	1,300,069	1,336,501
Bagmati	1,017,255	1,031,999	1,044,292	1,058,219	1,071,737
Gandaki	745,795	713,063	722,121	703,319	691,482
Lumbini	1,389,747	1,427,643	1,444,683	1,475,627	1,503,095
Karnali	419,649	365,390	369,565	334,784	309,742
Sudurpashchim	709,427	685,276	692,711	679,088	670,730
Total	**6,816,279**	**6,840,051**	**6,916,554**	**6,957,902**	**7,008,039**

(Extrapolated data from Energy Synopsis Report 2022, 2023)

Table XV: Total energy potential from animal dung (000 GJ)

Province	FY 2075/76	FY 2076/77	FY 2077/78	FY 2078/79	FY 2079/80
Koshi	20,164	20,497	20,700	20,989.4	21,257
Madhesh	17,650	18,543	18,737	19,397.0	19,941
Bagmati	15,177	15,397	15,581	15,788.6	15,990
Gandaki	11,127	10,639	10,774	10,493.5	10,317
Lumbini	20,735	21,300	21,555	22,016.4	22,426
Karnali	6,261	5,452	5,514	4,995.0	4,621
Sudurpashchim	10,585	10,224	10,335	10,132.0	10,007
Total	**101,699**	**102,054**	**103,195**	**103,812**	**104,560**

(Extrapolated data from Energy Synopsis Report 2022, 2023)

G. Coal

Table XVI: Total national production of coal and total imports up to FY 2079/80

	Year				
Production (kg)	**FY 2075/76**	**FY 2076/77**	**FY 2077/78**	**FY 2078/79**	**FY 2079/80**
National		7,250,100	11,303,900	6,927,040	2,947,600
Imports					
Anthracite, not agglomerated	3,201,287	2,982,833	110,479	96,559	245,266
Bituminous coal, not agglomerated	1,056	0	207,422	40,357,160	91,153,025
Other coal, not agglomerated, nes	1,664,409,818	1,337,212,825	1,911,595,559	1,740,764,608	1,180,189,198
Briquettes, ovoids and similar solid fuels manufactured from coal	28,675	79,906	176,426	60,316,200	34,797,054
Agglomerated lignite	0	2	14,000	0	0
Lignite, not agglomerated	0	0	0	500	0
Peat (including peat litter), whether or not agglomerated.					245,193
Coke and semi-coke of coal, of lignite or f peat; retort carbon	213,993,422	138,907,825	89,507,340	132,821,763	76,370,270
Coal gas, water gas, producer gas and similar gases, not petroleum gases	326	0	0	0	0
Total	**1,881,634,584**	**1,486,433,491**	**2,012,915,126**	**1,981,283,830**	**1,385,947,604**

(Source: DMG and DoC 2023)

H. Petroleum Import and Sales

Table XVII: Petroleum import throughout the fiscal years

Province	Petroleum Product	Fiscal Year					Province	Petroleum Product	Fiscal Year				
		2075/76	2076/77	2077/78	2078/79	2079/80			2075/76	2076/77	2077/78	2078/79	2079/80
Koshi	Petrol (kL)	105,907	89,664	111,724	134,640	120,112	Lumbini	Petrol (kL)	94,648	88,724	109,652	128,252	111,180
	Diesel (kL)	298,545	130,088	89,024	92,388	74,164		Diesel (kL)	404,772	267,308	298,616	246,148	186,612
	Kerosene (kL)	4,780	2,760	4,168	3,796	2,404		Kerosene (kL)	5,660	2,900	5,860	4,204	1,860
	ATF (kL)	7,740	6,588	5,584	11,244	9,836		ATF (kL)	10,992	8,004	7,656	13,968	11,528
	LPG (MT)	72,534	78,059	88,169	97,961	91,619		LPG (MT)	82,587	93,577	117,009	137,978	117,537
Madhesh	Petrol (kL)	130,376	133,276	149,104	177,108	147,588	Karnali	Petrol (kL)	0	0	0	0	0
	Diesel (kL)	593,584	805,088	1,129,966	1,289,069	1,039,306		Diesel (kL)	0	0	0	0	0
	Kerosene (kL)	8,284	9,392	9,500	6,120	5,767		Kerosene (kL)	0	0	0	0	0
	ATF (kL)	0	0	0	-	160		ATF (kL)	0	0	0	0	0
	LPG (MT)	265,060	267,522	259,376	284,575	290,282		LPG (MT)	0	0	0	0	0
Bagmati	Petrol (kL)	184,624	153,620	165,308	226,360	230,800	Sudurpashchim	Petrol (kL)	20,632	20,484	26,232	30,176	27,072
	Diesel (kL)	260,496	144,688	52,580	-	-		Diesel (kL)	84,448	76,564	95,088	95,952	82,896
	Kerosene (kL)	4,620	2,940	3,400	2,840	2,440		Kerosene (kL)	660	592	656	380	320

Province	Petroleum Product	Fiscal Year				
		2075/76	2076/77	2077/78	2078/79	2079/80
	ATF (kL)	175,056	118,264	56,060	125,008	145,068
	LPG (MT)	0	0	0	-	-
Gandaki	Petrol (kL)	30,640	26,360	29,680	39,740	38,740
	Diesel (kL)	73,060	49,800	30,928	-	-
	Kerosene (kL)	1,000	340	0	-	160
	ATF (kL)	3,880	2,820	1,300	3,240	3,700
	LPG (MT)	0	0	0	-	-

Province	Petroleum Product	Fiscal Year				
		2075/76	2076/77	2077/78	2078/79	2079/80
	ATF (kL)	2,440	1,748	1,664	3,668	3,180
	LPG (MT)	9,429	9,905	13,198	15,514	15,278

['0'or '-' in the table indicates no records of imports as those provinces do not import from the neighboring country]

(Source: NOC 2023)

Table XVIII: Petroleum sales throughout the fiscal years

Province	Petroleum Product	Fiscal Year					Province	Petroleum Product	Fiscal Year				
		2075/76	2076/77	2077/78	2078/79	2079/80			2075/76	2076/77	2077/78	2078/79	2079/80
Koshi	Petrol	105,907	89,664	111,724	134,640	119,974	Lumbini	Petrol	94,648	88,724	109,652	128,252	102,878
	Diesel	298,545	130,088	89,024	92,388	247,425		Diesel	404,772	267,308	298,616	246,148	277,618
	Kerosene	4,780	2,760	4,168	3,796	2,676		Kerosene	5,660	2,900	5,860	4,204	3,645
	ATF	7,740	6,588	5,584	11,244	8,666		ATF	10,992	8,004	7,656	13,968	10,501
	LPG	72,534	78,059	88,169	97,961	91,619		LPG	82,587	93,577	117,009	137,978	117,537
Madhesh	Petrol	130,376	133,276	149,104	177,108	146,069	Karnali	Petrol	0	0	0	0	8,049
	Diesel	593,584	805,088	1,129,966	1,289,069	404,248		Diesel	0	0	0	0	24,207
	Kerosene	8,284	9,392	9,500	6,120	3,162		Kerosene	0	0	0	0	242
	ATF	0	0	0	-	1,336		ATF	0	0	0	0	1,165
	LPG	265,060	267,522	259,376	284,575	290,282		LPG	0	0	0	0	0
Bagmati	Petrol	184,624	153,620	165,308	226,360	230,336	Sudurpashchim	Petrol	20,632	20,484	26,232	30,176	26,733
	Diesel	260,496	144,688	52,580	-	272,185		Diesel	84,448	76,564	95,088	95,952	82,416
	Kerosene	4,620	2,940	3,400	2,840	2,478		Kerosene	660	592	656	380	356
	ATF	175,056	118,264	56,060	125,008	146,393		ATF	2,440	1,748	1,664	3,668	3,182
	LPG	0	0	0	-	-		LPG	9,429	9,905	13,198	15,514	15,278

Province	Petroleum Product	Fiscal Year					Province	Petroleum Product	Fiscal Year				
		2075/76	2076/77	2077/78	2078/79	2079/80			2075/76	2076/77	2077/78	2078/79	2079/80
Gandaki	Petrol	30,640	26,360	29,680	39,740	38,722							
	Diesel	73,060	49,800	30,928	-	73,227							
	Kerosene	1,000	340	0	-	919							
	ATF	3,880	2,820	1,300	3,240	3,639							
	LPG	0	0	0	-	-							

['0'or '-' in the above table indicates no records of sales with the NOC]

(Source: NOC 2023)

Table XIX: Changes in petroleum imports and sales from FY 2078/79 to FY 2079/80

Petroleum Fuel	Imports			Sales		
	FY 2078/79	FY 2079/80	% change	FY 2078/79	FY 2079/80	% change
Petrol	736,276	675,492	-8.61%	730,488	672,761	-8.23%
Diesel	1,723,557	1,382,978	-21.93%	1,727,571	1,381,325	-22.27%
Kerosene	17,340	12,951	-28.98%	17,797	13,478	-27.61%
ATF	157,128	173,472	9.89%	154,078	174,882	12.65%
LPG	536,028	514,717	-4.06%	536,028	514,717	-4.06%
Furnace Oil	51,385	38,339	-29.08%	51,385	38,339	-29.08%

I. Consumption Tables of Past Fiscal Years

(1 TOE = 41.868 GJ | 1000 GJ = 0.28 GWh)

Table XX: Energy Consumption of FY 2075/76 (2019)

Category	Fuel Type	Energy (000 GJ)	000 TOE	GWh	% of National Total
Traditional	Fuelwood	365,088.96	8,720.00	102,224.91	62.03%
	Agricultural residues	18,045.11	431.00	5,052.63	3.07%
	Cow dung	18,840.60	450.00	5,275.37	3.20%
	Total	**401,974.67**	**9,601.00**	**112,552.91**	**68.30%**
Commercial	Coal	40,780.08	974.02	11,418.42	6.93%
	Petrol	18,735.01	447.48	5,245.80	2.93%
	Diesel	63,604.81	1,519.17	17,809.35	9.94%
	Kerosene	889.87	21.25	249.16	0.14%
	LPG	19,605.69	468.27	5,489.59	3.06%
	ATF	6,306.28	150.62	1,765.76	0.99%
	Furnace Oil	1,221.93	29.19	342.14	0.19%
	Total	**151,143.67**	**3,610.00**	**42,320.23**	**25.68%**
	Grid Electricity	**22,864.38**	**546.11**	**6,402.03**	**3.57%**
Renewable	Biogas	8,174.99	195.26	2,289.00	1.28%
	Wind	1.04	0.02	0.29	0.0002%
	Micro/Pico Hydro	325.94	7.78	91.26	0.05%
	Solar	4,080.09	97.45	1,142.43	0.64%
	Total	**12,582.06**	**300.52**	**3,522.98**	**2.14%**
Total		***588,564.78***	***14,057.63***	***164,798.14***	***100%***

(Source: Energy Synopsis Report, 2022)

Table XXI: Energy Consumption of FY 2076/77 (2020)

Category	Fuel Type	Energy (000 GJ)	000 TOE	GWh	% of National Total
Traditional	Fuelwood	366,847.42	8,762.00	102,717.28	64.87%
	Agricultural residues	18,254.45	436.00	5,111.25	3.23%
	Cow dung	17,877.64	427.00	5,005.74	3.16%
	Total	**402,979.51**	**9,625.00**	**112,834.26**	**71.26%**
Commercial	Coal	43,203.07	1,031.89	12,096.86	7.64%
	Petrol	14,473.37	345.69	4,052.54	2.26%
	Diesel	41,104.14	981.76	11,509.16	6.42%
	Kerosene	681.51	16.28	190.82	0.11%
	LPG	20,493.49	489.48	5,738.18	3.20%
	ATF	4,369.79	104.37	1,223.54	0.68%
	Furnace Oil	373.99	8.93	104.72	0.06%
	Total	**124,699.36**	**2,978.39**	**34,915.82**	**22.05%**
	Grid Electricity	**23,200.05**	**554.12**	**6,496.01**	**3.63%**
Renewable	Biogas	10,140.70	242.21	2,839.40	1.58%
	Wind	1.42	0.03	0.40	0.0002%
	Micro/Pico Hydro	435.89	10.41	122.05	0.07%
	Solar	4,080.09	97.45	1,142.43	0.64%
	Total	**14,658.10**	**350.10**	**4,104.27**	**2.59%**
Total		***565,537.02***	***13,507.62***	***158,350.37***	***100%***

(Source: Energy Synopsis Report, 2022)

Table XXII: Energy Consumption of FY 2077/78 (2021)

Category	Fuel Type	Energy (000 GJ)	000 TOE	GWh	% of National Total
Traditional	Fuelwood	377,790.36	9,023.37	105,781.30	60.38%
	Agricultural residues	18,782.36	448.61	5,259.06	3.00%
	Cow dung	17,967.02	429.13	5,030.77	2.87%
	Total	**414,539.74**	**9,901.11**	**116,071.13**	**66.26%**
Commercial	Coal	58,445.58	1,395.95	16,364.76	9.34%
	Petrol	19,560.86	467.20	5,477.04	3.06%
	Diesel	63,465.44	1,515.85	17,770.32	9.92%
	Kerosene	831.03	19.85	232.69	0.13%
	LPG	21,802.75	520.75	6,104.77	3.41%
	ATF	2,218.29	52.98	621.12	0.35%
	Furnace Oil	3,399.09	81.19	951.75	0.53%
	Total	**169,723.04**	**4,053.77**	**47,522.45**	**27.13%**
	Grid Electricity	**26,373.39**	**629.92**	**7,384.55**	**4.12%**
Renewable	Biogas	9,756.95	233.04	2,731.95	1.52%
	Wind	1.87	0.04	0.52	0.0003%
	Micro/Pico Hydro	514.96	12.30	144.19	0.08%
	Solar	4,759.67	113.68	1,332.71	0.74%
	Total	**15,033.45**	**359.07**	**4,209.37**	**2.40%**
Total		***625,669.62***	***14,943.86***	***175,187.49***	***100%***

(Source: Energy Synopsis Report, 2022)

Table XXIII: Energy Consumption of FY 2078/79 (2022)

Category	Fuel Type	Energy (000 GJ)	000 TOE	GWh	% of National Total
Traditional	Fuelwood	374,562.95	8,946.28	104,877.63	58.53%
	Agricultural residues	17,965.50	429.10	5,030.34	2.81%
	Cow dung	18,150.14	433.51	5,082.04	2.84%
	Total	**410,678.59**	**9,808.89**	**114,990.01**	**64.17%**
Commercial	Coal	58,148.22	1,388.85	16,281.50	9.09%
	Petrol	24,653.98	588.85	6,903.11	3.85%
	Diesel	66,079.60	1,578.28	18,502.29	10.33%
	Kerosene	640.68	15.30	179.39	0.10%
	LPG	24,657.27	588.93	6,904.04	3.85%
	ATF	5,392.72	128.80	1,509.96	0.84%
	Furnace Oil	1,834.45	43.82	513.65	0.29%
	Total	**181,406.91**	**4,332.83**	**50,793.94**	**28.35%**
	Grid Electricity	**31,766.40**	**758.73**	**8,894.59**	**4.96%**
Renewable	Biogas	10488.72	250.52	2,936.84	1.64%
	Wind	1.87	0.04	0.52	0.0003%
	Micro/Pico Hydro	539.97	12.90	151.19	0.08%
	Solar	5083.32	121.41	1,423.33	0.79%
	Total	**16113.88**	**384.87**	**4,511.89**	**2.52%**
Total		***639,965.79***	***15,285.32***	***179,190.42***	***100.00%***

(Source: Energy Synopsis Report, 2023)

J. Energy Shares

Table XXIV: Energy shares from 2075/76 to 2079/80

Energy Source	Unit	2075/76	2076/77	2077/78	2078/79	2079/80
Traditional biomass energy	Share in total	68.30%	71.26%	66.26%	64.17%	63.87%
Total renewable energy	Share in total	5.04%	6.42%	5.89%	7.48%	9.09%[11]
Imported energy	Share in total	27.5%	26.02%	28.71%	28.5%	27.04%[12]

K. Hydropower

Table XXV: Total Hydropower Capacity

Hydro Projects	Capacity(MW)
Operational Hydropower project	
Total Hydro (NEA)	583.16
Total Hydro (NEA subsidiary)	478.1
Total Hydro (IPPs)	1477.013
Total	2538.273
Under Construction	**Capacity(MW)**
With Financial Closure	
Total Hydro (NEA subsidiary)	573.367
Total Hydro (IPPs)	2500.342
Without Financial Closure	
Total Hydro (NEA subsidiary)	42
Total Hydro (IPPs)	2565.361
Sanjen	42.5
Tamakoshi - V	86.067
Total	5809.637
Planned and Proposed	**Capacity(MW)**
Total Hydropower plant	3572.4
Total sum	**11920.31**

Source: NEA Annual Report,2023

[11] Includes grid electricity without imported electricity

[12] Includes imported electricity

Table XXVI: Hydropower capacity by province

Province	DEVELOPER	PROJECTS	LOCATION	INSTALLED CAPACITY (kW)	PPA Date	COMMERCIAL OPERATION DATE
	Hydropower Projects (NEA's Subsidiary Companies)					
BAGMATI	Chilime Hydro Power Company Ltd.	Chilime	Rasuwa	22100	2054.03.11	2060.05.08
	Upper Tamakoshi Hydropower Ltd.	Upper Tamakoshi	Dolkha	456000	2067.09.14	2078.05.04

Province	DEVELOPER	PROJECTS	LOCATION	INSTALLED CAPACITY (kW)	PPA Date	COMMERCIAL OPERATION DATE
BAGMATI	National Hydro Power Company Ltd.	Indrawati III	Sindhupalchowk	7500	2054.09.15	2059.06.21
	Rairang Hydro Power Development Co. (P) Ltd.	Rairang Khola	Dhading	500	2059.08.27	2061.08.01
	Bhotekoshi Power Company Ltd.	Upper Bhotekoshi Khola	Sindhupalchowk	45000	2053.04.06	2057.10.11
	Himal Power Ltd.	Khimti Khola	Dolakha	60000	2052.10.01	2057.03.27
	Sanima Hydropower (Pvt.) Ltd.	Sunkoshi Small	Sindhupalchowk	2500	2058.07.28	2061.12.11
	Alliance Power Nepal Pvt.Ltd.	Chaku Khola	Sindhupalchowk	3000	2056.11.03	2062.03.01
	Unique Hydel Co. Pvt.Ltd.	Baramchi Khola	Sindhupalchowk	4200	2058.12.14	2063.09.27

	Thoppal Khola Hydro Power Co. Pvt. Ltd.	Thoppal Khola	Dhading	1650	2059.11.23	2064.07.13
	Kathmandu Small Hydropower Systems Pvt. Ltd.	Sali Nadi	Kathmandu	250	2062.04.24	2064.08.01
	Centre for Power Dev. And Services (P.) Ltd.	Upper Hadi Khola	Sindhupalchowk	991	2064.04.07	2066.07.22
	Laughing Buddha Power Nepal (P.) Ltd.	Middle Chaku	Sindhupalchowk	1800	2066.11.03	2069.11.15
	Laughing Buddha Power Nepal Pvt. Ltd.	Lower Chaku Khola	Sindhupalchowk	1800	2063.07.02	2070.04.24
	Bhairabkunda Hydropower Pvt. Ltd.	Bhairab Kunda	Sindhupalchowk	3000	2065.08.02	2071.02.22
	Electro-com and Research Centre Pvt. Ltd.	Jhyadi Khola	Sindhupalchowk	2000	2067.01.30	2073.05.31
	Century Energy Pvt. Ltd.	Hadi Khola Sunkoshi A	Sindhupalchowk	997	2074.05.05	2077.05.12
	Shiva Shree Hydropower (P.) Ltd.	Upper Chaku A	Sindhupalchowk	22200	2067.05.22	2078.02.01
	Balephi Hydropower Limited (Prv. Huaning Development Pvt. Ltd.)	Upper Balephi A	Sindhupalchowk	36000	2072.08.29	2079.08.06
	Aadishakti Power Dev. Company (P.) Ltd.	Tadi Khola (Thaprek)	Nuwakot	5000	2061.12.15	2069.12.14
	Buddha Bhumi Nepal Hydro Power Co. Pvt. Ltd.	Lower Tadi	Nuwakot	4993	2070.12.10	2078.12.10
	Ankhu Khola Jal Bidhyut Co. (P.) Ltd.	Ankhu Khola 1	Dhading	8400	2066.02.22	2070.05.05

	Prime Hydropower Co. Pvt. Ltd.	Belkhu	Dhading	518	2064.04.04	2071.12.30
	Nepal Hydro Developer Pvt. Ltd.	Charanawati Khola	Dolakha	3520	2067.01.13	2070.02.24
	Kutheli Bukhari Small Hydropower (P).Ltd	Suspa Bukhari	Dolakha	998	2069.04.32	2072.06.03
	Dronanchal Hydropower Co.Pvt.Ltd	Dhunge-Jiri	Dolakha	600	2068.09.25	2074.06.01
	Manakamana Engineering Hydropower Pvt. Ltd.	Ghatte Khola	Dolakha	5000	2070.04.28	2077.07.23
	Singati Hydro Energy Pvt. Ltd.	Singati Khola	Dolakha	25000	2070.07.27	2078.04.17
	Universal Power Company Ltd.	Lower Khare	Dolakha	11000	2069.10.22	2078.09.06
	Khani Khola Hydropower Company Pvt. Ltd.	Tungun-Thosne	Lalitpur	4360	2069.04.05	2073.07.09
	Khani Khola Hydropower Company Pvt. Ltd.	Khani Khola	Lalitpur	2000	2069.04.05	2073.08.20
	Mandu Hydropower Ltd.	Bagmati Khola Small	Makawanpur/ Lalitpur	22000	2069.10.07	2075.12.19
	Syauri Bhumey Micro Hydro Project	Syauri Bhumey	Nuwakot	23	2072.11.16	2074.10.18
	Aadishakti Power Dev. Company (P.) Ltd.	Tadi Khola (Thaprek)	Nuwakot	5000	2061.12.15	2069.12.14
	Buddha Bhumi Nepal Hydro Power Co. Pvt. Ltd.	Lower Tadi	Nuwakot	4993	2070.12.10	2078.12.10
	Chilime Hydro Power Company Ltd.	Chilime	Rasuwa	22100	2054.03.11	2060.05.08

	Mailung Khola Hydro Power Company (P.) Ltd.	Mailung Khola	Rasuwa	5000	2058.04.09	2071.03.19
	Chilime Hydro Power Company Ltd.	Sanjen	Rasuwa	42500		
		Tamakoshi V	Dolakha	86067		
KOSHI	Himal Dolkha Hydropower Company Ltd.	Mai Khola	Ilam	4500	2063.11.19	2067.10.14
	Joshi Hydropower Development Company Limited	Upper Puwa -1	Illam	3000	2066.01.23	2071.10.01
	Sanima Mai Hydropower Limited	Mai Khola	Ilam	22000	2067.01.08	2071.10.14
	Sanima Mai Hydropower Ltd.	Mai Cascade	Ilam	7000	2069.10.12	2072.10.29
	Panchakanya Mai Hydropower Ltd. (Previously Mai	Upper Mai Khola	Ilam	9980	2061.12.19	2073.03.09
	Sanvi Energy pvt. Ltd.	Jogmai	Ilam	7600	2069.08.07	2074.01.18
	Mai Valley Hydropower Private Limited	Upper Mai C	Ilam	5100	2068.12.23	2074.04.09
	Puwa Khola-1 Hydropower P. Ltd.	Puwa Khola -1	Ilam	4000	2070.10.09	2074.06.23
	Himal Dolkha Hydropower Company Ltd.	Mai sana Cascade	Ilam	8000	2069.11.14	2074.12.26
	Super Mai Hydropower Pvt. Ltd.	Super Mai	Illam	7800	2073.12.06	2075.07.11
	Sagarmatha Jalabidhyut Company Pvt. Ltd.	Super Mai 'A'	Illam	9600	2074.11.14	2077.02.32

	Mai Khola Hydropower Pvt. Ltd.	Super Mai Cascade	Illam	3800	2074.12.07	2077.03.31
	Samling Power Company Pvt. Ltd.	Mai Beni	Illam	9510	2073.07.26	2078.06.01
	Asian Hydropower Pvt. Ltd.	Lower Jogmai	Illam	6200	2074.12.07	2078.07.15
	People's Power Limited	Puwa 2	Illam	4960	2074.05.05	2079.08.12
	Eastern Hydropower Pvt. Ltd.	Pikhuwa Khola	Bhojpur	5000	2066.07.24	2076.02.27
	Taksar-Pikhuwa Hydropower Pvt. Ltd.	Taksar Pikhuwa	Bhojpur	8000	2073.09.01	2078.01.01
	Leguwa Khola Laghu Jalbidhyut Sahakari Sastha Ltd.	Leguwa Khola	Dhankuta	40	2072.11.21	2075.03.28
	Sapsu Kalika Hydropower Co. Pvt. Ltd.	Miya Khola	Khotang	996	2069.08.10	2073.09.03
	Rawa Energy Development Pvt. Ltd.	Upper Rawa	Khotang	3000	2073.04.24	2077.06.04
	Three Star Hydropower Company Ltd.	Sapsup Khola	Khotang	6600	2075.03.25	2078.09.23
	Molung Hydropower Company Pvt. Ltd.	Molung Khola	Okhaldhunga	7000	2069.11.21	2074.12.12
	Panchthar Power Company Pvt. Ltd.	Hewa Khola A	Panchthar	14900	2068.05.30	2073.10.22
	Mountain Hydro Nepal Pvt. Ltd.	Tallo Hewa Khola	Panchthar	22100	2071.04.09	2076.04.21
	Arun Valley Hydropower Development Company Ltd.	Kabeli B-1 Cascade	Panchthar	9940	2075.08.09	2078.12.12

	Khoranga Khola Hydropower Dev. Co. Pvt. Ltd.	Pheme Khola	Panchthar	995	2057.12.31	2064.08.05
	Garjang Upatyaka Hydropower (P.) Ltd.	Chake Khola	Ramechhap	2830	2065.11.06	2074.08.28
	Green Ventures Pvt. Ltd.	Likhu-IV	Ramechhap	52400	2067.10.19	2078.07.21
	Himalaya Urja Bikas Co. Pvt. Ltd.	Upper Khimti	Ramechhap	12000	2067.10.09	2079.02.04
	Himalaya Urja Bikas Co. Ltd.	Upper Khimti II	Ramechhap	7000	2069.12.09	2079.02.17
	Swet-Ganga Hydropower and Construction Ltd.	Lower Likhu	Ramechhap	28100	2073.09.14	2079.07.19
	Arun Valley Hydropower Development Co. (P.) Ltd.	Piluwa Khola Small	Sankhuwasabha	3000	2056.10.09	2060.06.01
	Baneswor Hydropower Pvt. Ltd.	Lower Piluwa Small	Sankhuwasabha	990	2064.07.21	2068.04.01
	Barun Hydropower Development Co. (P.) Ltd.	Hewa Khola	Sankhuwasabha	4455	2061.04.02	2068.04.17
	Dibyaswari Hydropower Limited	Sabha Khola	Sankhuwasabha	4000	2068.11.17	2074.06.02
	Upper Hewa Khola Hydropower Co. Pvt. Ltd.	Upper Hewa Khola Small	Sankhuwasabha	8500	2072.09.23	2078.12.19
	Menchhiyam Hydropower Pvt. Ltd.	Upper Piluwa Khola 2	Sankhuwasabha	4720	2072.05.11	2079.11.22
	Maya Khola Hydropower Co. Pvt. Ltd.	Maya Khola	Sankhuwasabha	14900	2070.08.30	2080.03.22
	Upper Solu Hydroelectric Company Pvt. Ltd	Solu Khola	Solukhumbu	23500	2070.07.24	2078.11.08

	Mid Solu Hydropower Company Pvt. Ltd.	Mid Solu Khola	Solukhumbu	9500	2075.04.21	2079.09.15
	Hydro Venture Private Limited	Solu Khola (Dudhkoshi)	Solukhumbu	86000	2071.11.13	2079.11.17
	Beni Hydropower Project Pvt. Ltd.	Upper Solu	Solukhumbu	18236	2069.09.16	2080.03.01
	Numbur Himalaya Hydropower Pvt. Ltd.	Likhu Khola A	Solukhumbu Ramechap	24200	2071.11.22	2078.10.25
	Shibani Hydropower Co. Pvt. Ltd.	Phawa Khola	Taplejung	4950	2063.12.01	2074.07.14
	Chimal Gramin Bidhyut Sahakari Sanstha Ltd.	Sobuwa Khola-2 MHP	Taplejung	90	2074.11.15	2075.07.14
	Rairang Hydropower Development Company Ltd.	Iwa Khola	Taplejung	9900	2070.01.29	2076.06.20
	Arun Kabeli Power Ltd.	Kabeli B-1	Taplejung, Panchthar	25000	2069.03.29	2076.07.23
	Terhathum Power Company Pvt. Ltd.	Upper Khorunga	Terhathum	7500	2073.07.29	2076.11.17
MADHESH	*No Projects*					
GANDAKI	Syange Electricity Company Limited	Syange Khola	Lamjung	183	2058.10.03	2058.10.10
	Butwal Power Company Ltd.	Andhi Khola	Syangza	9400	2058.03.29	2071.12.22
	Khudi Hydropower Ltd.	Khudi Khola	Lamjung	4000	2058.03.04	2063.09.15
	Unified Hydropower (P.) Ltd.	Pati Khola Small	Parbat	996	2062.10.28	2065.10.27

	Task Hydropower Company (P.) Ltd.	Seti-II	Kaski	979	2063.06.08	2065.11.14
	Gandaki Hydro Power Co. Pvt. Ltd.	Mardi Khola	Kaski	4800	2060.07.07	2066.10.08
	Bhagawati Hydropower Development Co. (P.) Ltd.	Bijayapur-1	Kaski	4410	2066.03.30	2069.05.04
	Mandakini Hydropower Limited	Sardi Khola	Kaski	4000	2068.11.11	2074.08.23
	Sikles Hydropower Pvt. Ltd.	Madkyu Khola	Kaski	13000	2066.08.03	2074.12.19
	United Idi Mardi and R.B. Hydropower Pvt. Ltd.	Upper Mardi	Kaski	7000	2073.02.25	2076.06.20
	Himalayan Hydropower Pvt. Ltd.	Namarjun Madi	Kaski	11880	2066.05.30	2077.06.12
	Civil Hydropower Pvt. Ltd.	Bijayapur 2 Khola Small	Kaski	4500	2072.09.12	2077.11.18
	Saidi Power Co. (Pvt.) Ltd.	Saiti Khola	Kaski	999	2077.06.13	2079.07.01
	Super Madi Hydropower Ltd. (Previously Himal Hydro and General Construction Ltd.)	Super Madi	Kaski	44000	2073.10.27	2079.12.27
	Syange Electricity Company Limited	Syange Khola	Lamjung	183	2058.10.03	2058.10.10
	Khudi Hydropower Ltd.	Khudi Khola	Lamjung	4000	2058.03.04	2063.09.15
	Nyadi Group (P.) Ltd.	Siuri Khola	Lamjung	4950	2064.04.17	2069.07.30
	Radhi Bidyut Company Ltd.	Radhi Khola	Lamjung	4400	2066.10.18	2071.02.31
	Chhyangdi Hydropower Limited	Chhandi	Lamjung	2000	2068.12.23	2072.12.13

	Sinohydro-Sagarmatha Power Company (P) Ltd.	Upper Marsyangdi "A"	Lamjung	50000	2067.09.14	2073.09.17
	Union Hydropower Pvt Ltd.	Midim Karapu	Lamjung	3000	2069.10.28	2074.10.15
	Deurali Bahuudesiya Sahakari Sanstha Ltd.	Midim Khola	Lamjung	100	2070.02.20	2075.09.04
	Chhyangdi Hydropower Limited	Upper Chhyangdi Khola	Lamjung	4000	2074.03.22	2078.08.24
	Upper Syange Hydropower P. Ltd.	Upper Syange Khola	Lamjung	2400	2072.06.14	2078.11.15
	Nyadi Hydropower Limited	Nyadi	Lamjung	30000	2072.02.12	2079.01.27
	Himalayan Power Partner Pvt. Ltd.	Dordi Khola	Lamjung	27000	2069.03.01	2079.06.14
	Dordi Khola Jal Bidyut Company Ltd.	Dordi-1 Khola	Lamjung	12000	2071.07.19	2079.06.14
	Aashutosh Energy Pvt. Ltd.	Chepe Khola Small	Lamjung	8630	2075.02.15	2079.06.16
	Liberty Hydropower Pvt. Ltd.	Upper Dordi A	Lamjung	25000	2069.06.02	2079.08.17
	Peoples' Hydropower Company Pvt. Ltd.	Super Dordi 'Kha'	Lamjung	54000	2071.11.13	2080.02.08
	Bindhyabasini Hydropower Development Co. (P.) Ltd.	Rudi Khola A	Lamjung and Kaski	8800	2069.10.28	2075.12.04
	Bindhyabasini Hydropower Development Co. (P.) Ltd.	Rudi Khola B	Lamjung and Kaski	6600	2071.4.20	2076.11.05
	Pashupati Environmental Eng. Power Co. Pvt. Ltd.	Chhote Khola	Gorkha	993	2067.11.09	2071.03.09

	Daraudi Kalika Hydro Pvt. Ltd.	Daraudi Khola A	Gorkha	6000	2068.05.19	2073.08.13
	Sayapatri Hydropower Private Limited	Daram Khola A	Baglung	2500	2068.12.19	2073.03.12
	Barahi Hydropower Pvt.ltd	Theule Khola	Baglung	1500	2066.12.16	2075.03.24
	Mount Kailash Energy Pvt. Ltd.	Thapa Khola	Myagdi	13600	2067.10.11	2074.08.22
	Ghalemdi Hydro Limited (Previously, Cemat Power Dev Company (P). Ltd.)	Ghalemdi Khola	Myagdi	5000	2069.12.30	2076.11.05
	Mountain Energy Nepal Ltd. (Previously Robust Energy Pvt. Ltd.)	Mistri Khola	Myagdi	42000	2067.10.20	2078.03.03
	United Modi Hydropower Pvt. Ltd.	Lower Modi 1	Parbat	10000	2065.10.20	2069.08.10
	Modi Energy Ltd. (Prv. Manang Trade Link Pvt. Ltd.)	Lower Modi	Parbat	20000	2068.05.20	2078.06.14
	Middle Modi Hydropower Ltd.	Middle Modi	Parbat	15100	2069.08.21	2079.09.07
	Butwal Power Company Ltd.	Andhi Khola	Syangza	9400	2058.03.29	2071.12.22
LUMBINI	Ridi Hydropower Development Co. (P.) Ltd.	Ridi Khola	Gulmi	2400	2063.05.08	2066.07.10
	Ruru Hydropower Project (P) Ltd.	Upper Hugdi Khola	Gulmi	5000	2066.04.04	2071.12.09
	Gautam Buddha Hydropower (Pvt.) Ltd.	Sisne Khola Small	Palpa	750	2061.04.29	2064.06.01
	Rapti Hydro and General Construction Pvt. Ltd.	Rukumgad	Rukum	5000	2073.03.07	2079.12.28

KARNALI	Bhugol Energy Dev Company (P). Ltd	Dwari Khola	Dailekh	3750	2069.12.30	2074.01.23
	Dolti Power Company Pvt. Ltd.	Padam Khola	Dailekh	4800	2074.08.01	2076.09.08
Sudurpashchim	Api Power Company Pvt. Ltd.	Naugadhgad Khola	Darchula	8500	2067.01.19	2072.05.02
	Api Power Company Pvt. Ltd.	Upper Naugad Gad	Darchula	8000	2073.07.12	2076.07.13
	Makari Gad Hydropower Pvt. Ltd.	Makarigad	Darchula	10000	2072.08.29	2079.11.27
	Rangoon Khola Hydropower Pvt. Ltd.	Jeuligad	Bajhang	996	2071.10.20	2076.08.27
	Kalanga Hydro Pvt. Ltd.	Kalangagad	Bajhang	15330	2072.03.15	2079.10.27
	Sanigad Hydro Pvt. Ltd.	Upper Kalangagad	Bajhang	38460	2072.03.15	2079.11.06
	Salmanidevi Hydropower (P). Ltd	Kapadi Gad	Doti	3330	2069.12.11	2076.02.25

Source: NEA Annual Report,2023

Table XXVII: Electricity Distribution System Data F/Y 2079/80

S.No.	Provincial Office	Number of 33/11 kV Substation	Substation Capacity (MVA)	Line Length (circuit km)			Distribution Transformers	
				33kV	11KV	0.4/0.23 kV	Quantity	Capacity (MVA)
1	Koshi PO	35	531.7	1,119.70	9,673.77	26,357.95	7,846	764.91
2	Madesh PO	26	418.7	773.04	6,851.03	23,271.59	6,577	641.19
3	Bagmati PO	22	162.6	537.4	7,481.16	24,829.51	8,380	816.97
4	Bagmati DO	9	103.8	253.46	3,324.62	8,870.38	2,897	282.43
5	Gandaki PO	24	212	769.8	5,483.32	14,053.47	3,916	381.77
6	Lumbini PO	23	340.4	1,384.26	4,417.11	13,895.89	4,352	424.28
7	Lumbini DO	13	178.2	1,227.37	3,418.10	11,424.12	3,016	294.03
8	Karnali PO	11	54.5	468	3,074.42	7,238.14	1,865	181.82
9	Sudurpashchim PO	24	202	703.69	4,008.99	15,328.98	3,336	325.23
F/Y 2079/080 Total		**187**	**2,204**	**7,237**	**47,733**	**145,270**	**42,185**	**4,113**

Source: NEA Annual Report,2023

L. Renewables

Table XXVIII: Renewable capacity according to province in kW

Province	Micro Hydro Projects	Solar Home System	Institutional Photovoltaic System	Solar Irrigation	Biogas	Total Renewable Capacity
Koshi	752	12.65	16.5	34.8	12746.965	13562.915
Madhesh	0	3.55	0	84	7283.98	7371.53
Bagmati	0	73.45	16.5	40.8	18290.745	18421.495
Gandaki	66	10.5	18	0	15723.95	15818.45
Lumbini	0	64.45	12	57.6	6351.73	6485.78
Karnali	135	414.05	106.5	20.4	2019.875	2695.825
Sudurpashchim	150.5	138.1	127.5	15.6	2678.665	3110.365
Total	**1103.5**	**716.75**	**297**	**253.2**	**65095.91**	**67466.36**

Source: AEPC Annual Report,2023

Table XXIX: Total Solar Energy Capacity

S No	Project	Capacity (MW)	Promoter	VDC/District
1	Solar Energy	0.68	Katthmandu Upatyaka Khanepani Byawasthapan Board	Bungamati (Lalitpur)
2	Bishnu Priya Solar Farm Project	1	Surya Power Company P. Ltd.	Ramnagar (Nawalparasi)
3	Grid-Connected Solar Power Project, Butwal , 33 kV S/S	8.5	Ridi Hydropower Development Company Ltd.	Butawal N.P. (Rupandehi)
4	Bel Chautara Solar Farm Project	5	Solar Farm Pvt. Ltd.	Khairenitar (Tanahu)
5	Mithila Solar PV Power Project, Dhanusa	10	Eco Power Development Pvt. Ltd	Begadawar (Dhanusha)
6	Som Radha Krishna Solar Farm Project (VGF)	4.4	Nepal Solar Farm Ltd.	Rupakot (Kaski)
7	Solar PV Pratappur, Grid Connected Solar PV (VGF), Nawalpara	5	National Solar Power Company PVt. Ltd.	Pratappur (Nawalparasi)
8	Chandranigahpur Solar Project	4	Api Power Company Pvt. Ltd	Chandranigahapur (Rautahat)
9	Grid Connected Solar PV Project, Ramgram, Nawalparasi	2	Saurya Bidhyut Power Pvt. Ltd	

10	Utility Scale Solar PV, Grid Connected Solar Project, Morang	6.8	G I Solar Pvt. Ltd,	Banigama (Morang)
11	Solar PV Project Banke, block-2	10	Pure Energy Ltd	Raniyapur (Banke)
12	Solar PV Project, Raniyapur, Block 1	10	Pure Energy Ltd	Raniyapur (Banke)
13	Solar Power Project, Dhalkebar 11 kV S/S	1	Api Power Company Ltd.	Dhalkebar (Dhanusha)
14	Lamahi Solar Project	3	Gorkha Congrnial Energy and Investment Pvt.Ltd	Dang
15	Duhabi Solar Project	8	Global Energy and Construction Pvt,Ltd	Sunari
16	Parwanipur Solar Project	8	Api power Company	Parsa
17	Solar PV Project (1032)	10	Pure Energy Pvt. Ltd	Banke
18	Bhrikuti Grid-tied Solar Project	8	First Solar Developers Nepal Pvt.Ltd	Kapilvastu
19	Saurya Bidyut Project	10	Jhapa Energy Limited	Jhapa
20	Grid Connected Solar Electricity Project	1.2	G.C Solar Energy Group Pvt. Ltd	Surkhet
21	Baigundhura Solar Power	5	East Solar Pvt. Ltd	Jhapa
Total		121.58		

Source: NEA Annual Report,2023

M. Energy Intensity

Table XXX: Final energy intensities (GJ per 1000 NRs value addition)

Year	GJ per 1000 NRs Value Addition
2075/76	0.28
2076/77	0.27
2077/78	0.29
2078/79	0.28
2079/80	0.11

Table XXXI: Per capita energy consumption (GJ per capita)

Year	Total Consumption	Residential Consumption
2075/76	20.62	13.27
2076/77	19.82	13.51
2077/78	21.92	13.86
2078/79	21.94	13.30
2079/80	18.26	11.09

Table XXXII: Agriculture, commercial, industrial, and residential energy intensity

Sector	Unit	2075/76	2076/77	2077/78	2078/79	2079/80
Agriculture	GJ per 1000 NRs	0.01	0.02	0.02	0.02	0.004
Industrial	GJ per 1000 NRs	0.76	0.78	0.97	0.91	0.18
Commercial	GJ per 1000 NRs	0.03	0.04	0.04	0.04	0.01

Table XXXIII: Electricity consumption

Parameter	Unit	2075/76	2076/77	2077/78	2078/79	2079/80
Electricity	kWh per 1000 NRs	3.08	3.20	3.52	3.63	2.30
	kWh per capita	228	232	265	305	370
Residential consumption	GJ per capita	13.27	13.51	13.86	13.30	11.09

Residential Electricity Consumption	kWh per HH	218	251	296	649	672.42

N. Progress in Achieving SDG-7 Goals

Table XXXIV: Energy goals and progress

SN	Targets	Baseline - 2015	Progress- 2019	Progress - 2023	Target - 2030
1	Proportion of population with access to electricity	74%	88%	98%	99%
2	Per capita energy (final) consumption (in gigajoules)	16	20.62	18.26	24
3	Households using solid fuel as primary source of energy for cooking (%)	74.7	68.6	45	30
4	People using liquid petroleum gas (LPG) for cooking and heating (%)	18	26.6	38	39
5	Electricity consumption (kWh per capita)	80	260	370	15000
6	Renewable energy share in the total final energy consumption	11.9%	5%	9.09%	50%
7	Installed capacity of hydropower (MW)	782	1250	2538.273	15000

O. Energy Conversion Table

Table XXXV: Energy conversion table

(unit)	MJ	TCE	cub m	btu	toe	boe	kWh	kwyr	kcal	TJ	Gcal	Mtoe	Mbtu	GWh	GWyr	PJ
MJ	1	3.41E-05	0.02684061	947.8672986	2.39E-05	0.0001751	0.277777778	3.17E-05	238.8459	0.000001	0.0002388	2.39E-11	0.0009479	2.78E-07	3.17E-11	1.00E-09
TCE	29307.6	1	786.633946	27779715.64	0.7	5.131	8141	0.9293379	7000000	0.0293076	7	0.0000007	27.779716	0.008141	9.29E-07	2.93E-05
cubm	37.256973	0.001271239	1	35314.66672	0.0008899	0.0065227	10.34915928	0.0011814	8898.6752	3.73E-05	0.0088987	8.90E-10	0.0353147	1.04E-05	1.18E-09	3.73E-08
btu	0.001055	3.60E-08	2.83E-05	1	2.52E-08	1.85E-07	0.000293056	3.35E-08	0.2519824	1.06E-09	2.52E-07	2.52E-14	0.000001	2.93E-10	3.35E-14	1.06E-12
toe	41868	1.428571429	1123.76278	39685308.06	1	7.33	11630	1.3276256	10000000	0.041868	10	0.000001	39.685308	0.01163	1.33E-06	4.19E-05
boe	5711.869	0.194893783	153.310066	5414093.869	0.1364256	1	1586.630286	0.1811222	1364256.5	0.005711869	1.3642565	1.36E-07	5.4140939	0.0015866	1.81E-07	5.71E-06
kWh	3.6	0.000122835	0.09662621	3412.322275	8.60E-05	0.0006303	1	0.0001142	859.84523	0.0000036	0.0008598	8.60E-11	0.0034123	0.000001	1.14E-10	3.60E-09
kwyr	31536	1.076034885	846.445568	29891943.13	0.7532244	5.521135	8760	1	7532244.2	0.031536	7.5322442	7.53E-07	29.891943	0.00876	0.000001	3.15E-05
kcal	0.0041868	1.43E-07	0.00011238	3.968530806	0.0000001	7.33E-07	0.001163	1.33E-07	1	4.19E-09	0.000001	1.00E-13	3.97E-06	1.16E-09	1.33E-13	4.19E-12
TJ	1000000	34.12084238	26840.6129	947867298.6	23.88459	175.07404	277777.7778	31.709792	238845897	1	238.8459	2.39E-05	947.8673	0.2777778	3.17E-05	0.001
Geal	4186.8	0.142857143	112.376278	3968530.806	0.1	0.733	1163	0.1327626	1000000	0.0041868	1	0.0000001	3.9685308	0.001163	1.33E-07	4.19E-06
Mtoe	4.19E+10	1428571.429	1123762780	3.97E+13	1000000	7330000	11630000000	1327625.6	1.00E+13	41868	10000000	1	39685308	11630	1.3276256	41,868
Mbtu	1055	0.035997489	28.3168466	1000000	0.0251982	0.1847031	293.0555556	0.0334538	251982.42	0.001055	0.2519824	2.52E-08	1	0.0002931	3.35E-08	1.06E-06
GWh	3600000	122.8350326	96626.2064	3412322275	85.984523	630.26655	1000000	114.15525	859845228	3.6	859.84523	8.60E-05	3412.3223	1	0.0001142	0.0036
GWyr	3.15E+10	1076034.885	846445568	2.99E+13	753224.42	5521135	8760000000	1000000	7.53E+12	31536	7532244.2	0.7532244	29891943	8760	1	31.536
PJ	1.00E+09	34120.84238	26840612.9	9.48E+11	23884.59	175074.04	277777777.8	31709.792	2.39E+11	1000	238845.9	0.0238846	947867.3	277.77778	0.0317098	1

MJ	Megajoule	kWh	kilowatt-hours	Mbtu	milliom bt
TCE	tons of coal equivalent	kWyr	kilowattyears	GWh	gigawatthours
Cub m	cubic meter	kcal	kilocalorie	GWyr	giiawattyear
Btu	British thermal unit	TJ	terajoule	PJ	petajoule
Toe	tones of oil equivalent	Gcal	gigacalorie		
Boe	barrels of oil equivalent	Mtoe	million toe		

P. Energy Calculations

Table XXXVI: Methodology

Fuel Type	Formula of Conversion
Firewood	◆ 1 chatta = 20x5x5 ft. (14.15 cu. m.) weighs 10.47 tons on average *(Subedi, et al., 2014)* ◆ 1 ton = 1000 kg ◆ Calorific value = 18 MJ/kg ◆ Energy = Total wood (kg) * Calorific value
Agriculture residue	◆ Total residue = Total production (kg) * Residue-to-product ratio ◆ Total energy = Total residue * Calorific value *(See Table XXXIII)*
Animal dung	◆ Total dung production per day = Dung production (in kg per head per day) * Total animal population ◆ Total collected dung per year = Total dung produced * collection factor (70%) * total days in year (365) ◆ Total usage for fuel = Total collected dung per year (kg) * utilization factor[13] ◆ Total energy = Total usage for fuel * calorific value (14.9 MJ/kg)
Solar	◆ Solar = kW * no. of hours (6.5) * no. of days (300)
Wind	◆ kW * no. of hours (7) * no. of days (300)
Biogas	◆ Size of plant * no. of plant * conversion factor
Micro/pico hydro	◆ kW * total hours

<u>Biogas Plant</u>

SN	Plant	Plant Size (m^3)				
1	Domestic Plant	2	4	6	8	10
2	Commercial Plant	35		4000		

[13]For this report, taken as 1%

Conversion factor = 0.25

Source: AEPC Data, 2024

Energy Calculation of Biogas

Capacity of total plant per day = Size of plant (m^3) * conversion factor * number of plant— *a*

According to AEPC data,

$1m^3$ = 22 MJ at NTP = 6.1kWh

<u>Example:</u> For 3 plants having the size of $2m^3$

Capacity of plants per day = 2*0.25*3 *(from equation a)* = 1.5 m^3 per day

Wehave,

$1m^3$ = 22 MJ at NTP = 6.1kWh

Therefore, 1.5 m^3 = 6.1 * 1.5 = 9.15 kWh per day

Table XXXVII: Calorific values of crops

Crop Residue	Residue to Product Ratio	Net Calorific Value ($MJkg^{-1}$)
Paddy Husks	0.36	16.57
Paddy Straws	1.97	15.80
Wheat Husks	0.82	17.46
Wheat Straws	1.46	17.46
Corn Stalks	2.12	15.44
Corn Cobs	0.28	15.57
Corn Ears	0.29	12.56
Millet Husks	0.14	12.56
Millet Straws	1.89	12.56

(Source: WECS, 2010; Adhikari & Denich, 2019)

Table XXXVIII: Calorific values of commercial resources

Fuel Type	Calorific Value (MJ)	
	per kg	per liter
Petrol	43.9	32.6
Diesel	42.8	36
Kerosene	43.2	35
ATF	43.1	35.4
Furnace Oil	43	35.7
LPG	46	
Biogas		20 MJ/m3*
Coal	23.8	
Anthracite	31.4	
Bituminous coal	29.3	
Sub-bituminous coal	18.8	
Lignite	31.4	
Peat	29.3	
Coke	28.5	
Briquettes	20.1	