

SAARC Webinar on “Demand Stimulation Techniques to Cater Likely Excess Electricity
Generation in Nepal”

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Presentation

on

**“Techniques to Absorb Excess Electricity Generation: Aligning Hydropower
Development with Socio-economic Development in Nepal”**

By:

Dinesh Kumar Ghimire

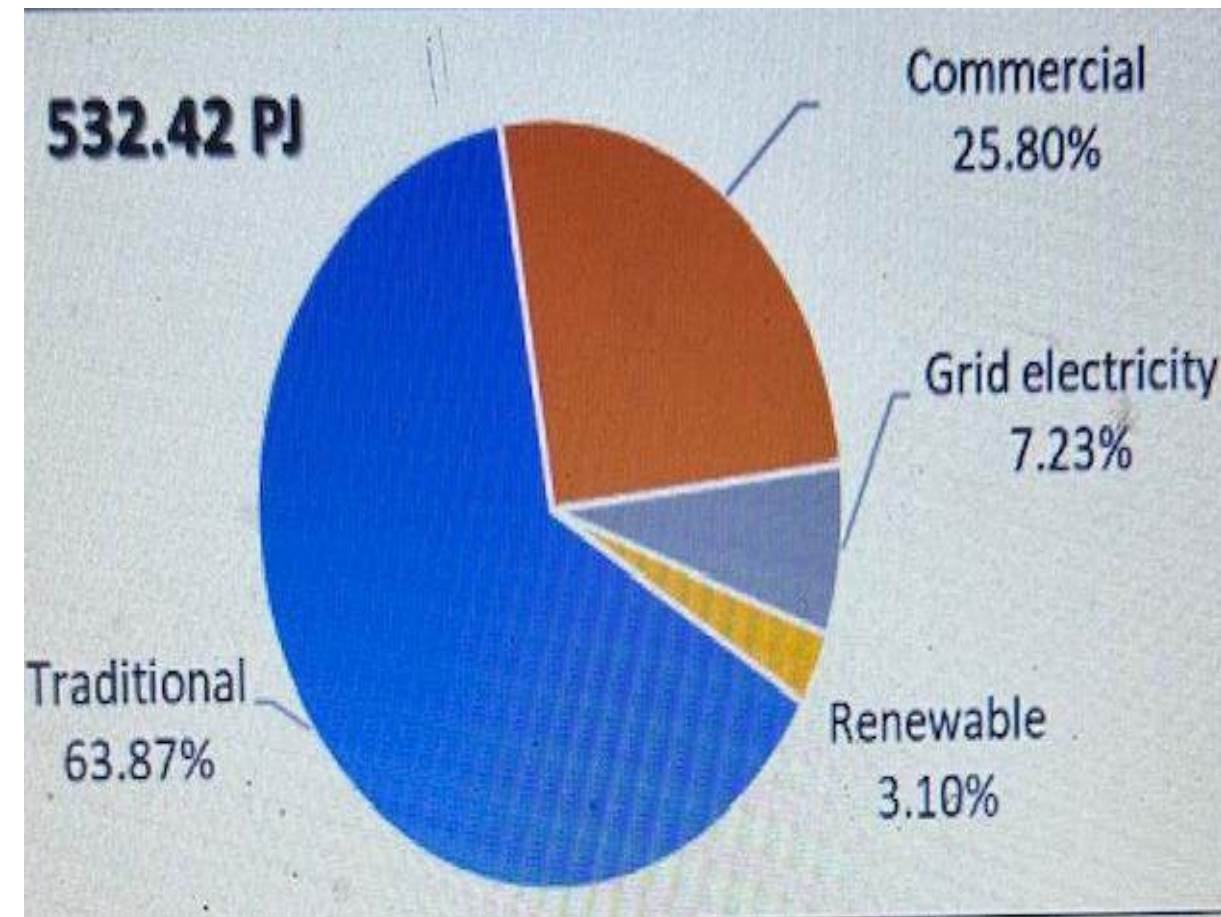
Former Secretary

Government of Nepal

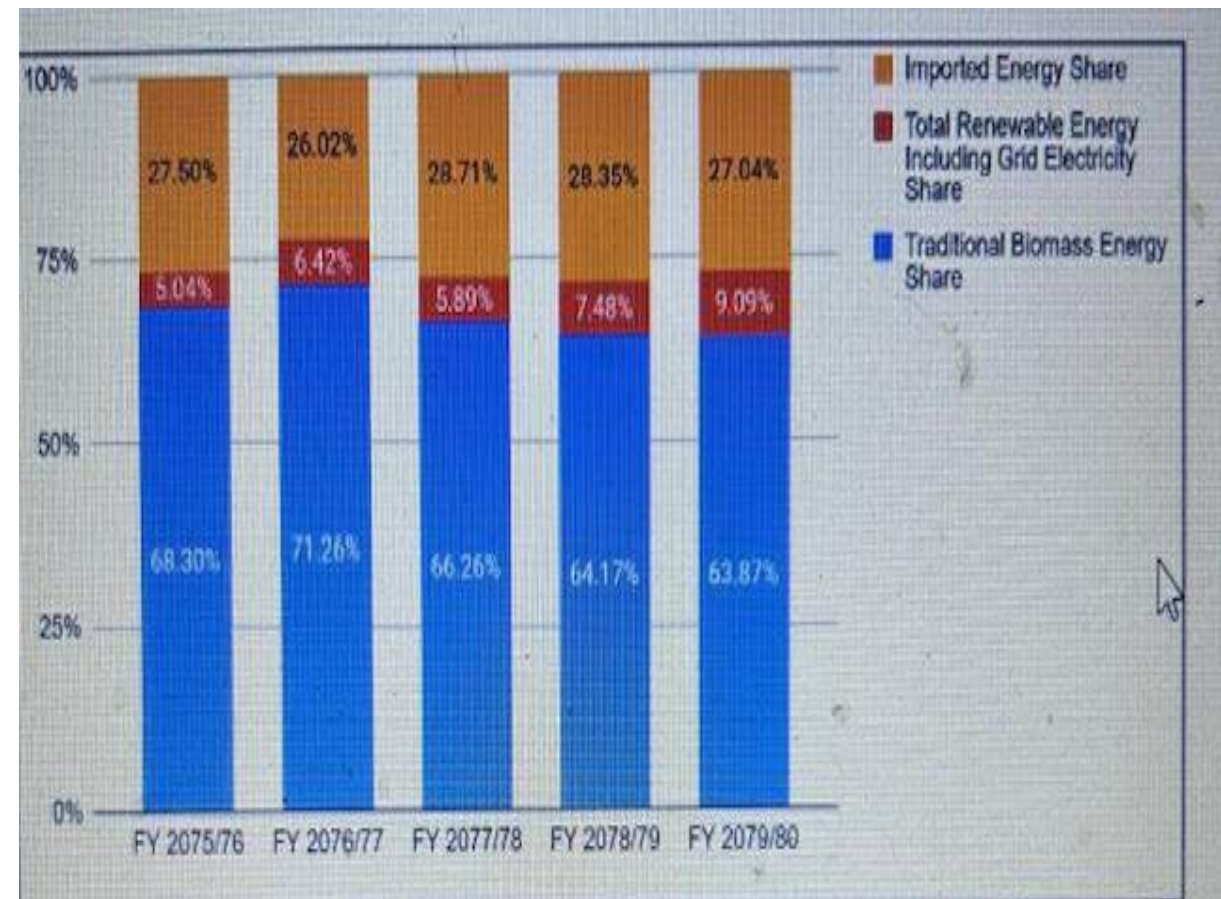
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Energy consumption mix and Energy share trend



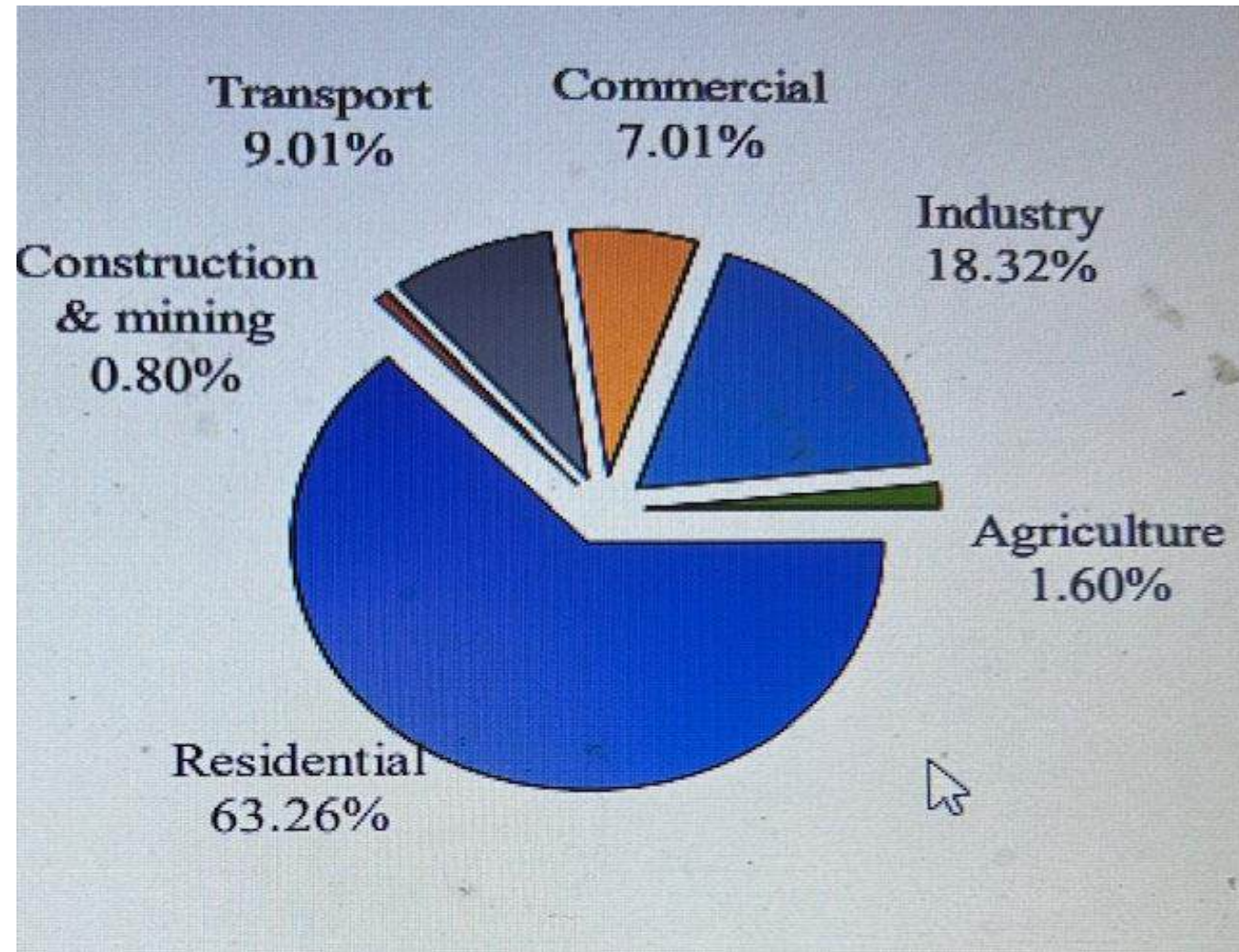
Source: Energy Sector Synopsis Report, 2024, WECS



Source: Energy Sector Synopsis Report, 2024, WECS

- Nepal's energy use strategy focuses on increasing the stake of renewables and grid electricity and decreasing the use of biomass and imported fossil fuels as the trend shows.
- The target to reduce the traditional biomass energy to 58.88% and increase the electrical energy to 38.62% and do away with imported fossil fuel by 2035.

Energy consumption- Sector wise

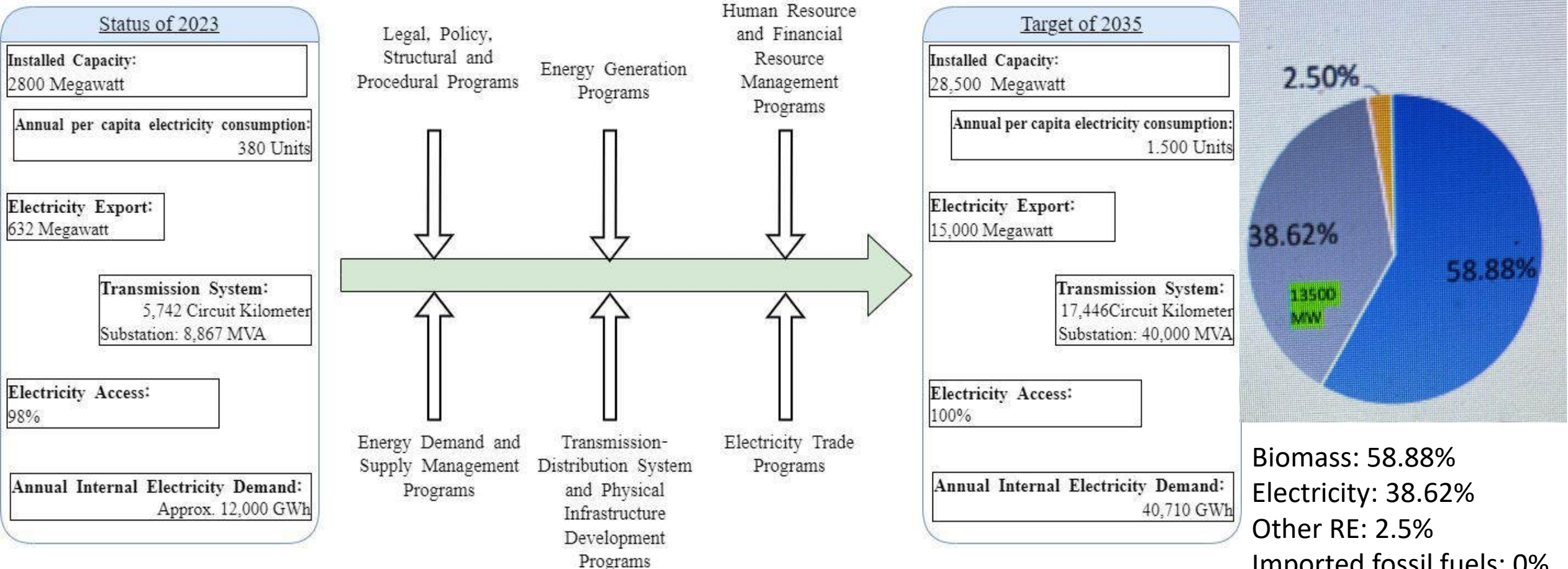


Source: Report on Electricity Demand Creation in Different Sectors, WECS, 2024

Nepal's power Scenario

- Electricity generation: Hydropower (98%), others : solar, diesel thermal etc. (2%)
- Techno-economically feasible potential at Q_{40} : 72544 MW(WECS's study, 2020)
- Annual System Peak Demand : 2467 MW (2023/24)
- Annual System Energy Demand : 14624 GWh (2023/24)
- Annual National Peak Demand : 2,212MW(2023/24)
- Annual National Energy Demand 12681 GWh (2023/24)
- Annual Load Factor: 65.56 %
- Installed capacity:3200 MW
- Total annual Exported Energy (2023/24): 1946 GWh
- Cumulative exported energy:
- Total exported power: upto 941 MW from 28 projects in the wet season (From June to November)
- Hydropower type: Majority with RoR/PRoR with only one Kulekhani storage (106 MW)
- Per capita electricity consumption: 420 Kilowatt-hours
- Electricity access to households: 98%, target for achieving 100% by end of the current FY 2024/24
- Projects under construction after Financial closure(FC): 4000 MW
- Projects with PPA signed and awaiting for FC: 3500 MW

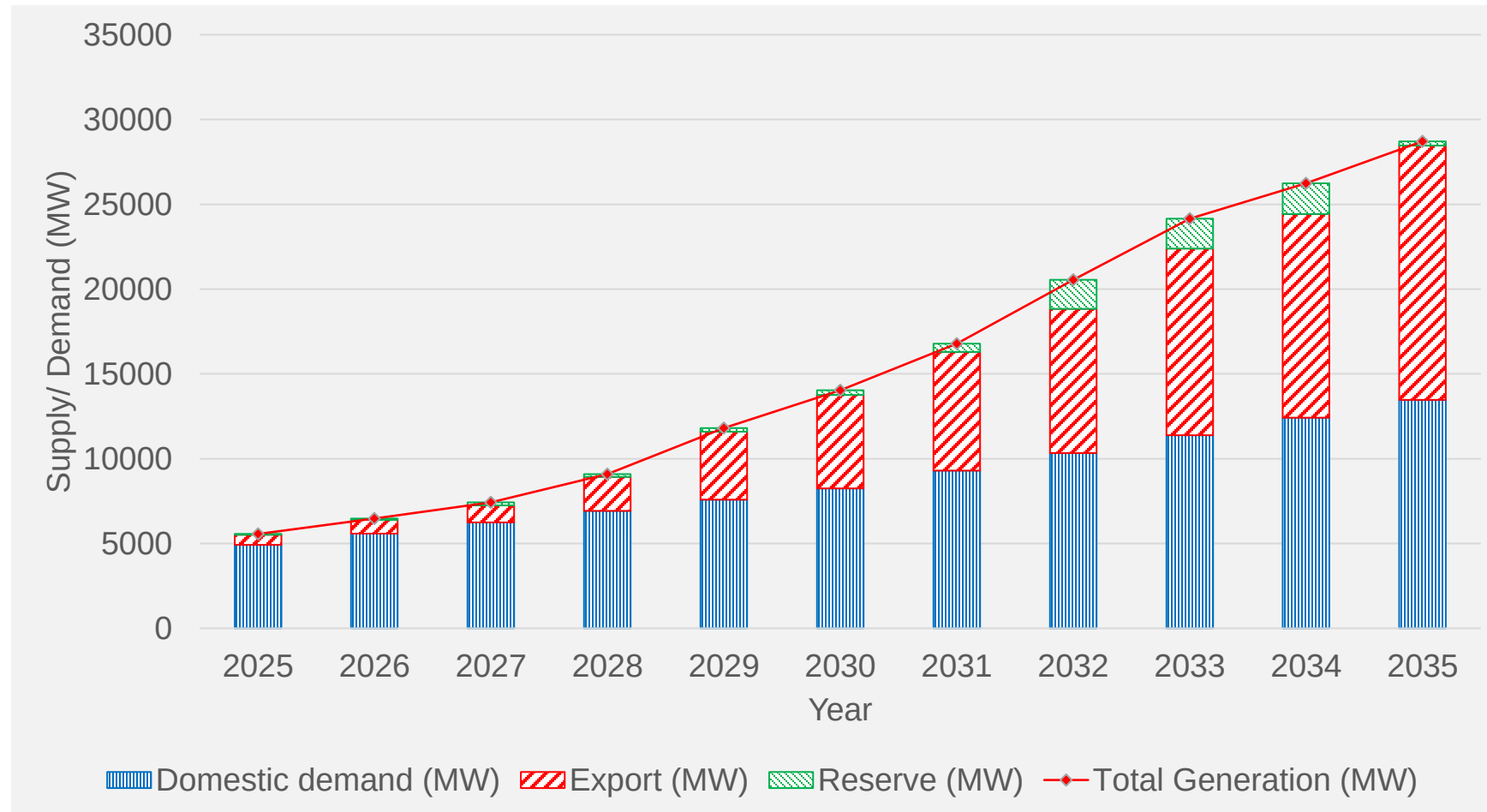
Energy Development Roadmap, 2023-2035



Source: energy Development Roadmap and Action plan, 2024, MoEWRI

Source: WECS, 2022

Domestic demand and excess generation scenario upto 2035



Source: energy Development Roadmap and Action plan, 2024, MoEWRI

Nepal's Renewable Energy Potential

Hydropower		Solar		Wind		
Sapta Koshi	27805 MW	Annual Sunny days	300 days		Height of 50m	Height of 100m
Sapta Gandaki	19803 MW					
Karnali Mahakali	20385 MW	Global Horizontal Irradiation (GHI) in North-West	5.5 kWh/m ² /day	Mean power density	542 W/m ²	521 W/m ²
Southern Rivers	4551 MW	Average daily GHI in South	4.4 to 4.9 kWh/m ²	Average wind speed	6.58 m/s	7.36 m/s
Techno economical potential of 72544 MW (source: WECS study, 2020)		Estimated Solar Energy Potential: 11.90 GW (Source: Solar & wind Energy Potential Assessment at Provincial level in Nepal: Geospatial and economic analysis. Renewable Energy Vol 181. Neupane D. et al 2022)		Estimated wind energy potential: 3 GW (Source: Solar & Wind energy resource assessment (SWERA) project, executed by AEPC, 2003)		

Identification of potential economic sectors for electrification aligned with socioeconomic needs and resource availability

- **Agricultural sector:**

- Over the past two decades, the agricultural industry has undergone notable changes in its electricity consumption
- Primary electricity consumption in the agricultural sector is mainly due to the usage of pumps for irrigation purposes
- Irrigated land from last 13 years showcasing a high increase in irrigation activities
- The NEA report for 2021-2022 highlights a substantial rise in electricity sales in water supply and irrigation, growing at a CAGR of 10.28% over the past decade.

- **Commercial sector:**

- The service sector is experiencing significant growth in electricity demand with a strong CAGR of about 13%,
- The share of electricity consumption within the service sector has doubled in last twenty years.

The electricity consumption in the commercial sector especially in cooking is increasing rapidly.

- **Industrial sector**

- Significant increase in industrial electricity demand and electricity consumption in the last 20 years i.e 521 GWh in 2001 to 2823 GWh in 2021
- Industrial motive power, which includes motors, pumps, and compressors, is currently the most electricity-consuming technology in industries

- **Residential sector**

- Notably, there has been a significant surge in electricity consumption among households, especially as the primary source for cooking purposes.
- Over the past decade, the number of households relying on electricity for cooking has experienced substantial growth, surpassing the increase in households using LPG for cooking.
- Residential Electricity Demand (GWh) increased from 518.4 GWh in 2001 to 3241.2 GWh in 2021 with CAGR of 9.60%
- Priority end use for residential sector might be electric cooking.

- **Transport sector**

The electricity demand in the transport sector has been experiencing a decline in the last 20 years which can be attributed to historical factors like use of trolley buses, electric cables cars, and ropeways for electricity consumption.

However, due to policy intervention by the government to electrify the transport sector, it is expected to achieve a very electricity consumption for charging of electric vehicles

- **Construction and mining sector**

The electricity demand grew only marginally over the last 20 years i.e from 0.83 GWh to 1.47 GWh in 2021.

But due to the availability of numerous electrification options, which have driven the sector's increased reliance on electricity, the electricity demand is expected to leap frog in this sector.

Electricity consumption plan and strategies

- Domestic consumption to be increased to 13500 MW by 2035.
- Export to be increased to 15000 MW (10000 MW to India and 5000 MW to Bangladesh) by 2035
- To use 13000 MW by 2035:
 - Develop sufficient T & D infrastructure
 - Complete 100% electrification
 - Electrify economic sectors: Agriculture, Transportation (Charging stations), commercial, domestic (clean cooking), industry(including hydrogen), construction and mining etc.
 - If generation is surplus at any time until these things are done, increase export. If domestic consumption increases, reduce export.
 - For export, develop sufficient cross border lines jointly with neighboring countries and develop in-country lines from the projects up to the border points together with 400 KV east-west electric highway.
- To export 15000 MW to India and Bangladesh:
 - Continue joint study and development of additional cross border transmission lines base on incoming generation designated for export.
 - Negotiate with Indian parties and Bangladesh and enter into medium and long term power sale agreement.
 - Continue selling power in competitive market through power exchange.
 - Get electricity act 2024 passed and develop trade guidelines to encourage private developers to participate in trading market.

Projected electricity demands in the identified economic sectors under different Scenarios

Scenarios considered:

- Base year: 2021
- Time horizon: 2021-2050
- Low GDP average growth rate : 4.817%
- Medium GDP: average growth rate: 7.727%
 - BAU
 - Electrification
- High GDP average growth rate : 10.487%

Economic sectors considered for electrification:

Agriculture, Commercial, Transport, Residential, Industry and construction and mining.

Medium growth Scenario (Electrification)

Sector	Subsector	End Use	Consideration	Target Year
Agricultural	All Subsector	Water Pumping	60% Electric, 40% Solar PV	2050
		Threshing	100% Electric	
		Tilling	100% Electric	
Commercial	All Subsector	All End Use	100% Electric	2050
Industrial	All Subsector	All End Use	100% Electric	
Residential	All Subsector	Cooking	25% Electric	2030
			100% Electric	2050
		Other End Uses Electricity Access/ Electrical appliances	100% Electric	2030
			99% Electric	2050
			100% Electric	
Transport	Public Vehicle	All Vehicles	25% Electric	2025
			50% Electric	2030
			100% Electric	2050
		Train	2 Electric Train	After 2030
	Private Vehicles	All Vehicles	30% Electric	2025
			65% Electric	2030
			100% Electric	2050
	Freight	All vehicles	50% Electric	
		Train	1 Electric Train	After 2030
Construction & Mining	All Subsector	All End Use	25% Electric	2050

Source: Report on Electricity Demand Creation in Different Sectors, WECS, 2024

Agricultural sector:

- Electrification for achieving 100% electric water pumping by 2050
- Compared to 203 GWh of demand in base year 2021, the transition to electric water pumps as a primary end use is projected to create an additional electricity demand of
 - 18.31 GWh by 2030,
 - 366.48 GWh by 2040,
 - 1168.50 GWh by 2050.
- The financial analysis reveals that investments in electric water pumps are highly profitable, with payback periods ranging from 3.45 to 6 years, depending on the level of subsidies.
- Electricity demand in the whole agriculture sector is expected to reach to 805.5 GWh by 2030, 1870 GWh by 2040 and 4558 GWh by 2050 with a CAGR (compound annual growth rate) of 11.33 %

Commercial sector:

- Compared to 24 GWh of demand in base year 2021, Primary end use of commercial electric cooking is projected to create an additional electricity demand of :
 - 332 GWh by 2030,
 - 700 GWh by 2040
 - 20,052 GWh by 2050.
- The financial analysis indicates favorable economic returns, making the adoption of electric cooking technologies an attractive option. The payback period for electric cooking is calculated to be 1.52 to 2.36 years, considering various levels of subsidies.
- Electricity demand in the commercial sector is expected to reach to 3888 GWh by 2030, 14004 GWh by 2040 and 43694 GWh by 2050 with a CAGR of 13.7%

Industrial sector:

- Compared to base year (2021) demand of 2281 GWh, Primary end use of Motive power, Boiler and furnaces is projected to create an additional electricity demand of :
 - 8096 GWh by 2030,
 - 34125 GWh by 2040
 - 102268 GWh by 2050.
- The financial analysis for electric boilers and furnaces shows positive returns, making these investments economically viable. The payback periods for electric boilers and furnaces range from 4.35 to 8.66 years, depending on the level of subsidies.
- Electricity demand in the Industrial sector is expected to reach to 11893 GWh by 2030, 41100 GWh by 2040 and 116925 GWh by 2050 with a CAGR of 13.7%

Residential Sector:

Primary end use of Electric cooking is projected to create additional electricity demand of 0.144 TWh by 2030

4.322 TWh by 2040

11.018 TWh by 2050.

The payback period for electric cooking ranges from 1.29 to 2.36 years, depending on the level of subsidies, and IRR exceeds 40%.

According to Nepal's second Nationally Determined Contribution (NDC), the goal is reach 25% of households using electric stoves as primary mode of cooking by 2030.

Electricity demand in the Residential sector is expected to reach to 9219 GWh by 2030, 14256 GWh by 2040 and 19361 GWh by 2050 with a CAGR of 8.02% (2021-2050)

Alternate Energy Promotion center (AEPC) is actively working towards this target through various programs and initiatives:

- Promoting e-cooking in partnership with Local Governments
- Promotion of e-cooking through the demand aggregation window of SECF
- Distributing e-cookstoves for students in coordination with academic institutions
- Altogether 96,034 e-cookstoves (induction cookstoves) have been disseminated by AEPC through above initiatives
- Implementation of clean cooking solutions project with funding support from Green Climate Fund (GCF) has recently started in the 22 districts of Terai Region: aiming to cover 150 Local Governments and reach 1 million households through 500,000 e-cookstoves, 490,000 tier 3+ improved cookstoves and 10,000 household biogas

- Also, with the electric charging station initiatives through SECF, it is estimated that 0.45 MWh of electricity is consumed daily while 156.24 MWh of electricity will be consumed annually.
- Additionally, the target of distributing 5 million induction cook stoves over the next five years under the GCF-supported Clean Cooking Solutions (CCS) project will significantly increase electricity demand.
- This indicates the significant impact of the induction stoves and charging station initiatives on electricity consumption, highlighting the importance of sustainable energy solutions.

- **Electricity consumption Scenario under these initiatives**

- If induction stoves are used for 2 hours each day (1 hour in the morning and 1 hour in the evening) and operated for 300 days a year, with a rated power of 2000 W, the electricity consumption can be calculated as follows:

- Daily Consumption=Power Rating ×Daily Usage=2kW×2hours=4kWh

- **Total Daily Consumption for 96,034 Units**

- 4kWh×96,034≈**384,136kWh**

- **Total Annual Consumption=1,200kWh×96,034≈115,240,800kWh**

Transport sector:

- Compared to base year (2021) demand of 2.07 GWh, Primary end use of Public transport, private transport and freight transport, is projected to create an additional electricity demand of :

2446 GWh by 2030,

5521 GWh by 2040

11554 GWh by 2050.

The financial analysis indicates that electric buses, cars, and two-wheelers are economically viable investments, especially with reduced tax rates. The payback periods for electric vehicles range from 3.14 to 6.04 years, depending on the vehicle type and level of subsidies.

Electricity demand in the transport sector is expected to reach to 2448 GWh by 2030, 5523 GWh by 2040 and 11556 GWh by 2050 with CAGR of 27.92%

- In the transportation sector, Nepal aims for 25% of private electric vehicles (EVs) sales and 20% of public four-wheelers to be electric by 2025, contributing to a 9% reduction in fuel consumption and an 8% decrease in emissions. AEPC is supporting the establishment EV charging stations through SECF, which are essential for accelerated adoption of EVs. So far, 6 charging stations with capacity ranging from 120 kW to 1,800 kW have been supported by AEPC under SECF with funding support from Nepal Renewable Energy Program (funded by UKAid) and Renewable Energy and Energy Efficiency Program (funded by BMZ and EU through GIZ). Additionally, there are 17 new projects at different stages of implementation, further enhancing the infrastructure for electric mobility.

Construction and mining sectors:

- The construction and mining sectors heavily rely on large and powerful equipment, and much of their operations are carried out in rural or remote areas where electrification is challenging due to lack of electricity grid in rural areas. As a result, it is not feasible to achieve complete electrification or a complete shift to electric equipment in these sectors within the next twenty to thirty years. Due to these limitations, the electrification scenario assumes only about 25% of equipment will be electrified, while the majority will continue to use conventional non-electric methods.
- Electricity demand in the Construction and mining sector is expected to reach to 77 GWh by 2030, 400 GWh by 2040 and 1484 GWh by 2050 with a CAGR of 26.94% (from 2021-2050)

Share of Electricity (of Total Energy demand) in Different Scenario

Scenario	2021	2025	2030	2035	2040	2050
BAU Scenario	4.2%	8.7%	13.3%	18.7%	21.9%	28.3%
Electrification Scenario		8.4%	15.5%	25.5%	39.0%	80.7%
High Growth Scenario		8.8%	13.8%	20.0%	23.7%	30.2%
Low Growth Scenario		8.6%	12.8%	17.6%	20.2%	25.7%

Source: Demand creation, 2024, WECS

Government's Policy support for implementation

- **Sustainable Development Goals (SDGs):**

- Increase in proportion of population with access to electricity to 99% in 2030
- Increase in per capita electricity consumption to 1,027 kWh in 2025 and 1,500 kWh in 2030
- Increase in installed capacity of hydropower from 782 MW to 10,260 MW in 2025 and 15,000 MW in 2030
- Increase in share of electric vehicle in public transport from 1% in 2020 to 35% in 2025 and 50% in 2050

- **Second Nationally Determined Contribution, 2020:**

- By 2030, expand clean energy generation from approximately 1400 MW to 15000 MW of which 5-10% will be generated from mini and micro hydropower, solar, wind and bioenergy. Of this, 5,000 MW is an unconditional target. The remainder is dependent upon the provision of funding by the international community.
- In 2025, sales of electric vehicle will be 25% of all private passenger vehicle sales, comprising of two-wheeler and 20% of all four-wheeler public passenger vehicle sales excluding e-rickshaws and electric tempos.
- By 2030, electric vehicles sales will increase to cover 90% of all private passenger (two wheelers and 60% of four-wheeler public passenger vehicle excluding erickshaw and e-tempos.
- By 2030, develop 200 km of electric rail network to use as public travelling as well as freight transportation.

• **Nepal Government's Plan & Policies, 2080**

- Production and use of electric vehicles will be encouraged to reduce dependence on petroleum products. Carbon emissions will be reduced by using renewable and clean energy in the transport sector.
- Access to energy for all citizens will be ensured. Electricity will be connected to each household within two years. Free electricity will be provided to consumers consuming up to 50 units per month in rainy season and up to 30 units in winter. Cooking gas will be gradually replaced by electricity.
- Electricity generation, transmission and distribution will be promoted in a coordinated way. Transmission and distribution system will be reinforced and expanded
- New infrastructure will be constructed in order to promote internal consumption of electricity produced in the country.
- Underground electricity transmission system will be expanded in major cities. All renewable energy products will be connected to national transmission line.

• **Nepal's Energy Sector Vision 2050 A.D.**

- The following electricity generation plan were suggested by Energy Sector Vision 2050 AD:

11500 MW in 2030

31000 MW in 2050

- **Hydropower Development Policy (2001)**
 - Policies for taking resources from the private sector, government, and bilateral and regional cooperation to develop hydroelectric plants.
- **Environment friendly Vehicle and Transport Policy (2014)**
 - Development and promotion and extension of environment-friendly and electric vehicles (EV) and transportation.
- **Industrial Policy (2011)**
 - Provision for No or lower tax for Industry using completely electricity as fuel
- **The current situation and future road map of Water, Energy, and Irrigation (2019/20)**
 - Specify electricity consumption per consumer goal of 700 kWh per consumer within the first 5 years and 1500 kWh in the next 10 years by changing other sources of energy to electricity.
 - East-West High-Tension transmission (400 kV) line development
 - Development of policies for international trade of electricity
- **Energy Development Roadmap, 2023-2035**
 - 28500 MW of installed capacity by 2035
 - 10000 MW export to India and 5000 MW export to Bangladesh by 2035

- **16th Periodic plan**

- Increase production and productivity by developing more hydropower.
- Subsidy on electrical appliances for domestic use for increasing electricity demand.
- Increase agricultural production and productivity by developing hydropower and using lift irrigation system.
- Increase electricity access and conduct demand escalation programs.
- Expand transmission and distribution infrastructures.
- Increase the use of electricity to replace fossil fuel base energy and reduce import.
- Prioritize green energy development and implement energy development road map.
- Build transformative storage hydro projects to balance energy supply and demand.

Thank you!