SECTORAL PROFILE

ENERGY

GOVERNMENT OF NEPAL

INVESTMENT BOARD NEPAL

Technical and Financial Support:
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CONTENTS

ACRONYMS

ADB	Asian Development Bank
AEPC	Alternative Energy Promotion Centre
ATF	Aviation Turbine Fuel
BIMSTEC	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
BOOT	Build, Own, Operate and Transfer
CBS	Central Bureau of Statistics
CBTL	Cross-Border Transmission Line
CDM	Clean Development Mechanism
CIT	Citizen Investment Trust
CNG	Compressed Natural Gas
Co_2	Carbon dioxide
COP6	Sixth Conference of the Parties
DoED	Department of Electricity Development
DOI	Department of Industry
EIA	Environmental Impact Assessment
ERC	Electricity Regulatory Commission
EV	Electric vehicle
FDI	Foreign Direct Investment
FITTA	Foreign Investment and Technology Transfer Act
FPI	Foreign Portfolio Investments
FY	Fiscal Year
GDP	Gross Domestic Product
GHG	Green House Gas
GJ	Giga Joules
GMR	Grandhi Mallikarjuna Rao
GoN	Government of Nepal
GW	Giga Watt
GWh	Giga Watt hours
GWyr	Giga Watt Year
HEP	Hydroelectric project
HIDCL	Hydroelectric Investment Development Company Limited
IBN	Investment Board of Nepal
IEE	Initial Environment Examination
IPPs	Independent Power Producers
JICA	Japan International Cooperation Agency
kL	Kilo litres
kV	Kilo volt
kWh	Kilowatt hours
LPG	Liquefied Petroleum Gas
MCAN	Millennium Challenge Account Nepal
MHP	Micro Hydro Project

MoEWRI	Ministry of Energy, Water Resources, and Irrigation
MoU	Memorandum of Understanding
MW	Megawatt
NDC	Nationally Determined Contribution
NEA	Nepal Electricity Authority
NOC	Nepal Oil Corporation
NPC	National Planning Commission
NRB	Nepal Rastra Bank
NTPC	National Thermal Power Corporation (India)
NVVN	NTPC Vidyut Vyapar Nigam Limited
PDA	Project Development Agreement
PEPP	Petroleum Exploration Promotion Project
PEVC	Private Equity Venture Capital
PJ	Petajoule
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PROR	Peaking Run-of-the-River.
PTC	Power Trading Corporation of (India)
PV	Photo Voltaic
RE	Renewable Energy
RETs	Renewable Energy Technologies
ROR	Run-of-the-River
SAARC	South Asian Association for Regional Cooperation
SASEC	South Asia Sub Regional Economic Cooperation
SDGs	Sustainable Development Goals
SECF	Sustainable Energy Challenge Fund
SEZ	Special Economic Zone
SIF	Specialised Investment Fund
SJVN	Sutlej Jal Vidyut Nigam
STEPS	Stated Policies Scenario
SWF	Sovereign Wealth Fund
T&D	Transmission and Distribution
TOE	Tonne of Oil Equivalent
TSMO	Transmission System Master Plan
TWh	Trillion watt-hours
USD	United States Dollars
VAT	Value Added Tax
WAM	With additional measures
WB	World Bank
WECS	Water and Energy Commission Secretariat
WEM	With existing measures
WHRS	Waste Heat Recovery System

1. OVERVIEW

1.1 Global energy market

Global primary energy consumption reached around 604 Exajoules in 2022 (Statista). As per the global energy consumption data 2022 31% of oil, 23.5% natural gas, 26.7% coal, 4% nuclear energy, 6.7% hydropower, 7.5% renewable and 0.6% other energy sources were used for different purposes globally. (Forbs/Global Energy Trends-2023).

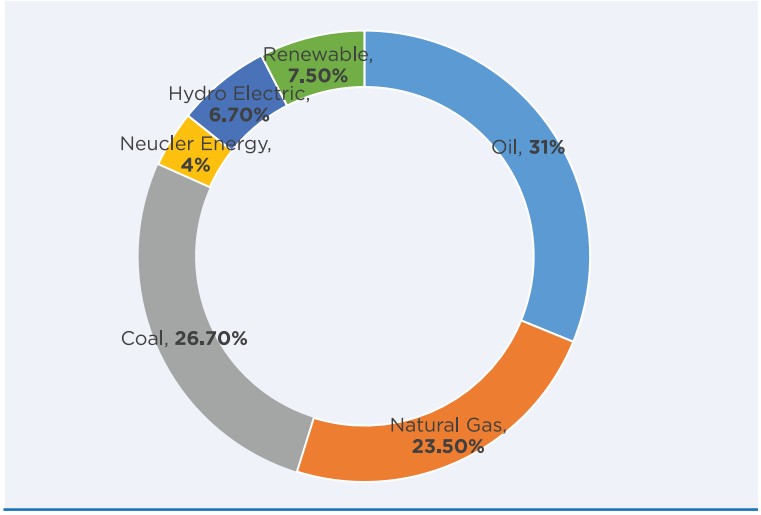
The International Energy Agency (IEA) publishes the World Energy Outlook[1] which provides in-depth analysis and strategic insights into different aspects of the global energy system. Information relevant to investors in Nepal are discussed below.

2022 was a turbulent year for global energy markets, with prices – notably for natural gas – skyrocketing in Europe and many other parts of the world. The effects of the price shock on consumers were cushioned by government interventions. Global energy demand rose 1.3% and the global primary energy consumption reached around 604 exajoules in 2022 (Statista).

The global average surface temperature today is around 1.2 °C above pre industrial levels, prompting heat waves and other extreme weather events. The energy sector is a primary cause of the polluted air which is linked to more than 6 million premature deaths a year. Against this backdrop, the emergence of a new clean energy economy, led by solar PV and electric vehicles (EVs), provides hope. Investment in clean energy has risen by 40% since 2020. In 2020, one in 25 cars sold was electric; in 2023, the number was one in five. More than 500 Gigawatts (GW) of generation capacity of renewables was set to be added in 2023 – a new record. More than USD 1 billion a day is being spent on solar deployment. Manufacturing capacity for key components of a clean energy system, including solar PV modules and EV batteries, have been expanding.

The share of coal, oil, and natural gas in global energy supply – stuck for decades at around 80% – will begin to edge downwards and reach 73% in the Stated Policies Scenario (STEPS) by 2030. This is an important shift. However, if demand for these fossil fuels

Figure 1: Primary global energy consumption-2022



Source: Forbs/Global Energy Trends: Insights from the 2023 Statistical Review of World Energy

[1] https://www.iea.org/reports/world-energy-outlook-2023

remains at a high level, as has been the case for coal in recent years, and as is the case in the STEPS projections for oil and gas, it is far from enough to reach global climate goals.

The key actions required to bend the emissions curve downwards are widely known, and in most cases, very cost effective. Tripling renewable energy capacity, doubling the pace of energy efficiency improvements to 4% per year, ramping up electrification and slashing methane emissions from fossil fuel operations together provide more than 80% of the emissions reductions needed by 2030 to put the energy sector on a pathway to limit warming to 1.5 °C.

The World Energy Outlook report has analysed the 2030 scenario of the global energy market; the key highlights are given below:

- 45% of electricity generated in the United States in 2030 is from renewables, up from 22% today.
- 65% of all cars sold in the European Union are electric by 2030.
- Energy from water distillation doubles by 2030 in the Middle East.
- 18% of the electricity generated in India is from solar sources by 2030, up from 6% today.
- 100 million electric cars on the road in China by 2030.
- 55% growth by 2030 in Latin America and Caribbean revenue from the production of critical minerals used in clean energy technologies.
- 1.2 billion Africans receive access to clean cooking if the continent achieves universal energy access by 2030.
- USD 17 billion in spending can reduce methane emissions from oil and gas operations in Eurasia by 75%.
- 45% of the two/three wheelers sold in Southeast Asia are electric by 2030.
- 18 GW of new offshore wind capacity added in Japan and Korea by 2030.

Energy demand

In the Stated Policies Scenario, average annual growth rate of 0.7% in total energy demand to 2030 is around half the rate of energy demand growth of the last decade. Demand continues to increase through to 2050. In the Announced Pledges Scenario, total energy demand flattens, thanks to improved efficiency and the inherent efficiency advantages of technologies powered by electricity – such as electric vehicles and heat pumps – over fossil fuel-based alternatives. In the Net Zero Emissions by 2050 Scenario, electrification and efficiency gains proceed even faster, leading to a decline in primary energy of 1.2% per year to 2030.

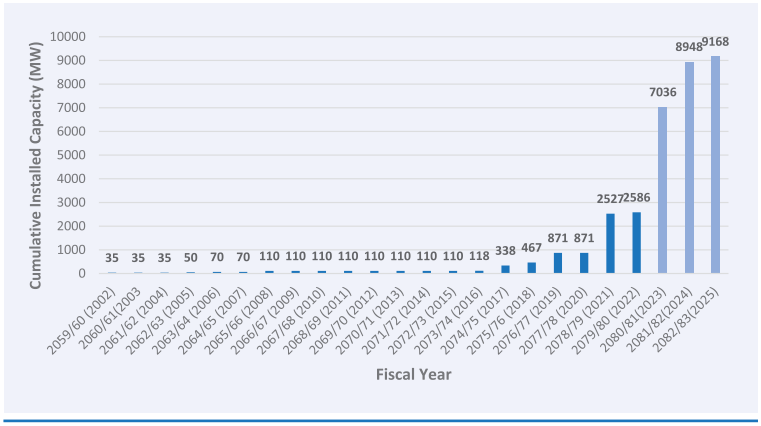
Energy Trilemma Index

The Trilemma framework strives to strike a balance between energy security, equity, and environmental sustainability. The World Trilemma Index serves as a tool for assessing how countries are responding to these challenges. According to the 2022 Trilemma Index Report, Sweden was the top performer with a score of 84.3 while Switzerland and Denmark were in the second position with scores of 83.4 and 83.3, respectively. Nepal had a rank of 84 with a score of 39.

According to the energy security rankings, Canada was on the top spot with a score of 79.6, while the United States followed in second place with a score of 74.1. Finland came third with a score of 73.8, and Sweden had the fourth position with a score of 73.1. In terms of

energy equity, Luxembourg led with a perfect score of 100, with Qatar in second place with a score of 99.9. Kuwait and UAE shared the third position with scores of 99.8 each. For environmental sustainability, Sweden took the first position with a score of 87.5, followed by Switzerland with a score of 87.1, and Norway with a score of 85.8. Nepal has been successful in improving energy security (+48%) as well as the equity (+69%) while China ranked as the top improver in energy sustainability with a score improvement of +32% (World Energy Trilemma Index Report 2022).

Figure 2: Electricity generation through DoED-studied projects



1.2 Regional energy market

Energy development through regional networks

Energy has been the central development and co-operation agenda in regional bodies where Nepal is a member. The South Asian Association for Regional Co-operation (SAARC) Framework Agreement on Energy Co-operation (Electricity), endorsed in 2014, paved the way for relevant institutions in respective countries to develop transmission interconnectivity to allow cross-border power supply.[2] Similarly, the Fourth Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) Summit on 30-31 August 2018 in Kathmandu signed the Memorandum of Understanding on establishing BIMSTEC Grid Interconnection.[3] Further, the SAARC Energy Centre in Islamabad, Pakistan has conducted a number of studies including one on energy trade in South Asia. There are also energy co-operation initiatives at the sub-regional level, such as the South Asian Sub-Regional Energy Cooperation (SASEC) and Bangladesh, Bhutan, India, Nepal (BBIN). Brief overview of energy sector of south asian countries are presented in annex iv.

1.3 Nepal's energy sector: a brief overview

Ministry of Energy, Water Resources and Irrigation (MoEWRI) formulates electricity sector policies that are implemented mainly by Department of Electricity Development (DoED) and Nepal Electricity Authority (NEA), a 100% Government undertaking. The DoED's functions include licensing private hydro projects of over 1 MW capacity. Figure 1 shows the cumulative installed capacity of the projects studied by the DoED till FY 2079/80. It also includes installed capacity of projects studied and those that are to be completed in the coming years. (DoED-White paper 2080)

Nepal's energy consumption pattern seems unusual if compared to the global trends. Nepal's total energy consumption reached 640 PJ (Petajoule) i.e. 179-Terawatt hour (TWh) in 2022, a slight increase over the previous year. Nepal

[2] SAARC Framework Agreement for Energy Cooperation
[3] Ministry of Foreign Affairs (2018), Nepal and BIMSTEC

Table 1: Year wise energy consumption trends

Fiscal Year	Energy (000 GJ)	000 TOE	GWh	% Consumption by type			
				T	C	GE	R
2075/76 (2019)	588,564.78	14,057.63	164,798.14	68.30%	25.68%	3.57%	2.14%
2076/77 (2020)	565,537.02	13,507.62	158,350.37	71.26%	22.05%	3.63%	2.59%
2077/78 (2021)	625,669.62	14,943.86	175,187.49	66.26%	27.13%	4.12%	2.40%
2078/79 (2022)	639,965.79	15,285.32	179,190.42	64.17%	28.35%	4.96%	2.52%

T- Traditional, C- Commercial, GE- Grid Electricity, R- Renewable
(1 TOE = 41.868 GJ | 1000 GJ = 0.28 GWh)

used 64.17% of energy from traditional biomass sources (including fuel wood, agriculture residue, animal waste, etc.), 28.35% from commercial sources (coal and petroleum products), 4.96% from grid electricity and only 2.52% from renewable sources. Overall, the consumption of grid energy, renewable energy, and non-renewable commercial energy has been increasing, while that from traditional sources has been declining.

Sector wise energy consumption

Considering 2022 as reference year, of the total energy consumed (640 PJ), 0.94% (6.04 PJ) was used by the agriculture sector, 4.79% (30.64 PJ) by the commercial sector, 22.17% (141.86 PJ) by the industrial sector, 69.59% (387.78 PJ) by the residential sector, 10.49% (67.10 PJ) by transportation sector, and 1.02% (6.55 PJ) by construction and mining sectors. Table 2 depicts the type and quantity of energy consumed by different sectors.

Per capita energy use

The per capita energy consumption in 2015 was 979 kWh. It increased to 1,426 kWh in 2016, 1,615 kWh in 2017 and 1,754

Table 2: Percentage of energy consumption by different sectors and source types (%)

Energy: Sectors→ Sources↓	Agriculture	Commercial	Industrial	Residential	Transportation	Construction and mining
	6.04 PJ	30.64 PJ	141.86 PJ	387.78 PJ	67.10 PJ	6.55 PJ
Fuel wood	-	61.87%	27.64%	81.56%	-	1.71%
Ag. Residue	-	0.86	8.07	1.61	-	-
Animal Waste	-	1.85	-	4.53	-	-
Kerosene	-	0.21	0.28	0.04	-	0.37
LPG	-	15,0		4.88	0.002	5.12
Coal	-	2.0	40.51	0.02	-	
Electricity	14.37	7.69	8.74	3.99	0.02	10.27
Biogas	-	0.03	-	2.70	-	-
Solar	0.42	9.49	-	0.55	-	-
Wind	-	0.001	-	0.0004	-	-
MHPs/Pico	-	0.35	-	0.11	-	-
Petrol	1.14	0.64	1.98	-	31.60	5.68
Diesel	84.06	-	10.91	-	60.34	76.82
Furnace oil	-	-	1.29	-	-	0.02
ATF	-	-	-	-	8.04	-

PJ- Petajoule. 1 PJ = 31.6 million m of natural gas or 278 million kilowatt hours of electricity.
[Energy Synopsis Report-2023/WECS).

Table 3: Total available energy and national peak demand

Year	NEA own Generation (GWh)	Power Purchase-NEA subsidiaries (GWh)	Power purchase from IPPs (GWh)	Power purchase from India (GWh)	Total Availability (GWh)	National Peak demand (MW)
2014	2,298	151	919	1,319	4,687	1,201
2015	2,368	147	1.122	1,370	5,007	1,291
2016	2,133	154	1,012	1,778	5,077	1,385
2017	2,305	155	1,623	2,175	6,258	1,444
2018	2,308	149	2,019	2,582	7,058	1,508
2019	2,548	157	2,033	2,813	7,551	1,320
2020	3,021	155	2,836	1,729	7,741	1,408
2021	2,804	148	3,093	2,806	8,851	1,482
2022	3,259	1,976	4,286	1,543	11,064	1,748
2023*	2,930	2,488	5,118	1,833	12,369	1,870

*Subject to audit.

kWh in 2018. The per capita consumption began decreasing to 1,702 kWh in 2019, 1,678 kWh in 2020 and 1,608 kWh in 2021 (Our World in Data-Nepal). The decrease in per capita consumption is explained by the increase in population during the COVID pandemic after which there was no significant energy production.

Main sources of energy for cooking and lightning

Cooking: Over 51% households in Nepal use wood/ firewood as the main cooking fuel. Other fuels used in cooking by the households are liquefied petroleum gas (LPG) (44.3%), cow-dung (2.9%), biogas (1.2%), electricity (0.5%), kerosene (0.05%) and others (0.1%). The 2011 census said 64% of the total households used wood/firewood for cooking. (CBS-2021)

Lighting: Most households use electricity for lighting. The percentage of the households that use electricity as the main source of lighting increased to 92.2% in 2021 from 67.3% in 2011. Other main sources used by households for lighting in 2021 were solar energy 6.6%, kerosene 0.6% and other sources 0.6%. The percentages were 18.3%, 7.4% and 6.1% for kerosene, solar and other sources, respectively, in 2011. (CBS-2021)

Total available energy and peak demand

The power sector is dominated by national utility – Nepal Electricity Authority (NEA). The NEA owns and operates almost all transmission and distribution systems in the country and is also the largest power producer.

NEA's hydropower plants generated 2,930 GWh of electricity in 2023, about 10.10% lower compared to the highest recorded generation of 3,259 GWh in FY 2021/22. The decrease was attributed to unexpected reduction in river discharge during the dry season. 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

Table 4: Total electricity demand (2015-2040)

Year	Electricity Demand (GWh)				
	Business as usual (4.5%)	Reference Scenario (7.2%)	High Scenario (9.2%)	Policy Intervention @7.2%	Policy Intervention @9.2%
2015	3866.3639	3866.363904	3866.36	3866.36	3866.36
2020	7600.75872	8110.66	8522.97	14870.92	15304.29
2025	12998.2503	14863.67	16545.84	22431.68	24265.05
2030	20073.8344	24956.79	29864.09	35334.66	41264.82
2035	29744.6919	40709.77	52983.16	51771.84	65657.50
2040	43016.6893	66096.60	94851.06	81958.97	115294.44

Table 5: Total installed capacity requirement (2015-2040)

Year	Total Installed capacity Requirement (MW)				
	Business as Usual	Reference Scenario	High Scenario	Policy Intervention @7.2%	Policy Intervention @9.2%
2015	1721	1721	1721	1721	1721
2020	3384	3611	3794	6621	6814
2025	5787	6617	7366	9987	10803
2030	8937	11111	13296	15731	18371
2035	13242	18124	23588	23049	29231
2040	19151	29427	42228	36489	51330

Source: WECS/Electricity Demand Forecast Report 2017.
MAED-Model for Analysis of Energy Demand

Table 6: Share of primary, secondary, and tertiary sectors in GDP (at current price)

Sectors	Percent of GDP				
	2017/18	2018/19	2019/20	2021/22 (Revised)	2021/22 (Preliminary estimate)
1. Primary *(Agriculture, forestry and fishery, and mining and quarrying)*	26.25%	25.58%	25.755%	25.49%	24.53%
2. Secondary *(Manufacturing, industries, electricity, gas and water, and construction)*	14.54%	14.36%	13.075%	13.10%	13.70%
3. Tertiary *(Service)*	59.21%	60.06%	61.18%	61.41%	61.76%

Source: NRB Annual Report 2021/22.

25.91 % over the 4,286 GWh and 1,976 GWh in FY 2021/22, respectively. The total energy imported from India was 1,833 GWh in FY 2022/23, an 18.79% increase over the import of 1,543 GWh in FY 2021/22. The total available energy in the system increased by 11.80% to 12,369 GWh in FY 2022/23 over 11,064 GWh in FY 2021/22. NEA and its subsidiaries contributed 43.80% of the available energy and import from India and purchase from domestic IPPs accounted for 14.82% and 41.38%, respectively. The contribution of domestic generation to total available energy has remained almost same with a slight decrease from 86% in FY 2021/22 to 85.18% in FY 2022/23. Table 3 shows the available energy and national peak demand between 2014-2023.

The total system loss has been reduced to 13.46% in 2022/23 from 15.38% in the previous year. Total domestic consumption was 9,358 GWh in 2022/23 an increase of 7.76% over 8,870 GWh consumed in the previous year. Energy export to India increased by 173% to 1346 GWh in 2022/23 from 493 GWh in 2021/22. In 2023 NEA had 0.51 million consumers, 92.32% domestic, 1.31% industrial, and remaining 6.37% of other types. The percentage of the population with access to grid electricity reached 95.03% in FY 2022/23, an increase of 2.52% over 2021/22. (NEA Annual Report 2023). The total population with access to electricity, including off grid, has reached to 98%. (Source: One year, December 2022-December 2023 progress report of the Government, Ministry of Energy, Water Resources, and Irrigation)

Transmission system

Transmission lines are the most essential infrastructure for the development of the electricity sector. Most of Nepal's transmission network is 132 kV and needs major upgrading. With increase in the installed power and load demand, new lines of 220kV and 400kV have been introduced. The 400kV Dhalkebar-Muzaffarpur cross-border transmission line was completed in February 2016 and was charged at 400 kV voltage level on 11 November 2020. The Hetauda-Dhalkebar-Inaruwa 400kV transmission line is under construction and its completion will strengthen the East-West transmission network. Likewise, the Khimiti-Dhalkebar 220kV transmission line was completed in January 2017 and few others of the same capacity such as, Bharatpur-Bardaghat, Hetauda-Bharatpur, Chilime-Trishuli, Tumlintar-Sitapani, Lekhanath-Damauli and Basantapur-Dhungesanghu (Koshi corridor) are under construction

Table 7: Existing high voltage transmission lines in Nepal

Sn	Capacity	Length in circuit Km		
		Existing	Under construction	Planned and proposed
1.	66 kV Transmission line	514.46	NA	NA
2.	132 kV Transmission Lines	3,873.87	1,111	1,141
3.	220 kV Transmission Lines	675.10	988	1,752
4.	400 kV Transmission line	78	754	3,858
	Total	**5,141.43**	**2,852**	**6,715**

Source: NEA Annual Report, 2022/23

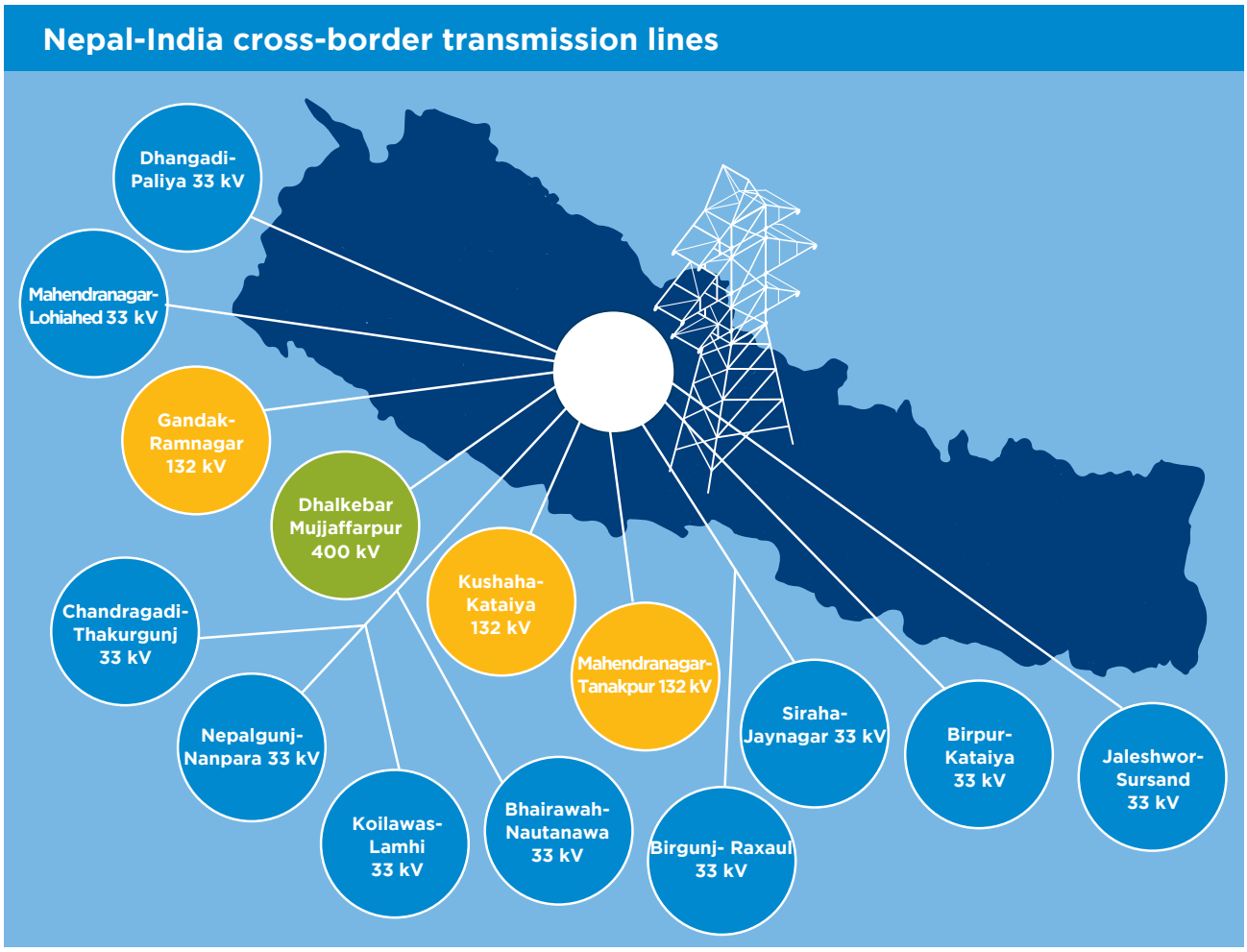
The 400 kV Dhalkebar-Muzaffarpur cross-border line allows interconnections and is being used for electricity trade with India. Several other cross-border transmission lines have been proposed, and among them the 400 kV Butwal (Nepal)-Gorakhpur (India) line is a priority undertaking. The new transmission lines are aimed at meeting Nepal's requirement in the short run, and for exporting power to neighbouring countries in the long run. The Transmission System Master Plan (TSMP) prepared by Rastriya Prasaran Grid Company Ltd (RPGCL) and approved by MoEWRI, covers the 2015-2035 period. It says how different hydropower projects can be clustered to evacuate power along the river corridors optimally and efficiently for export to India.[4] In 2018, RPGCL unveiled the TSMP, which encompasses the development of 6,867 km of transmission lines across Nepal.

Existing Nepal India cross-border transmission lines (CBTLs)

Nepal and India already have several cross-border transmission lines used for power exchange, which are shown in the following figure.

SJVN Arun-3 Power Development Company Pvt. Ltd. (SAPDC) is constructing a dedicated 400 kV double circuit transmission line to transmit electricity generated from its projects in Nepal to Sitamari, India. The length of the Nepal section of the line is expected to be 217

Nepal-India cross-border transmission lines



[4] ibid

Table 8: Projected investment needs (USD millions) and GDP contribution by energy sector

Type	Forecast Period- Reference Scenario				Total Investment Financing Needs
	2018-2025	2026-2030	2031-35	2036-40	Total
Hydro-Storage	393	404	631	1,017	13,012
Hydro (RoR, PRoR)	301	485	757	1221	14,424
Solar	43	34	54	87	1,177
Wind	26	23	36	58	768
Transmission and Distribution (T&D)	414	539	842	1,356	16,587
Total investment needs	*1,177*	*1,487*	*2,321*	*3,739*	*45,968*
GDP contribution (%)	2.7	2.4	2.6	3.0	2.0-3.0

Source: WB Group/Nepal infrastructure sector assessment-2018.

km. Some new Nepal-India CBTLs that have been proposed are as follows:

1. 400 kV, Double Circuit, Attariya-Bareilly Cross Border Transmission Line, 140 km
2. 400 kV Double Circuit, Dododhara–Bareily Cross Border Transmission Line, 200 km
3. 400 kV, Double Circuit, Phulbari–Lukhnow Cross Border Transmission Line, 200 km
4. 400 kV, Double Circuit, New Butwal–Gorakhpur Cross Border Transmission Line, 125 km
5. 400 kV, Double Circuit, Inaurwa – Purnea - Cross Border Transmission Line, 110 km

The Dhalkebar-Muzaffarpur transmission line with capacity of 1000 MW is already operational at 400 kV and has been carrying around 600 MW of power. The New Butwal–Gorakhpur CBTL is a priority of both Nepal and India and is jointly funded by the two governments. This project is under construction through a joint venture company of NEA of Nepal and PGCIL of India and is expected to be completed within three years. The two countries have also decided to build two more CBTLs – Anara-Purnea and Dodhodhara-Bareilly – by 2029. Negotiations on the financial modality are underway.

Proposed Nepal-China CBTLs

Nepal is considering two 400 kV CBTLs for large-scale export of power from various hydroelectric projects in Nepal to China by 2040. The substation areas are proposed to ensure that load centre and generation centres are close to each other. The proposed CBTLs are:

1. 400 kV, Double Circuit, Chilime-Keyrung CBTL, 80 km
2. 400 kV, Double Circuit, Kimanthanka – Latse CBTL, 250 km

NEA and the State Grid Corporation of China have signed a cooperation agreement to execute the project.[5]

Future electricity demand

The Water and Energy Commission Secretariat published its Electricity Demand Forecast Report in 2017. The energy demand is calculated by the model MAED_D as a function of a scenario of possible development. It

[5] Ministry of Energy, Water Resources, and Irrigation (2018) White Paper (page 24)

Table 9: Power capacity and investment requirement under WEM and WAM

Investment areas	2030		2040		2050	
	WEM	WAM	WEM	WAM	WEM	WAM
Power Capacity (GW)	14.3	15.2	22.8	28.5	35.9	52
Investment (billion USD)	5.18	5.34	3.78	6.69	9,85	15.05

has been assumed that the average GDP growth rate is 4.5%, 7.2% and 9.2% per annum in Business as usual, Reference and High growth scenarios, respectively. Tables 4 and 5 depict the total electricity demand and total installed capacity requirement in the coming years.

Contribution to GDP

The Central Bureau of Statistics (CBS) had estimated the real gross domestic product (GDP) to increase by 5.49% (basic prices) and 5.84% (producer prices) in 2021/22. The growth in the year-earlier period was 3.83% and 4.25%, respectively. The preliminary estimate is based on nine-month data of 2021/22, and the final projection was expected to increase alongside decrease in COVID-19 infections. Growth rate of electricity, gas, steam, and air conditioning was 19.51% in FY 2019/20, 2.57% in FY 2020/21(revised) and 36.67% in 2021/22 (preliminary estimate).

Investment needs and GDP contribution by energy sector

The electricity sector is strategically important for two reasons. Firstly, inadequate electricity availability can constrain economic growth, while increased access and availability of electric power can result in significant economic dividends resulting from high growth. Secondly, Nepal's vast hydropower potential has resulted in an opportunity using which Nepal can earn revenue by exporting power to the South Asia region. The Government of Nepal has set an ambitious target of installing 3 Giga watts (GW) of generation capacity in three years, 5 GW in five years, and 15 GW in 10 years. Despite the moderate economic growth, the demand for electricity in Nepal has risen rapidly. To keep up with the increase, electricity sector investments will need to accelerate substantially to around US$1.3 billion to US$2.1 billion annually between 2018 and 2040.

The development of hydropower in Nepal is a key step towards achieving energy independence and reducing dependence on non-renewable sources. With the right support and investment, hydropower has the potential to play a significant role in the country's energy sector, and in overall economic and social development. (World Bank, 2020)

The MoEWRI has updated generation targets leading to 2035. Expecting the domestic demand to reach around 13,500 MW and considering an export potential of 15,000 MW to India and Bangladesh, the targeted generation, assuming an economic growth rate of 7.2% by the year 2035, is 28,500 MW. Total investment required to meet this generation, and associated transmission and distribution facilities, has been estimated to be USD 46.5 billion of which, financial closure of USD 8 billion has been ensured. (Source: Energy Development Roadmap and Acton Plan, 2080, MoEWRI)

Table 10: Institutional sources of financing in electricity sector (USD million)

Institution	Instrument	Benchmark fund	Hydro financing	Share (%)
Commercial banks	Debt	21,717	784	4
	• FY2019 monetary policy requires 5% of total loan portfolio of commercial banks to be in hydropower. • If a PPA has been signed, banks can invest up to 50% of their core capital in a single project; 25% of core capital, if otherwise.			
Insurance companies	Equity and Debt	1,643	20	1
	• Insurance companies can have up to 5% of their total investments in hydropower projects as share capital.			
Employee Provident Fund	Equity and Debt	1,070	230	21.5
	• Investment up to a maximum limit of 25% of issued debentures. • Provides loans to companies against guarantees of banks or financial institutions. • Investment in any area against securities or guarantees and after obtaining the government's approval.			
Citizen Investment Trust	Equity and Debt	920	28	3
	• Invest in securities up to 20% of share capital of the company or 20% of Investment Fund of CIT, whichever is lower. • Invest in a consortium with banks up to 20% of total fixed assets (up to 50% if company owned by the GoN) or 20% of Investment Fund of CIT, whichever is lower.			
Private Companies	Equity and Debt	99	50	50
	• HIDCL can invest in a consortium with banks, up to 25% of its capital fund. • Company can invest up to 20% in the hydropower company's shares or 25% of its capital fund, whichever is lower. • Company can invest up to 25% of its capital fund in hydropower project as loans, bonds, or debentures.			

World Bank/Nepal energy sector infrastructure assessment Report, April 2021
HIDCL= Hydroelectric Investment Development Company Limited

Nepal's long-term strategy for zero emission

In October 2021, Nepal issued its Long-term Strategy for Net-Zero emissions. The Government is committed to accelerating climate action whilst adhering to the principle of shared but differentiated responsibilities and respective capabilities towards the implementation of the Paris Agreement as per national circumstances. Nepal's goal is to achieve full Net Zero emissions by 2045. Nepal also seeks to be recognised for its contribution to mitigating climate impact through clean energy trade. Nepal's total carbon dioxide (CO_2) emissions in 2019 was 23 $mMtCO_2$ in the reference scenario. This is expected to rise to 34 $mMtCO_2$ in 2030 and 79 $mMtCO_2$ in 2050. While non-energy-related emissions accounted for 46% of net CO_2 emissions in 2019 the energy sector accounted for 54%. (Nepal's Long-term Strategy for Net Zero Emissions-2021).

Potential investment opportunities

The focus of the energy sector has been on producing 3,000 MW, 5,000 MW and 15,000 MW hydroelectricity within the next three, five and 10 years, respectively, through public and private investment in small, medium, and large hydroelectricity projects.[6] These targets have been recently revised. The Energy Development Roadmap and Action Plan of MoEWRI sets the generation target at 26,500 MW by 2035. The Government also aims to increase per capita electricity consumption to 700 kWh in the next five years and 1,500 kWh in 10 years.[7] The Government intends to develop one mega hydro/solar project in each of Nepal's seven provinces[8] and solar systems of 100-500 kW in all 753 local jurisdictions or around 200 MW.

There are various compelling reasons for investing in hydropower in Nepal. Most important among them is the still unmet domestic demand, where about 5% households do not have access to electricity. Further, even in households with access, the demand has been increasing every year, and there is a growing demand for electricity in neighbouring countries. In addition, Nepal still faces electricity shortages during the winter months, when supply from Run-of-River projects decrease.

The Investment Board of Nepal (IBN) has been facilitating development of energy projects generating more than 200 MW. IBN has Project Development Agreements (PDAs) with two Indian investors, GMR for the development of the 900 MW Upper Karnali Hydropower Project, and SJVNL, for developing the 900 MW Arun III Hydropower Project and the 669 MW Lower Arun Hydroelectric project. The combined cost of these three projects exceeds USD $3 billion.

There are investment opportunities in other energy sub-sectors such as in modernising traditional energy uses. Coal production and supply is another area for investment. Nepal aims to extract coal to replace imports from India. Exploration, production, storage, and conveyance related infrastructure for petroleum products is another area for investment. There are other opportunities to invest in renewables such as solar power, biogas and wind energy.

Investment required

The installed capacity of power generated would be 4 GW in 2030 and 10.1 GW in 2050 under the reference scenario. The 14.9 TWh of electricity generated in 2030 would increase to 37.7 TWh in 2050. Under the WEM (with existing measures) scenario, electrification measures will result in additional power generation capacity requirement of 14.3 GW in 2030 and 35.9 GW by 2050, with a 30% reserve margin, mostly through hydropower generation. In 2030, an additional 53 TWh of electricity will be required, which will increase to 131 TWh in 2050.

The required investment in the power sector under the WEM scenario is estimated to be USD 5.18 billion in 2030, USD 3.78 billion in 2040, and USD 9.85 billion in 2050. Similarly, the electrification measures will result in a power generation capacity requirement of 15.2 GW in 2030 and 52 GW by 2050 under the WAM (with additional measures) scenario. In 2030, the electricity demand will be 56.2 TWh, and in 2050,

[6] Ministry of Energy, Water Resources, and Irrigation (2018) White Paper
[7] Ibid (page 15)
[8] Ibid (page 24)

it will be 189.5 TWh. The required investment in the power sector under the WAM scenario is estimated to be USD 5.34 billion in 2030, USD 6.69 billion in 2040, and USD 15.05 billion in 2050. The capital requirements for generating electricity as desired exceeds the in-country investment capacity.

The MoEWRI's Energy Development Roadmap and Action Plan has estimated a total investment requirement of USD 46.5 billion to generate 28,500 MW and build associated transmission and distribution facilities by 2035.

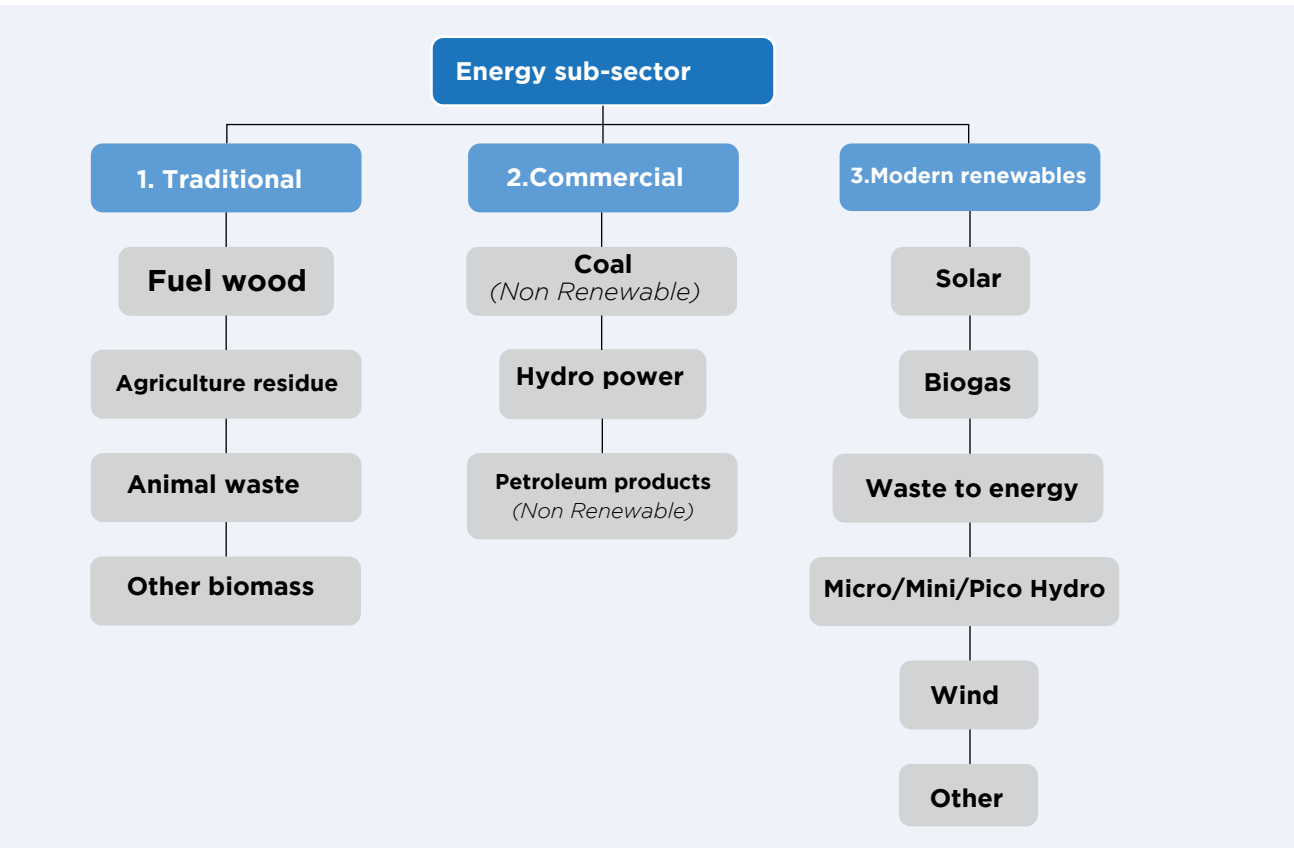
Climate finance

Accessing climate finance typically involves meeting certain conditions and requirements set by international climate finance institutions, donors, and funding mechanisms. Most of IBN's projects are in renewable energy, and these would likely be able to access some form of climate finance. Provided such financing is received at a concessional rate, it can be used in the form of blended finance to enhance the bankability and sustainability of projects in IBN's basket.

2. INVESTMENT OPPORTUNITIES

Nepal's energy consumption depends heavily on traditional sources, particularly biomass, including fuel wood, agricultural waste, and animal dung. Firewood mainly comes from the forests. Nepal has about 5.962 million hectares or 40.4% of total land area under forest cover. Traditional energy sources such as firewood, agricultural residue, and animal dung, dominate the energy mix and make up 64.17% of total consumption. Firewood remains the primary fuel consumed, accounting for 58.53% of total use. In FY 2078/79 (2022), Nepal's total energy consumption reached 640 PJ (179 TWh), which was a slight increase compared to the previous year. The contribution of agricultural residue was 223.317 PJ and biomass 104.5 PJ (Agriculture Census 2021).

Figure 2: Energy sub-sector of Nepal



Source: Synopsis of Energy Sector-2023/WECS

The traditional fuel use rate has decreased from nearly 90% to less than 70% over the past 15 years. But total energy consumption has increased in the same period from 8,616,000 tons of oil equivalent (ToE) to 14,464,000. This increase in energy consumption is slightly covered by that obtained from renewable sources while the rest is still sourced in commercial sources *(Nepal energy outlook 2022, Kathmandu University).*

2.1 Areas of investment

2.1.1 Hydropower

Projects and energy generation

Nepal has huge potential for generating hydropower from perennial rivers flowing from the high Himalaya in the north to the low-lying plains in the south. If harnessed, the energy in these rivers can help to meet energy needs of not only Nepal but also its neighbours such as Bangladesh and India. In 2018, Government of Nepal set a target to develop 15,000 MW of electricity from hydropower projects by 2028, which has been subsequently revised. The new target is to generate 28,500 MW of hydroelectricity by 2035, including 15,000 MW for export to India and Bangladesh.

Total electricity generation capacity of Nepal reached 2,684 MW at the end of FY 2022/23 of which 2,680.087 MW was grid connected. Total installed hydropower capacity reached 2,538.27 MW, including 583.16 MW from NEA, 478.1 MW from NEA subsidiaries and 1,477.01 MW from IPPs. In 2022/23, hydropower projects with combined capacity of generating 3,103 MW were under construction and NEA had signed power purchase agreements with many projects adding up to a combined generation capacity of 7,758 MW (NEA Annual Report 2023).

Most of the hydropower projects are in Bagmati (985) and Gandaki (724) provinces followed by Koshi (415), Sudur Paschim (71), Lumbini (36) and Karnali (9). The Kulekhani HEP is the only storage project. Among the projects under construction, Arun III (900 MW), the largest so far, is a FDI project being built by an Indian company.

A total of 2,240 hydropower projects were in operation in July 2023. Out of them, only 121 projects (generating 2,085 MW) and with capacity above 1MW, were paying royalty to the Government. In the FY 2022/23, total royalty generated from hydro projects was NPR 3,057.2 million.

Nepal has issued permissions for generating 9,012 MW of hydro and 707 MW of solar energy. The Government has also completed studies of 39 new projects, with cumulative capacity of 2,585.58 MW. The projects include the RoR type that will generate 1,768.38 MW, Peaking-Run-of-the-River (PRoR) type to generate 69.5 MW and storage projects to produce 747.74MW. Another 26 projects are in different stages of study and have potential generation capacity of 6,582.21 MW. So far, the Government has issued 9,041 construction licences and 10,826 survey licences. There were 8,613 applications for generation licenses being processed by the Government in 2023 (DoED, July 2023).

Energy trading

Nepal has transitioned from a country with electricity shortages to one with a surplus, which NEA has begun trading in India. Nepal has an agreement to export up to 10,000 MW of power to India in the next 10 years. Likewise, NEA has mid-term agreements with NTPC Vidyut Vyapar Nigam Ltd. (NVVN) and

Table 11: Major hydropower projects in Nepal

Operational	Capacity MW	Under construction	Capacity MW	Planned	Capacity MW
Upper Tamakoshi	456 MW	Arun III	900 MW	Upper Arun	1,061 MW
Kaligandaki A	144 MW	Tanahu Storage	140 MW	Uttar Ganga Storage	828 MW
Mid Marsyangdi	70 MW	Rasuwagadi	111 MW	Dudhkoshi Storage	635 MW
Marsyangdi	69 MW	Madhya Bhotekoshi	102 MW	Arun-IV	490 MW
Upper Trishuli 3A	60 MW	Lower Solu	82 MW	Chainpur Seti	210MW
Kulekhani I	60 MW	Upper Sanjen	14.8 MW	Aadhikhola Storage	180 MW
Likhu IV	52 MW	Sanjen	42.5 MW	Begnas Rupa Pump Storage	150 MW
Kulekhani II	32 MW	Raghuganga	40 MW	Upper Modi	18 MW
Upper Bhotekoshi	45 MW	Upper Trishuli 3B	37 MW	Upper Karnali Hydro-power Project	900 MW
Khimti	60 MW	Tamakhusi-V	86 MW	Lower Arun Hydroelec-tric project	669 MW
Chameliya	30 MW	Upper Modi 'A'	42 MW	West Seti and SR6 Hy-droelectric Project	750 MW + 450 MW
Trishuli	24 MW	Upper Trishuli-1	216 MW	Upper Marsyangdi-2 Hydropower Projects	327 MW
Gandak	15 MW			Tamor Storage Hydroe-lectric Project	756 MW
Devighat	15 MW				
Modikhola	14.8 MW				
Kulekhani III	14 MW				
Sunkhoshi	10 MW				
Puwakhola	6.2 MW				

Power Trading Corporation (PTC) India for the export of 200 MW and 300 MW of power to India, respectively. Similarly, a tripartite agreement between NEA, the Bangladesh Power Development Board (BPDB) and NVVN is under discussion for the export of 40 MW of power to Bangladesh from Nepal using the existing transmission infrastructure of India. Nepal Power Trading Company, a NEA subsidiary, has been approved for transactions and its operationalisation will facilitate both in-country and cross-border energy trade.

Even though, Nepal still imports more energy than what is exported, energy imports from India rose by 20% while the exports increased by 173% in FY 2022/23 compared to 2021/22. Hydropower is being exported to India on the Day-Ahead basis through the Indian Energy Exchange (IEX). This export volume is likely to increase after Nepal receives approvals for exporting more power from the list of projects submitted to the Government of India.

Table: 12: Energy trade with India

FY	Imported	Exported
FY 2021/22	1,543 GWh	493 GWh
FY 2022/23	1,854 GWh	1,346 GWh
Trends	20.16%	173%

Table 13: Theoretical hydropower potential in Nepal

River Basin	Shrestha-1966) (MW)	Bajracharya-2015 (MW)	WECS -2019 (MW) at Q40
Koshi	22,350	35,166	27805
Narayani	20,650	32,086	19803
Karnali	32,010	25,755	20385
Rest of small basin	8,171	10,334	4551
Total	83,181 (80% Efficiency)	103,341	72544

Hydropower potential

The estimated theoretical potential for generating hydropower in Nepal is 83,000 MW, and the technical and economically feasible potential is about 45,000 MW and 42,000 MW (Shrestha, 1996). A study carried out by WECS in 2019 said that the gross hydropower potential was 72,544 MW. The potential is distributed among three major river basins – Koshi, Gandaki, and Karnali. The distribution of the power generation potential province wise is: Koshi (22,619 MW), Madhesh (275 MW), Bagmati (10,568 MW), Gandaki (14,981 MW), Lumbini (2,677 MW), Karnali (13702 MW) and Sudur Paschim (7,722 MW).

2.1.2 Solar energy

Production potential

Nepal has an advantageous location for solar generation. Its high-altitude south facing slopes receive ample radiation for harnessing solar energy. The

Figure 3: Power development map of Nepal

Source: Rastriya Prasaran Grid Company Limited

average solar radiation ranges from 3.6 to 6.2 kWh/m2 /day, and Nepal has about 300 sunny days per year. This has made solar energy promising in many parts of the country. According to the Solar & Wind Energy Resource Assessment in Nepal published by the AEPC in 2008, the commercial potential for grid-connected solar power is estimated to be 2,100 MW. NEA mainly develops grid-connected solar PV systems, while the AEPC has been developing both on-grid and off-grid systems, institutional solar PV systems, solar pumping systems, and solar/wind hybrid systems. (WECS/Energy synopsis report 2023)

Solar PV projects

Forty companies have obtained survey licences for different solar energy projects. The total installed capacity of these projects is around 707.6 MW. Similarly, 19 solar energy projects have already obtained generation permission. These have a combined capacity of 125.66 MW. Three other projects have obtained energy generation license under the "co-generation" category for producing a total of 9MW.

IBN has been facilitating two large solar energy projects. One is the Grid Connected Solar Project in Kohalpur and Banganga (250 MWp with 40 MW storage). This project's feasibility has been completed and EIA & PPA are underway. Its total cost is USD 158.5 million. The other is the Grid Connected Solar Photovoltaic Project with BESS Technology (245 MWp with 20 MW storage). This project is expected to cost USD 176.43 million and has reached the MoU stage.

The Government of Nepal requires the contribution of solar to the renewable energy mix to be around 5-10%. Several solar projects have already concluded PPAs with NEA.

Solar energy production

The Government has completed a World Bank-supported project (USD 130 million) with counter financing of USD 8 million to generate 25MW. GoN has also received a grant from the ADB for the SASEC Power System Expansion Project. Several PPAs have been signed under the project to generate solar electricity adding up to 24 MW. Total solar energy produced and connected to the grid has reached 61.94 MW (NEA 25.0 MW; IPPs 36.94 MW) (Annual Report 2022/23, NEA).

The NEA has estimated that the economic potential of solar power is 1,829 Megawatt-peak (MWp), assuming average generation of 33.5 MWp per km2 of land area by utilising 2% of the best solar irradiance area (out of the total available of 2,729 km^2). Electricity production in a photo-voltaic (PV) power plant depends on the site position and follows a combined pattern of global tilted irradiation and air temperature. According to a study by World Bank Group, high PV power production has been identified at Jomsom and Simikot sites whereas lower potential exists in Khandbari and Biratnagar. It has been found that the difference in PV power production between the sites with higher and lower elevation is quite large: Jomsom (5.07 kWh/kWp) and Biratnagar (3.62 kWh/kWp).

Role of AEPC

The AEPC works to develop and promote renewable/alternative energy technologies in Nepal. It is also a national focal point for resource mobilisation in the renewable energy sector. The Renewable Energy Subsidy Policy provides guidance on subsidies for solar production in areas without access to electricity. This subsidy is intended to promote solar PV home systems, so-

lar mini-grids, solar pumping, and solar thermal systems. AEPC's accomplishments in renewal energy promotion and use are listed below:

Solar installed at religious places and homestay (units)	4,511
Solar street lights (units)	3,309
Solar home system (units)	974,001
Institutional solar PV system (units)	3,817
Solar drinking water and irrigation pump (units)	3,129
Solar dryer and cooker (units)	2,464
Roof top solar (kW)	10,080
Solar mini grid Solar/Wind mini-grid system (kW)	2,929

(AEPC: Progress at a Glance/Year in Review FY 2021/22)

2.1.3 Biogas

Agriculture involves 60.4% of the population and the abundant biomass from livestock and farming makes biogas an ideal technology for cooking. Approximately 1.9 million households (42% of total) have the potential for installing biogas systems (Adhikari and Adhikari 2021). This study shows that 4.57 kg of fuel wood is equivalent to 1m^3 of biogas and 1kg of fresh dung can produce 0.036 m^3 of biogas. Annual per capita biogas requirement in Nepal is estimated to be 3,501 m^3/year in mountain, 5,386 m^3/year in hills and 7,669 m^3/year in the plains (*Energy Synopsis Report 2023/WECS).*

The Government has been actively promoting biogas plants of various capacities, including 2 cubic meters, 4 cubic meters, 6 cubic meters, and 8 cubic meters for domestic use. These small plants adhere to the GGC 2047 standard, and the modified design based on the standard. Such biogas plant installations had reached 439,547 in FY 2078/79 *(Energy Synopsis Report 2023/WECS).*

The development of large biogas plants with capacity exceeding 12 cubic meters in Nepal is a significant achievement. This has resulted from long-term practices based on the modified GGC 2047 model and valuable insights from international technological experiences. The large biogas plant category encompasses a wide range of systems including institutional, community-level, and commercial installations. As of 2078/79, 355 large biogas plants had been installed across the country *(Energy Synopsis Report 2023/WECS).*

At the national level, the energy equivalent of the net annual available dung (cattle and buffalo) and crop residues (paddy, corn, wheat, millet, and barley) is about 72% of the total annual fuel wood consumption, which is equivalent to more than the total annual LPG imports for household consumption. The introduction of cattle dung-based domestic biogas, even by excluding all households in urban and mountain areas, produced an energy equivalent of 97% (251,759 t yr-1) of imported LPG (2014/15 estimate). Similarly, it was found that the use of the potential of cereal crop residues could replace 28% of the LPG.

2.1.4 Waste to energy projects

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. Specific areas like Kathmandu, Lalitpur, and Pokhara have the potential to generate 1,745 MWh, 278 MWh, and 244 MWh of electricity from waste respectively, (Sodari & Nakarmi, 2018). Another study (Lohani, et al., 2021) suggested that us-

ing 100% of the organic municipal solid waste in Kathmandu can generate 130,294 cubic meters of biogas, equivalent to filling 21,045 LPG cylinders per day and saving NPR 515 million (Energy synopsis report-2023/WECS)

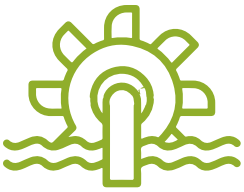
The Government of Nepal, via AEPC, has successfully commissioned seven industrial-scale large waste-to-energy facilities with World Bank support. AEPC has plans to up-scale 20 waste-to-energy plants in various locations. The intended end uses of these sub-projects include biogas bottling, distribution via gas-grid, replacement of transportation fuel and electrification for captive use. Five of these projects are being built as commercial sub-projects while seven of them are municipal waste-to-energy projects.

2.1.5 Mini/micro hydropower

Nepal was a pioneer of decentralized, small, mini, and micro hydro plants. APEC is the current institutional home for the development of mini/micro/pico hydro projects.

Micro/mini-hydro (10 kW to 1000 kW) and Pico-hydro (Up to 10 kW) are small-scale hydroelectric systems. They mostly used turbines technologies are Pelton and Crossflow types. Most of the MHP turbines are manufactured locally. These systems primarily serve nearby households through local, decentralised, isolated mini grids. Micro hydro plants are practical and cost-effective solutions for providing electricity in rural and remote areas. Most of these plants are concentrated in mountainous and hilly regions where water sources are abundant.

Cumulative total energy generated by MHPs reached 37,734 kW in 2021/22. In 2023 there were more than 3,000 micro hydro projects in Nepal. However, most of these projects are no longer in operation following the expansion of the national grid. MHPs are the better and cheaper ways to provide electricity in isolated villages not reached by the national grid.



2.1.6 Wind energy

Despite its huge potential, there has been no significant development of wind energy in Nepal. Two 10 kW wind turbines installed by the NEA in Kagbeni, Mustang in 1989 were destroyed within three months of project commencement (Ghimire & Poudel, 2010). The AEPC has implemented small wind and solar/wind hybrid systems for the electrification of off-grid communities. Wind and solar/wind hybrid mini-grid projects are eligible for subsidies if the sites are not accessible to the national grid and no other means of electrification exist. AEPC has installed two 5 kW wind turbines with 2kW solar hybrid system in Nawalparasi, with ADB support. It has also established wind-solar hybrid systems with 400 W and 150 W solar power projects at a few other sites. The total capacity of the solar-wind hybrid mini-grid system has reached to 1500 kW (SEMAN, 2022).

Nepal has a high potential for wind energy. A nation-wide assessment[9] on potential of the wind power estimated that the area for possible energy generation was about 6,074 sq. km. After analysis of 10% of this area, it was found that more than 3000 MW of electricity could be generated, with consideration of the installed capacity of 5 MW per sq.km. The areas with most potential

[9] The study was carried out throughout the country by Solar and Wind Energy Resource Assessment (SWERA) project, executed by AEPC in joint in-country partnership with the Centre for Energy Studies/ IOE with support from United Nations Environment Program/ Global Environment Facility (UNEP/GEF) in 2003.

was in conservation areas in the mountains.[10]

According to an assessment by AEPC, a wind power density of more than 300 W/m^2 was observed in Mustang and Solukhumbu districts. Similarly, the power density was observed to be between 200-250 W/m^2 in Humla and Sankhuwasabha, between 150-200 W/m^2 in Myagdi and Manang, and between 100-150 W/m^2 in Bajhang, Darchula, Dolakha, Dolpa, Mugu, and Taplejung districts. The remaining districts have a wind power density of less than 100 W/m^2, which is generally not feasible for harnessing. Wind power densities greater than 200 W/m^2 are considered for non-grid-connected power generation, while greater than 300 W/m^2 are considered for grid connectivity in developing countries (Energy Synopsis Report-2-23/WECS)

2.1.7 Other energy sources

Geothermal

Geothermal energy is in its early stage of development in Nepal but has a high potential. Most of the major geothermal springs in the country lie to the north of the Main Central Thrust and south of the Main Boundary Fault. Most of these geothermal springs are confined to three distinct tectonic and structural features that characterize the Himalayas in general. One group lies to the north of the Main Central Thrust (MCT) and is located beyond the Higher Himalayas in a geological formation like the Tibetan Autonomous Region in China. The second group of thermal springs lies close to the MCT. The third group falls on the Main Boundary Fault (MBF) in the Siwalik. The maximum surface temperature recorded at the springs in Nepal was 73°C in Srihagar (Darchula district) followed by 71°C at Tatopani (Mustang district), and 69°C in Sadhu Khola (Rupandehi district). At present, the use of geothermal spring water in Nepal is largely confined to bathing and laundry. The Tatopani spring in Myagdi district, for example, is a popular tourist destination and is extensively used for bathing and recreation. The absence of adequate knowledge on the use of low temperature thermal waters has been a major impediment to the promotion of this resource.

Green hydrogen

Hydrogen reacts with oxygen to generate heat and electricity with water vapour as the sole by-product. It is produced via processes like electrolysis or steam methane reforming, the latter method has carbon emissions and requires carbon capture and storage technologies. Approximately 50 units of electricity are required to produce 1kg of hydrogen fuel, which in turn allows a car to travel about 60-70 km, depending on driving conditions. The hydrogen fuel cells can be used in the transportation sector and also for generating electricity and heat for buildings. It also has industrial applications (Energy Synopsis Report-2023/WECS).

Major requirements for producing hydrogen fuel/green hydrogen are electricity and water, and both are available in Nepal. Hydrogen fuel can be used as an alternative to all non-renewable energy sources such as petrol, diesel, and LPG and coal. Production of hydrogen energy can reduce import of fossil fuel, contribute to energy security, and can also be exported. Nepal has significant potential for hydrogen fuel generation

[10] Alternative Energy Promotion Centre (2018) Achievement

and the Kathmandu University has been studying the possibility to provide recommendations to the Government. The Government of Nepal has approved the Green Hydrogen Policy 2080, which forms the basis for formulating the necessary laws to support its development.

Waste heat recovery system

The electricity that will be generated by waste heat recovery technology in cement industries will substitute the equivalent amount of electricity that would have been generated by using more carbon intensive fuel. The technology will prevent the waste heat from being released into the atmosphere and thus reduce anthropogenic GHG emissions. The GHG emission reduction can be monetised as Certified Emission Reduction (CER) and sold/traded in the carbon market through Clean Development Mechanism (CDM)

Waste heat recovery technology enables cement plants to recover large amounts of waste heat and reduce energy consumption in the production process. It also reduces the emission of dust & CO^2 and enhances production efficiency. There is a huge potential of

energy-saving and other co-benefits if Nepal's cement plants implement such energy efficient new technologies. The potential for electricity generation using waste heat in the cement industry is estimated to be 2,988.35 GWh, which is a cumulative figure for 2030, under cement's high growth scenario. This would be equivalent to cumulative reduction of 36.2% of CO^2 emission in the same year as compared to the high growth scenario of cement industries.[11]

[11] Policy Intervention to Reduce Energy Consumption and Mitigate Environmental Emission in Cement Industries of Nepal, Mar. 9, 2016

3. SUPPORT SYSTEM

3.1 Incentives

The Income Tax Act 2058 offers various incentives in tax rates for build, own, operate and transfer (BOOT) projects. It also has provisions for tax holiday, and disclosure norms. Similarly, the Value Added Tax Act 2052 offers exemptions on various renewable energy-related goods. There are also custom duty concessions on energy generation and related machinery parts.

The Foreign Investment and Technology Transfer Act, 2019 (2075) offers various incentives to foreign investors. Some of the key facilities are:

- Facility to repatriate investment and earnings.
- Facility relating to foreign currency.
- Facility for employing, top-level technical and managerial personnel.
- Industrial security.
- Facility of identity card.
- Facility of visa.
- Treatment of foreign investors as national investors.

To protect foreign investors from currency fluctuation, the Hedging Regulation, 2079 allows the Government of Nepal and relevant agencies to bear the hedging fee as provided in Page 26.

Investing in hydropower

Nepal's hydropower investment opportunities are robust. Annex-1 provides an updated list of study-completed and under-study projects. The Foreign Investment and Technology Transfer Act (FITTA) 2019 has broadened the ways of investing in Nepal, such as:

Applicable income tax for hydro power generation and transmission: 20%

Category	Income tax holiday
Hydropower, solar, wind and biofuel, starting commercial production, transmission, or distribution within April 2028	100% exemption for 1st 10 years and 50% exemption for next 5 years
Peaking ROR (PROR) and storage hydropower plant more than 200 MW (financial closure by April 2029)	100% exemption for 1st 15 years and 50% exemption for next 6 years.

VAT exempted projects	VAT exempted items
All hydro-power and solar plants	Construction equipment, machinery, tools, and spare parts required for generation, transmission, and distribution
PROR and storage hydropower plant more than 200 MW (financial closure by April 2026)	Construction equipment, machinery, tools, and spare parts required for generation, transmission, and distribution, in addition to explosives, penstock pipe and steel plates
Biogas, solar, wind energy industries	Equipment and machines, tubular batteries, solar lead batteries
Solar energy producing industries	Batteries produced and supplied by Nepali industries

Hedging fee borne by

Project Type	GON	Relevant GON entity
PROR and storage projects over 100 MW	5%	40%
Transmission line of 220 volt and above, with transmission line above 30 km	20%	35%

- Foreign currency investment in hydropower shares.
- Reinvestment of prior investment dividends.
- Purchase of shares or assets in a hydropower company incorporated in Nepal.
- Purchase of loans in the hydropower sector.
- Investment in hydropower through technology transfer.
- Investment received because of a company's issuance of securities in the foreign capital market.
- Investment received because of the establishment of a venture capital fund for the hydropower sector.

3.2 Relevant laws and policies

The Government has initiated work to reform relevant laws, including that relating to the forests. In addition, a new Development Project Facilitation Act has been drafted for discussion in parliament. Also, a new Electricity bill, which is expected to address the most pressing issues faced by electricity sector, is under discussion in the parliament. Various laws and regulations related to investing in energy in Nepal are discussed bellow.

The Electricity Bill: A bill to amend and update the Electricity Act, 1992 – the Electricity Bill 2023 – tabled in the House of Representatives has proposed major changes in the institutional arrangement for generation, transmission, distribution, and trade of electricity. It has also proposed introducing competition among the prospective developers to obtain the single stage generation license. Another proposal concerns delegating authority to all three tiers of government for development and licensing of electricity projects in line with the provision of the Constitution of Nepal 2015. The bill also has provisions relating to domestic and cross-border trade of electricity.

Foreign Investment and Transfer of Technology Act 2019: The FITTA 2019 repealed its predecessor FITTA 1992 and has introduced reforms in the foreign investment regime.

Public Private Partnership and Investment Act, 2019: PPPIA 2019 provides the framework for mobilising private investment – both domestic and foreign – for building large infrastructure projects.

Electricity Regulatory Commission Act 2017: The ERC Act 2017 provides the framework for regulating electricity generation, transmission, distribution, and cross-border power trade. The law also addresses the management of demand and supply of electricity, tariff fixation, consumer rights and benefits and seeks to enhance competitiveness in the electricity market.

Electricity Act 1992 and Electricity Rules 1993: The Electricity Act 1992 has been the law guiding the survey, generation, transmission, and distribution of electricity. The electricity rules provide the basis for enforcing the law.

Relevant policies

Other relevant policies, directives, strategies, etc., related to investment in energy are the National Water Resource Policy 2020, Hydropower Development Policy 2001; Water Resources Strategy 2002; Directive on Licensing of Hydropower Project, 2017; NEA PPA Policy 2017; Subsidy Policy and Delivery Mechanism, 2017; Biomass Energy Strategy 2017; National Energy Efficiency Strategy 2018; National Renewable Energy Framework 2017; Low Carbon Economic Development Strategy; Second Nationally Determined Contribution; Nepal SDG Status and Roadmap 2016-2030; Nepal's Energy Sector Vision 2050; Nepal's 20-Year Renewable Energy Perspective Plan 2000-2020; National Energy Strategy of Nepal, 2013; Nepal's Long-Term Strategy for Net Zero Emissions, 2021 and Five-Year Plan (2019/20-2023/24).

3.3 Regulatory institutions

The Ministry of Energy, Water Resources, and Irrigation (MoEWRI) is the federal line ministry with jurisdiction and authority for the development of energy sector. Its main role is policy making and oversight and coordination with other independent agencies. The Electricity Regulatory Commission is an independent body, while the NEA, its subsidiaries and IPPs are operational level institutions. The Department of Electricity Development (DoED), Office of the Investment Board Nepal (OIBN) and Alternative Energy Promotion Centre (AEPC) are implementation level institutions.

Investment Board Nepal (IBN)

IBN was established in 2011 under the Investment Board Act 2011 and was later strengthened with the enactment of the Public Private Partnership and Investment Act (PPPIA) 2019. It is an agency chaired by the Rt. Hon. Prime Minister to develop, implement and facilitate PPP projects and private investment by mobilising domestic or foreign private sector investment. OIBN is the secretariat of the board.

IBN has played an important role in attracting FDI since 2011, with full support of the Government of Nepal and from its development partners. IBN's mission is to promote transformative infrastructure projects and facilitate private investment. IBN has so far approved and facilitated 42 projects involving investment of about USD 9.27 billion. Twenty-eight of these projects are in energy and 14 are in the non-energy sectors. IBN has been effectively handling around 4,000 MW of clean energy projects.

Electricity Regulatory Commission (ERC)

The ERC was established in April 2019. The five-member body regulates electricity generation, distribution, transmission, and trade. The Commission is mandated to perform technical management functions, including development of grid code and distribution code relating to electricity services, and the standards, quality and safety level of the National Grid System and the determination of responsibilities of electricity system operators. ERC fixes consumer tariffs as well as PPA tariffs and is responsible for promoting competition in electricity trade, protecting consumer rights, enhancing the institutional capacity of licensees, and for advising the government on policy for generation, transmission, distribution, and trade of electricity, among others.

Department of Electricity Development

The DoED was established on 16 July 1993 as the Electricity Development Centre (EDC) with primary objective of

promoting private sector investment in hydropower. It was converted into DoED on 9 February 2000. The major functions of DoED include licensing private developers, feasibility studies of hydropower projects, inspection, and monitoring, facilitating Project Development Agreement, etc.

Nepal Electricity Authority

NEA was established on 16 August 1985 following a merger of various existing organisations. The objectives of NEA are to generate, transmit and distribute adequate, reliable, and affordable power, and prevent leakages. NEA trades electricity in the competitive market of India and has plans to expand to subregional markets.

Alternative Energy Promotion Centre

Alternative Energy Promotion Centre (AEPC) is a federal government institution that was established on 3 November 1996 for developing and promoting renewable/alternative energy technologies. It is organised under MoEWRI and is directed by an 11-member board with representatives from government, industry, and non-governmental organizations.

3.4 Recent breakthroughs

Various changes have taken place in Nepal's energy sector in the past five years. Some major breakthroughs are discussed below:

India's New Policy: The Indian government has allowed hydropower purchased from neighbouring countries to be counted in the hydro-renewable energy component of India's renewable purchase obligation. (Note 3 of the gazette of India: Extraordinary, 23 October 2023). This policy change has opened door for Nepal to export more hydropower to India.

Nepal-India electricity export agreement: Nepal signed an agreement with India to export up to 10,000 MW of power over a period of 10 years. The agreement opens a major market for electricity produced in Nepal.

Millennium Challenge Account: The Millennium Challenge Account Nepal (MCAN) Compact came into force on 31 August 2023. Nepal had signed the MCC compact on 14 September 2017. The MCA will build 315 km of 400kV transmission line within the five-year grant period.

Power trade procedure: India's Central Electricity Authority published the Procedure for Approval and Facilitating Import/Export (Cross Border) of electricity on 26 February 2021. The document details the process to be followed by both the exporting and importing countries.[12] NEA has begun trading electricity directly in the Indian Energy Exchange market at competitive rates.[13]

BIMSTEC Grid Interconnection: Member countries signed a MoU on BIMSTEC Grid Interconnection in August 2018, and have instructed relevant agencies to take concrete measures to harmonise technical, planning, and operational standards for removing barriers to interconnections. The MoU envisages an early establishment of a BIMSTEC Grid and early operationalisation of the BIMSTEC Energy Centre for strengthening regional energy cooperation.

Nepal-Bangladesh pact on the power sector: Governments of Nepal and Bangladesh signed a MoU on co-operation in the power sector in August 2018.

[12] https://kathmandupost.com/national/2021/02/28/india-introduces-procedure-that-will-allow-nepal-to-export-power-to- it
[13] https://myrepublica.nagariknetwork.com/news/nea-starts-importing-electricity-from-india-at-competitive-rate/

The cooperation includes investment and development of power projects for mutual benefit. The two countries have also agreed to exchange power as and when it becomes feasible. They have agreed to participate in and promote regional/sub-regional power sector cooperation bodies such as SAARC, BIMSTEC, and BBIN.

Nepal-China MOU and Joint Statement: In June 2018, Nepal and China signed the MOU on energy cooperation.[14] A joint statement was signed on 26 September 2023[15] during a visit to China by Nepal's prime minister. The statement includes the following commitments relating to energy cooperation: "The two sides will further promote cooperation in the field of energy, particularly the development of hydropower and cross-border transmission lines and associated substations. The two sides will continue working toward the finalisation of the China-Nepal Electric Power Cooperation Plan by convening the second meeting of the Joint Implementation Mechanism at the earliest. The two sides will launch the construction of the Jilong/Keyrung-Rasuwagadhi-Chilime 220 KV Cross-Border Power Transmission line at an early date".

h) Cross-border Electricity Trade: The new guidelines on cross-border trading of electricity (Guidelines for Import/Export (Cross Border) of Electricity–2018) revised by the Indian Power Ministry has a provision which allows Nepal to trade electricity with another country that has bilateral relations with India through Indian power lines after agreement with India's Central Transmission Utility. Based on this provision, a 40 MW power export deal from Nepal to Bangladesh is now in the final stage of negotiations and sale is likely to start from upcoming wet season. Similarly, the qualification criteria linked to equity ownership (51% or more Indian stake) to sell power to India has been relaxed. Additionally, NEA can now sell electricity in the open market of India and can join the energy exchange market there through India's NTPC Vidyut Vyapar Nigam Limited (NVVN).

3.5 Availability of inputs

Money: According to the Nepal Energy Sector Infrastructure Assessment Report 2021 of the World Bank, foreign investment in electricity generation was limited between 2010 and 2017. The investment that came as joint venture with local companies, accounted for about a tenth of the sector investments. The flow of private investment to transmission, distribution, and solar and wind generation was limited. The report has considered the 900 MW (USD 1.1 billion) Arun III hydroelectric project as a ground-breaking export-oriented undertaking.

According to the report, the NEA will continue to play an important role and be responsible for about a third of the total sector investment requirements until 2030. More than 95% of NEA's capital expenditure is expected in the Transmission and Distribution (T&D) network. The NEA will also continue to make equity investments in subsidiary companies to develop generation projects. About half of the additional generation capacity between 2018 and 2030 is expected to be developed by NEA subsidiary companies. From 2019 to 2025, NEA debt financing requirements to meet capital expenditure (capex) needs range between US$ 250

[14] https://www.firstpost.com/world/nepal-forms-panel-to-discuss-energy-cooperation-with-china-agree ment-might-end-de penden cy-on-india-5022531.html
[15] https://mofa.gov.np/joint-statement-between-the-peoples-republic-of-china-and-nepal/

million and US$ 500 million annually. By removing constraints to greater private sector participation in the ownership, operations, and financing of power projects, the Government can leverage its public sector resources by using a range of PPP models.

According to the World Bank's assessment, Nepal's institutional investors have shown a growing appetite for hydropower investments, but the capital market has had a limited role in mobilising the same, although it could become an important source of funds. Commercial banks, insurance companies, Employees Provident Fund, Citizen Investment Trust, and hydroelectricity investment and development companies have been investing in the sector. Table 9 depicts various institutional sources of financing in the electricity sector.

Human resources: Nepal has highly skilled and experienced human resources such as project managers, engineers, economists, lawyers, technicians, etc. required for project development, implementation, and management. Similarly, the country also has an abundance of a young, semi-skilled and unskilled workers available.

Materials: Nepal has sustainable quantity of natural resources such as land, snow, rivers, lakes, wood, rocks, gravel, sand, soil, etc. Even though internal production of manufactured construction materials is not adequate, Nepal manufactures significant quantity of cement, steel & rods, bricks, tiles, pipes, ply board, electrical goods, and explosives. Electricity required is available and other energy sources and material can be imported from neighbouring countries.

Machinery: Nepal has limited capacity to produce power generation, transmission, and distribution-related equipment; construction machinery; refrigeration equipment, drilling and boring equipment, ground & underground equipment, etc. But Nepal has several established machine and equipment suppliers who import construction equipment.

Methods: Methods involve the processes, procedures, and techniques used to transform the construction inputs into completed projects. This includes the specific production methods, quality control procedures, and operational processes followed at each government agency. Even though limited, Nepal has established various policies, procedures, technical standards, manuals, etc. to streamline workflows for smooth project implementation.

3.6 Investment procedure

The OIBN is the first point of reference for FDI and in-country investments in energy and infrastructure projects costing NPR 6 billion or more. The requirements and procedures involved are provided in the FITTA Regulations 2021, which are also available on the OBIN website.

Licensing procedures

The "Directives for licensing of Electricity projects, 2017" detail the requirements for the different types of licenses that are applicable for developing a hydropower project within Nepal. The information below is based on a project with an installed capacity of over 1,000 kW.

Survey License: A Survey License is required for investigating a project site, and it provides exclusive rights to study the site throughout the license term. The maximum term of a Survey License is five years. It is issued within 30 days of receiving a complete application together with a nominal fee.

Generation License: A Generation License is required to construct and operate a hydropower production facility.

The maximum term for a Generation License is 50 years. However, practice has been to grant this license for 30 years for projects designed solely for export, and for 35 years for the projects designed for domestic use. The Generation License is issued within 120 days of receiving the complete application and the application fee. There are several information requirements that need to be fulfilled before receiving a Generation License, including i) Details of the project, ii) Feasibility Study Report, iii) Report of initial environment examination (IEE) or environment impact assessment (EIA), (iv) the method of financing (a Detailed Financing Plan), v) details of required house and land, and a power purchase agreement.

c) Transmission License: A Transmission License is required to construct and operate a transmission facility after the survey has been completed (which also requires a license). The maximum term for a Transmission License is 50 years but is generally aligned with the duration of the Generation License. The license is issued within 120 days of receiving a complete application. Several documents, including those submitted to acquire a Generation License, need to be submitted to obtain a Transmission License.

Distribution License: Once a survey has been completed, a Distribution License is required to construct and operate a distribution facility. The maximum term of a Distribution License is 50 years and is issued within 120 days of receiving a complete application.

The directive of MoEWRI provides guidance on the licencing processes.

Further, the IBN also issues survey and project licenses under PIPPA 2019 for energy projects with installed capacity of over 200 MW, and other infrastructure projects.

Project development agreement

The Project Development Agreement (PDA) is a long-term contract between Government of Nepal and the private company, and a basis for sharing risk wherein significant portion of that is transferred to the private sector over a significant part of the asset life cycle. For example, the Government allows and facilitates the use of river water, assures availability of land (also for transmission line, if needed), allows the right to sell the power, provides approvals, tax exemptions and incentives, etc. In addition, there are provisions in the PDA that allow extension of the term of the project. For example, prior to financial closure, term extension is possible if there is delay in land acquisition, severe market disruptions, etc. In a sense a PDA itself is a kind of project assurance where the Government also shares liability with developers, investors and the lenders.

The PDA includes assurances of all requirements to get the project started and completed. Generally, projects could have a timeframe of 30-35 years, as per license, and the financial closure is expected to take place within two years after a project has been awarded a Generation License. The different sections of a PDA include the following:

1. Government to facilitate land acquisition (Generation/ Transmission)
2. Direct agreement (Lenders, Developers and Government)
3. Exclusive water rights for use
4. Protection
5. Taxes and incentives
6. Carbon and other benefits shared in between developer and GoN
7. Force majeure/ event of default
8. Transfer price: Termination process
9. Performance security
10. Environment and social safeguards
11. Hand back

ANNEXES

Annex I. List of hydropower projects in development phase at DoED

i) Study completed projects

Total capacity: 2,780.42MW
RoR Type: 1,963.18 MW
PRoR Type: 69.50 MW
Storage Type: 747.74 MW

List of Projects

1 Arun-4 HPP, RoR, Sankhuwasabha, 490.20 MW
2 Beni-Kaligandaki HPP, RoR, Parbat, 50.53 MW
3 Bheri Khola HPP, RoR, Jumla, 4.10 MW
4 Budhiganga Hydropower Project, PRoR ,Achham, 20.00 MW
5 Dotigad HPP, RoR, Doti, 2.52 MW
6 Dudhkoshi-4 HPP, RoR, Solukhumbu, 47.00 MW
7 Dudhkoshi-5 HPP, RoR, Solukhumbu, 110.00 MW
8 Ikhuwa Khola, RoR, Sankhuwasabha, 30.00 MW
9 Inkhu Khola HPP, RoR, Solukhumbu, 21.40 MW
10 Jawa Khola HPP, RoR, Jumla, 15.25 MW
11 Kankai Multipurpose Project, Storage, Jhapa, Ilam 60.00 MW
12 Kawadi Khola HPP, RoR, Humla, 30.00 MW
13 Khare Khola HPP, RoR, Dolakha, 14.47 MW
14 Loti Karnali (Darma) HPP, PRoR, Humla, 49.50 MW
15 Lower Apsuwa Khola HPP, RoR, Sankhuwasabha ,45.00 MW
16 Lower Arun HEP, PRoR, 669 MW
17 Lower Chameliya HPP, RoR, Darchula, 20.00 MW
18 Lower Chepe, RoR, Lamjung, 8.74 MW
19 Lower Hongu HPP, RoR, Solukhumbu, 30.20 MW
20 Lower Solu Khola HPP, RoR, Solukhumbu, 40.00 MW
21 Lungri Khola HPP, RoR, Rolpa, 6.00 MW
22 Madi Khola HPP, RoR, Rolpa, 12.98 MW
23 Maiwa Khola HPP, RoR, Taplejung, 12.50 MW
24 Maya Khola HPP, RoR, Sankhuwasabha, 5.00 MW
25 Mewa Khola HPP, RoR, Taplejung, 10.00 MW
26 Myagdi Khola HPP, RoR, Myagdi 15.2 MW
27 Naumure Storage HPP,Storage, Arghakhanchi, Pyuthan, Kapilvastu, 281.04 MW
28 Nyaurigad HPP, RoR, Jumla,, 4.01MW
29 Pikhuwa Khola HPP, RoR, Bhojpur, 6.11MW

30 Rupagad HPP, RoR, Dolpa, 8.63 MW
31 Sankhuwa 1 HPP, RoR, Sankhuwasabha, 40.82 MW
32 Sankhuwa Khola HPP, RoR, Sankhuwasabha, 41.06 MW
33 Sarda Babai HPP, RoR, Salyan, 93.00MW
34 Saru Khola, RoR, Salyan, 12.30 MW
35 Seti River-6 HPP, Storage, Doti, Achham, 309.00 MW
36 Singati Khola HPP, RoR, Dolakha, 25.00 MW
37 Siwa Khola HPP, RoR, Taplejung, 26.86 MW
38 Solu Khola HPP, RoR, Solukhumbu, 15.25 MW
39 Upper Jhimruk ,Storage, Pyuthan, 97.70 MW

ii) Projects in study stage

Total capacity: 6,582.21MW

RoR type: 272.62 MW
PRoR type: 1,026.26 MW
Storage type: 5,283.33 MW

List of projects

1 Bharbung Storage HPP, Storage, Dolpa, 322.18 MW
2 Dandagau Khalanga Bheri HEP, PRoR, Jajarkot, 99.98 MW
3 Hima Khola HPP, PRoR, Jumla, 10.80 MW
4 Humla Karnali HPP, PRoR, Humla, 61.02 MW
5 Humla Karnali-Cascade, PRoR, Humla, 684.44 MW
6 Kaligandaki 2 Storage, Storage, Syangja, Tanahun,Nawalparasi West, 500.00 MW
7 Kaligandaki Multipurpose Storage Parbat, Gulmi, Baglung, 620.00 MW
8 Kawadi-1 HPP, RoR, Humla, 23.74 MW
9 Khimti Those Shivalaya, Storage, Ramechhap, 1547.00 MW
10 Kokhajhor Storage, Storage, Sindhuli, Kavre, 63.00 MW
11 Lower Badigad, Storage, Gulmi 350.00 MW
12 Madi Siti HPP, Storage, Lamjung, Kaski 165.00 MW
13 Manahari Khola HPP, Storage, Makwanpur, 55.15 MW
14 Marsyangdi 3, PRoR, Lamjung, 42.00 MW
15 Middle Inkhu HPP, RoR, Solukhumbu, 27.90 MW
16 Mugu Karnali, PRoR, Mugu, 93.02 MW
17 Sunkoshi 2 HPP, Storage, Sindhuli, Ramechhap, 978.00 MW
18 Sunkoshi 3 HPP, Storage Kavre, Sindhupalchok, Ramechhap, 683.00 MW
19 Super Budhigandaki HEP, RoR, Gorkha, 34.93 MW
20 Tila River HPP, PRoR, Jumla, Kalikot 35.00 MW
21 Tom Dogar HEP (Budhi Gandaki), RoR, Gorkha, 40.20 MW
22 Upper Chameliya HPP, RoR, Darchula, 53.85 MW
23 Upper Hongu, RoR, Solukhumbu, 32.00 MW
26 Yanma Khola HPP, RoR, Taplejung, 60.00 MW

Source: Department of Energy Development,
Note: RoR= Run-of-the-River, PROR= Picking- Run-of-the-River

Annex II. Synopsis of energy projects (IBN)

Name of the project	Arun-3 Hydropower Project
Installed capacity of the project	900 MW
Stage of the project development	Under construction
Project type	Peaking Run of River; Minimum Peaking 3.65 hrs
Location of site	Sankhuwasabha District (Koshi Province)
Dam location	Phaksinda Dovan near Num village along the Koshi Highway
Powerhouse location	Near Diding village
Design annual energy	4019 MU
Plant load factor (design)	51%
Estimated cost	USD 1110 million (Financing Plan, 2020)
Transmission line	217 km 400 KV line from substation at powerhouse to Nepal Border
Concession	BOOT, 25 years of operation

Name of the project	Lower Arun Hydroelectric Project
Installed capacity of the project	669 MW
Stage of the project development	Under implementation
Project type	In tandem operation with Arun-3 HPP
Location of site	Khandbari Municipality and Chichila Rural Municipality of Sankhuwasabha District
Design annual energy	2901.02 MU
Project cost	NPR. 92.68 billion (Investment approval, 2023)
Benefits to GoN	Royalty, income taxes, direct employment
Transmission line	The power from Lower Arun HEP shall be evacuated through 400 kV D/C LILO arrangement of line length of approximately 2 km with under-construction Arun-3 400 kV D/C Transmission line
Concession	BOOT, 25 years of operation

Name of the project	Upper Karnali Hydropower Project (UKHPP)
Installed capacity of the project	900 MW
Stage of the project development	Under implementation (Signing of Tripartite Long term (25 years) Power Sale Agreement among GMR Upper Karnali Hydropower Limited (GUKHL), Bangladesh Power Development Board (BPDB) and NTPC Vidyut Vyapar Nigam Limited (NVVN) for 500 MW power export to Bangladesh is in final stage)
Project type	Peaking Run of River; Minimum Peaking 3.26 hrs
Location of site	Surkhet, Dailekh and Achham District (Sudurpashchim and Karnali Province)
Dam location	Eastern arm of Karnali bend 1.5 km upstream of Ramgad Khola confluence

Powerhouse location	Western arm of Karnali bend on right bank 1.25 km upstream of Tallo Ballade khola
Design annual energy	3466 MU
Plant load factor (design)	43.96%
Estimated cost	USD 1223.30 (Investment Approval, 2023)
Transmission	Around 99 km up to Nepal border (299 km 400 kV D/C connecting to Bareilly, India)
Concession	BOOT, 25 years of operation

Name of the project	**Upper Trishuli-1 Hydroelectric Project**
Installed capacity of the project	216 MW
Stage of the project development	Under construction
Project type	Run of River
Location of site	Rasuwa District
Project cost	USD 647 million USD
Benefits to GoN	Royalty, income taxes, direct employment
Transmission	220 KV Single Circuit from UT-1 switchyard to the nearest possible point of NEA's Chilime – Trishuli 3B Transmission Line
Concession	BOOT, 30 years of operation

Name of the project	**Upper Marsyangdi 2 Hydropower Project**
Installed capacity of the project	327 MW
Stage of the project development	DPR under evaluation
Project type	Peaking Run of River
Location of site	Manang, Lamjung
Headworks location	50 m d/s suspension bridge at Tal village, Nashong Rural Municipality
Powerhouse location	100 m u/s suspension bridge at village Syange, Marsyandi Rural Municipality
Design annual energy	1,934 GWh
Estimated cost	USD 647.15 million
Benefits to GoN	Royalty, income taxes, direct employment
Transmission	220 kV, ACSR 20 km

Name of the project	**West Seti & SR6 Hydroelectric Project**
Installed capacity of the project (West Seti + SR6)	750 MW + 450 MW
Stage of the project development	Under study
Project type	Storage
Location of site (West Seti and SR6)	West Seti: Doti, Baitadi, Dadeldhura and Bhajhang SR6: Doti and Achham
Indicative total cost (West Seti & SR6)	West Seti: USD 1320 million SR6: USD 800 million

Name of the project	Tamor Storage Hydroelectric Project
Indicative capacity of the project	756 MW
Stage of the project development	Under study
Project type	Storage
Location of site	Tehrathum and Panchthar district
Estimated cost	USD 1217.4 million (Feasibility Study, 2016)
Benefits to GoN	Royalty, income taxes, direct employment

Name of the project	Grid Connected Solar Project in Kohalpur and Banganga
Installed capacity of the project	Site 1: 78.16 MWp (DC) with 12.5 MW two hours storage Site 2: Capacity: 171.9 MWp (DC) with 27.5 MW two hours storage
Stage of the project development	Detailed Feasibility Study Report acknowledged; EIA & PPA ongoing
Project type	Grid connected Solar Project with Battery Energy Storage System (BESS)
Location of site	Site 1: Kohalpur Municipality, Banke Site 2: Banganga Municipality, Kapilvastu
Estimated project cost	USD 158.5 million
Benefits to GoN	Royalty, income taxes, direct employment

Name of the project	Grid Connected Solar Photovoltaic Project with BESS Technology
Installed capacity of the project	245 MWp (DC) with 20 MW four hours storage
Stage of the project development	MOU signing stage
Project type	Grid connected Solar Project with Battery Energy Storage System (BESS)
Location of site	Rajpur Rural Municipality, Dang District
Estimated project cost	USD 176 million
Benefits to GoN	Royalty, income taxes, direct employment

Annex III. Overall energy consumption in Nepal in 2022

Category	Fuel type	FY 2078/79				Previous FY
		Energy (000GJ)	000TOE	GWH	% of National total	
Traditional	Firewood	374,562.95	8,946.28	104,877.63	58.53 %	-0.85 %
	Agricultural	17,965.50	429.10	5,030.34	2.81 %	-4.35 %
	Animal Waste	18,150.14	433.51	5,082.04	2.84 %	1.02 %
	Total	410,678.59	9,808.89	114,990.01	64.17 %	-0.93 %
Commercial	Coal	58,148.22	1,388.85	16,281.50	9.09 %	-0.51 %
	Petrol	24,653.98	588.85	6,903.11	3.85 %	26.04 %
	Diesel	66,079.60	1,578.28	18,502.29	10.33 %	4.12 %
	Kerosene	640.68	15.30	179.39	0.10 %	-22.91 %
	LPG	24,657.27	588.93	6,904.04	3.85 %	13.09 %
	ATE	5,392.72	128.80	1,509.96	0.84 %	143.10 %
	Furnace Oil	1,834.45	43.82	513.65	0.29 %	-46.03 %
	Total	181,406.91	4,332.83	50,793.94	28.35 %	6.88 %
Renewable	Grid Electric-ity	31,766.40	758.73	8,894.59	4.96 %	20.45 %
	Biogas	10488.72	250.52	2,936.84	1.64 %	7.50 %
	Wind	1.87	0.04	052	0.0003 %	0.00 %
	Micro / Pico Hydro	539.97	12.90	151.19	0.08 %	4.86 %
	Solar	5083 32	121.41	1,423.33	0.79 %	6.80 %
	Total	16113.88	384.87	4,511.89	2.52 %	7,19 %
Total		**639,965.79**	**15.285.32**	**179,190.42**	**100 %**	**2.28 %**

Source: Energy Synopsis Report-2023/WECS
TOE=Tonne of oil equivalent

Annex IV. Brief energy profile of South Asian countries

INDIA

An overview of India's energy sector	
• Fifth largest economy of the world and 3rd largest energy consuming country after China and USA. • Energy use has doubled since 2000. Primary energy consumption of 929 million Tons of Oil Equivalent (MTOE) in 2019 which is expected to grow to 1,237 MTOE in 2030. • 60% of energy demand met by coal. Coal generates 70% of the electricity. • Solar generates only 4% of total electricity. • Energy demand is expected to increase by 35% till 2030 and if it continues at this pace, India will have the largest increase in energy demand in the world by 2040. • India expects to reach 450 GW of renewable energy generation by 2030. • Estimated increase of emission will be 50% by 2040.	• Total installed energy capacity stood at around 412,000 MW, February 2023. • Peak energy demand across India amounted to approximately 182,000 MW in fiscal year 2020. • Total renewable energy capacity in India was around 163 gigawatts in 2022. This was up from about 134.4 gigawatts in 2020. • India's highest energy capacity came from thermal energy, amounting to an installed capacity of over 236,000 MW as of February 2023. Close to 70% of the country's electricity generation was from thermal power plants. Coal dominated power supply with a contribution of over 86 %. Along with coal, thermal power is generated from lignite, diesel, and gas. • As of February 2023, the private sector in India had the highest installed renewable energy capacity with about 105,000 MW. • The northern region of India was anticipated to have the highest energy requirement in financial year 2023, at over 460 thousand million units. Meanwhile, the availability of energy in that same region was estimated at a deficit of 1.2% that year.
Source: India Energy Outlook 2021	Source: Statista (Germany) https://www.statista.com/topics/5075/india-s-energy-sector/#topicOverview

BANGLADESH

An overview of Bangladesh's energy sector	
• Bangladesh has had rapid economic development due to the development of its industrial sector. • In 2018, the primary energy consumption was 37.6 MTOE. The demand is expected to rise to 85.3 MTOE in 2030. • Natural gas is the major contributor to the country's primary energy as it covers two-thirds of its primary energy consumption. • The status show that the production of gas within the country is decreasing and its energy security is at high risk due to its dependency on the import of coal and LNG. • Capacity of electricity generation has increased from 5GW (2009) to 25.5 GW in 2022. • The government claimed in March 2022 that 100% of the population had access to electricity.	• During FY 2021-22 (up to January 2022), total installed electricity generation capacity stood at 22,066 MW which was 25,284 MW including captive and renewable energy. • The maximum electricity generation was 13,792 MW in April 2021. • Total net electricity production was 80,423 million kilowatt-hours in FY 2020-21. • Out of total net generation, 40.02% power was generated by public sector, 47.39% by private sector, 4.10% by joint ventures and 8.50% came from import. • The government has set a target to increase installed electricity generation capacity to 40,000 MW by 2030 and 60,000 MW by 2041. • Natural gas met almost 62% of the country's total commercial use of energy.
Source: Analysis by the Student Team Based on BPDB Annual Report, 2020-2021.	Source: Bangladesh Economic Review, 2022.

BHUTAN

An overview of Bhutan energy sector	
■ Installed capacity of 2,335MW, which accounted for 7 percent of the country's total hydropower potential.	■ The country's energy demand grew by 6% annually from 2010 to 2021.
■ The government plans to generate around 10,000 MW of power through hydroelectric, solar, wind, and other forms of renewable sources by 2030.	■ The Energy Data Directory 2015 reported that in 2014, the total energy supply in the country was 650,220 tons of oil equivalent (TOE). Out of the total energy supply, thermal energy accounted for 72%, and the remaining 28% was a hydro electricity.
■ The country has installed solar water heating systems (SWHS) with a daily heating capacity of 30,000 litres, as well as 1000 solar home lighting systems and a 180 kilowatt (KW) solar water project.	■ In 2021 it generated a total of 11,059 GWh of which 73.9% (8,178.38GWh) was exported to India.

Source: Energy Synopsis Report 2023/WECS

MALDIVES

An overview of Maldives energy sector	
■ Total energy consumption is around 103.5 GWh per year.	■ The country's main source of energy is fossil fuels, specifically diesel and heavy fuel oil, accounting for around 96% of the total energy consumption.
■ Despite this, there has been a small but growing use of renewable energy in the form of solar and wind power.	■ The Maldives has a total electricity consumption of around 99 GWh per year, and 100% of the population has access to electricity.
■ The Maldives has set a goal to generate 100% of its electricity from renewable sources by 2030, to decrease its dependence on fossil fuels and become more self-reliant.	

Source: Energy Synopsis Report 2023/WECS

PAKISTAN

An overview of Pakistan energy sector	
■ Pakistan's energy sector is facing several challenges, including a significant energy deficit, high dependence on fossil fuels, and a lack of investment in renewable energy.	■ The Government of Pakistan has set a target to increase the share of renewable energy in the power mix to 30% by 2030.
■ As of 2020, its primary energy consumption was around 131 MTOE, with most of it (around 60%) met through fossil fuels, particularly natural gas, and oil. Coal plays an important role in the country's energy mix, accounting for around 15% of total primary energy consumption.	

Source: Energy Synopsis Report 2023/WECS

AFGHANISTAN

An overview of Afghanistan energy sector	
■ In 2018, total primary energy consumption in Afghanistan was around 3.4 MTOE, with most of it (around 80%) being met through firewood and dung. The remaining 20% met by oil.	■ The total electricity generation in Afghanistan is around 6 TWh, which is less than 10% of the total electricity consumption.
■ Less than half of the population has access to electricity, with a total installed capacity of 1 GW generated mostly by small hydroelectric plants and diesel generators.	■ Renewable energy resources such as solar, wind, and hydro have significant potential in the country but are hindered by a lack of infrastructure, limited financial resources, and security issues.
■ A small contribution of electricity comes from grid-connected power plants that are mostly imported from neighbouring countries, such as Turkmenistan, Uzbekistan, and Iran.	■ Despite setting a target of increasing renewable energy's share to 40% by 2030, Afghanistan faces challenges of inadequate investment and a lack of clear policy in the sector.

Source: Energy Synopsis Report 2023/WECS

SRI LANKA

An overview of Sri Lanka energy sector	
■ Sri Lanka has a total installed electricity generation capacity of around 8 GW, with hydro and thermal power being the main sources of electricity generation.	■ The power sector consumes 56% and industry sector consumes 25% of the total energy.
■ In 2019, total primary energy consumption was around 11 MTOE.	■ The government has set a target of generating 8% of the country's total electricity from renewable sources by 2025.
■ The main source of energy is coal, accounting for around 42% of total primary energy consumption, followed by oil (38%), hydro (16%), and other renewable sources (4%).	■ Sri Lanka has also been looking to increase its liquefied natural gas (LNG) imports to reduce dependence on oil and coal. The country's first LNG terminal was opened in 2018, and the government aims to increase the share of natural gas in the energy mix to 20% by 2027.

Source: Energy Synopsis Report 2023/WECS

CHINA

An overview of China energy sector	
■ China is the world's largest energy consumer and producer. In 2020, primary energy consumption in China was 4,527 MTOE.	■ The Chinese government has set a target of increasing the share of non-fossil energy in primary energy consumption to 20% by 2030.
■ Coal remains the largest source of primary energy in China, accounting for 57% of the country's total energy consumption, followed by oil (19%), natural gas (8%), hydro (6%), and non-fossil renewables (7%).	■ China is also a major player in the global energy market, being a significant producer and exporter of oil and natural gas, and a major importer of oil and LNG.
■ China is also the world's largest producer of hydroelectricity and wind power and the second-largest producer of solar power. ■ The Chinese government has pledged to peak its carbon dioxide emissions by 2030 and to achieve carbon neutrality by 2060.	■ The country is also investing heavily in clean energy technologies such as electric vehicles and renewable energy, to reduce air pollution and greenhouse gas emissions. However, China remains the world's largest emitter of carbon dioxide, which is the main greenhouse gas responsible for climate change.

Source: Energy Synopsis Report 2023/WECS

Annex IV. Government agencies associated with energy sector investments

Office of the Prime Minister and Council of Ministers
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Website: www.opmcm.gov.np

Ministry of Industry, Commerce and Supplies
Singh durbar, Kathmandu, Nepal
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Toll Free No: 16600142114
Email: info@moics.gov.np
Website: www.moics.gov.np

Ministry of Energy, Water Resources, and Irrigation
Singh durbar, Kathmandu, Nepal
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Website: www.moewri.gov.np

Ministry of Science, Technology and Environment
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Website: www.moe.gov.np

Investment Board Nepal, Office of the Investment Board,
ICC Complex, New Baneshwor
Kathmandu, Nepal
Tel: 977-1-4475276/77/78
Email: info@ibn.gov.np
Website: www.ibn.gov.np

National Planning Commission Secretariat
Singh Durbar, Kathmandu
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Email: npcs@npc.gov.np
Website: www.npc.gov.np

Water and Energy Commission Secretariat
Singh Durbar, Kathmandu, Nepal
Tel: +977 1 4211415, 4211417
Email: wecs@mos.com.np
Website: www.wecs.gov.np

Independent Power Producers Association, Nepal (IPPAN)
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Kathmandu
Tel: +977-1-4169175
Email: info@ippan.org.np
Website: www.ippan.org.np

Alternative Energy Promotion Center(AEPC)
PO Box 14364
Mid Baneshwor, Kathmandu, Nepal
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Email: cni@wlink.com.np
Email: info@aepc.gov.np

Hydroelectricity Investment and Development Company Limited
Tel.: 977-1-4257024, 4257025
Singha Durbar, Kathmandu, Nepal
Email: info@hidcl.org.np
Website: www.hidcl.org.np

Nepal Rastra Bank
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Tel: +977-1- 4410158, 4410201, 4411250
Fax: +977-1-4410159
Email: nrbtcu@nrb.org.np
Website: www.nrb.org.np

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Website: www.doed.gov.np

Department of Customs
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Website: www.customs.gov.np

Department of Immigration
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Web: www.nepalimmigration.gov.np

Office of the Company Registrar
Tripureshwor, Kathmandu, Nepal
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Email: info@ocr.gov.np
Website: www.ocr.gov.np

Inland Revenue Department, Lazimpat, Kathmandu
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Department of Industry
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Federation of Nepalese Chambers of Commerce and Industry (FNCCI)
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Confederation of Nepalese Industries (CNI)
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Ministry of Forests and Environment
Phone: +977-1-4211567
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Email: info@mofe.gov.np
Website: www.mofe.gov.np

Value added tax (VAT) and custom duty concessions

Incentive category	Ordinary provisions	Incentive provisions
Value Added Tax (VAT)*	VAT Act 2052/ Schedule 2	■ VAT exemption for Peaking RoR and storage hydropower plant more than 200 MW (financial closure by April 2026): Construction equipment, plant, machinery, tools, spare parts, explosives, penstock pipe and steel plates. ■ VAT exemption for other hydropower and solar plants – construction equipment, machinery, tools, and spare parts required for generation, transmission, and distribution. ■ 0% VAT facility based on recommendation from AEPC for batteries produced and supplied by Nepali industries for use in solar energy producing industries. ■ VAT exemption for equipment and machines, tubular batteries, solar lead batteries, required by biogas, solar, wind energy industries (based on recommendation from AEPC) [VAT Act 2052/Schedule 2]
Custom Duty concessions	Various	■ Peaking RoR and storage hydropower plant over 200 MW: Construction equipment, plant, machinery, tools, spare parts, explosives, penstock pipe and steel plates; 1% ■ Other hydropower and solar plants – construction equipment, machinery, tools, and spare parts required for generation, transmission, and distribution. ■ Duty on generation plant having a capacity equal to or exceeding 10 Kw: 1%. ■ Duty on generating parts imported by VAT registered industries producing generators: 1%. • Windmill and related parts imported by wind energy-based industries. • Solar panel, modules, tubular batteries solar pump imported by solar industries producing electricity. • Bio-stoves imported by bio industries. • Import of mill, machinery, equipment, and spare parts thereof and chemicals for the purpose of producing organic fuel: 1%. • Appliances and equipment such as main gas valves, valves used in biogas, fitting, elbow, gas pipes, gas gauge, biogas (dung gas) lamps, gas taps (brass), gas stoves, and parts thereof, reduction elbows and rubber hose pipe necessary for dung gas, including biogas. • Construction equipment, machineries, and spare parts thereof and raw materials (steel sheet) needed to produce that equipment, which are required for generation, transmission, distribution and operation and maintenance of the hydropower plants.

* Government of Nepal, *Income Tax Act 2058*

Income tax and losses carried forward

Incentive category	Ordinary provisions	Incentive provisions
Income Tax[7]	Normal tax rate: 25% (General business)	**Tax rates:** Build, Own, Operate and Transfer (BOOT) model projects; Construction of powerhouse, hydro power generation and transmission: 20% (Schedule 1/ Rates of Tax/ 2 (4)) ■ Income generated by entity from export: 20%. ■ For hydro generation and transmission entities listed in the stock exchange: 15% exemption in normal tax rate. (Section 50 and 63) **Tax holiday:** ■ Licensed person or entity producing electricity through hydro, solar, wind and biofuel, starting its commercial production, transmission, or distribution within April 2028 (Chaitra end 2084): 100% exemption for 1st 10 years and 50% exemption for next 5 years. (Section 11/3 Gha /Ka) ■ Peaking RoR and storage hydropower plant more than 200 MW (financial closure by April 2029/Chaitra 2085): 100% exemption for 1st 15 years and 50% exemption for next 6 years. (Section 11/3 Gha /Ka) ■ 15% exemption in normal tax rate for industries engaged in hydro generation and transmission and listed in the stock exchange.
Forward of Losses Carried	Normal provision: 7 Years	Construction of powerhouse, generation, and transmission of electricity: 12 years.

[7] Government of Nepal, *Income Tax Act 2058*

For this document

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