100%RE multi-actor partnerships

POLICY ROADMAP FOR NEPAL
TO TRANSITION TO
100% RE BY 2050

AUGUST 2023

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PROJECT's CONSORTIUM

The **Prakriti Resources Centre (PRC)** is an NGO focusing on sustainable development and environmental justice in Nepal. Its mission is the adoption of climate and disaster-resilient, sustainable and gender-responsive development policies, strategies and programmes by local, provincial and federal governments.

WWF Nepal is a program office of the international NGO World Wildlife Fund (WWF). The Nepali office's priority is to support the country's conservation efforts and community development with an attempt to address the issues of livelihoods of local people living near protected areas.

WWF Germany is an independent, non-profit, non-partisan foundation, and part of the WWF network, which operates in over 100 countries and consists of national organisations and programme offices.

Brot für die Welt is the globally active development and relief agency of the Protestant Churches in Germany. In more than 90 countries all across the globe, we empower the poor and marginalized and closely and continuously cooperate with local, often church-related partner organizations. Through lobbying, public relations and education we seek to influence political decisions in favour of the poor and to raise awareness for the necessity of a sustainable way of life.

The **World Future Council** is a foundation based in Hamburg, Germany. Against the background of ever-increasing global problems that affect all areas of human life, a global group of experts have set up the WFC as a politically neutral and independent body. It brings the interests of future generations to the centre of policy making and addresses challenges to our common future and provides decision makers with effective policy solutions.

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Federal Ministry for Economic Cooperation and Development

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LIST OF ABBREVIATIONS

AEPC	Alternative Energy Promotion Centre
AFOLU	Agriculture, Forestry, and Other Land Use
AWD	Alternate Wetting and Drying
BFIs	Bank and Financial Institutions
BRT	Bus Rapid Transit
CBS	Central Bureau of Statistics
CDM	Clean Development Mechanism
CNI	Confederation of Nepalese Industries
COP	Conference of Parties
COVID-19	Coronavirus Disease 2019
CRI	Climate Risk Index
CSO	Civil Society Organization
CSR	Corporate Social Responsibility
DES	Distributed Energy Services
DoTM	Department of Transport Management
EPA	Environment Protection Act
EPR	Environment Protection Rules
ERC	Electricity Regulatory Commission
ESP	Energy Service Providers
FY	Fiscal Year
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GESI	Gender Equality and Social Inclusion
GGC	Gobar Gas Company
GHG	Green House Gas
GNI	Gross National Income
GoN	Government of Nepal
HR	Human Resource
ICS	Improved Cooking Stove
IPPU	Industrial Processes and Product Use
kw/hr	Kilowatt-hour
LDC	Least Developed Country
LG	Local Government
LPG	Liquefied Petroleum Gas
MAPs	Multi-Actor Partnerships
MEPS	Minimum Energy Performance Standards
MoEST	Ministry of Education, Science and Technology
MoEWRI	Ministry of Energy, Water Resources and Irrigation
MoF	Ministry of Finance
MoFE	Ministry of Forests and Environment
MoICS	Ministry of Industry, Commerce and Supplies
MoPIT	Ministry of Physical Infrastructure and Transportation
MT	Metric Tons
MW	Mega Watt
N-1.5°C	Nepal 1.5°C
NDCs	Nationally Determined Contributions
NEA	Nepal Electricity Authority
NLTS-NZ	Nepal's Long-term Strategy for Net Zero Emissions
NSO	National Statistics Office
OECD	Organization for Economic Development
O&M	Operation and Maintenance
PG	Provincial Government
PHS	Pumped Hydro Storage
PJ	Peta Joule
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PROR	Peaking Run-of-the-River
PV	Photovoltaics
QAP	Quality Assurance Plan
R&D	Research and Development
RE	Renewable Energy
REDD	Reducing Emissions from Deforestation and Forest Degradation
RETs	Renewable Energy Technologies
RETS	Renewable Energy Test Station
ROR	Run-of-the-River
SMEs	Small and Mid-size Enterprises
SRF	Short Rotation Forestry
UMMB	Urea Molasses Mineral Block
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WECS	Water and Energy Commission Secretariat

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PREFACE

On 12th December 2015, the 21st Conference of Parties (COP 21) to United Nations Framework Convention on Climate Change (UNFCCC) endorsed the legally binding treaty on climate change. The treaty, commonly referred to as the 'Paris Agreement' envisions limiting global warming to well below 2 °C, preferably to 1.5 °C, compared to pre-industrial levels. Although Nepal's contribution to global Green House Gas (GHG) emissions is very low compared to other countries, Nepal has ratified the Agreement to support global endeavors to combat impacts of climate change. In line with the commitments, Nepal submitted its first Nationally Determined Contributions (NDCs) in 2016, which included both adaptation and mitigation actions. At the COP 26, the Government of Nepal (GoN) announced its ambitious commitment to remain cumulatively 'net zero' from 2022-2045 and thereafter become carbon negative. In the second NDC submitted in 2020, Nepal has set more ambitious targets to reduce emissions with increased coverage of sectors encompassing Energy (cooking, residential, transportation); Agriculture, Forests and Other Land Use (AFOLU); Waste; and Industrial Processes and Product Use. By 2030, the country plans to increase clean energy generation to 15,000 MW, with 5-10% coming from diverse Renewable Energy (RE) technologies such as mini and micro-hydropower plants, solar, wind, and bioenergy.[1]

With ambitious plans in place, it is imperative to explore potential transition pathways for RE with policy level recommendations that are crucial to facilitate the transition Nepal wants to achieve by 2050. In a bid to support the government in planning for 100% RE, WWF Nepal and the Prakriti Resources Centre (PRC) in partnership with WWF Germany, Brot für die Welt and World Future Council, technical support from University of Technology, Sydney and financial support from the German Federal Ministry for Economic Cooperation and Development (BMZ) prepared a "Technical Scenario for 100% Renewable Energy in Nepal by 2050: Possible transition pathways for NDC & LTS implementation" (herein referred to as Technical Scenario) as a part of the project "Multi-Actor Partnerships (MAPs) for Implementing Nationally Determined Contributions with 100% Renewable Energy for All in the Global South" hereafter referred to as **100% RE MAP**. The Technical Scenario compares various scenarios and pathways on how Nepal can achieve 100% RE by 2050. Additionally, it also highlights the possible transition pathways based on the current energy mix and planned energy (renewable and traditional) plans and programs of the government. The report builds on Nepal's Long-term Strategy (LTS) for Net Zero Emissions 2021 and presents a 100% RE plan to decarbonize the energy sector of Nepal by 2050 within a carbon budget to remain at a 1.5 °C increase in global temperature. The report has presented three scenarios -

- Reference scenario that assumes no technical interventions till 2050 with medium economic growth rate,
- With the existing measures i.e., intervention measures specified in the plans and policies implemented and adopted up to 2020, and
- Nepal 1.5 °C (N-1.5°C) scenario that is built on the framework of targets and assumptions that accelerate rapid uptake of RE technologies mainly in electricity, heating, and transportation sector.

The main assumptions considered for achieving the target of 100% RE under N-1.5°C scenarios are:

- Emissions reduced to net zero;
- Significant growth of renewable industry;
- Fossil-fuel is phased out;
- Energy supply is secured;
- Biomass is consumed at a sustainable level;
- Transport system is electrified; and
- New renewables such as hydrogen and synthetic fuels are introduced.

The Technical Scenario is expected to be a crucial tool for decision-makers, planners, government agencies, researchers and advocates to promote a clean energy mix in the country. The Technical Scenario has been developed in consultation with the experts from the energy sector as well as other stakeholders that have been involved through Multi-Actor Partnership (MAP) platform. The Technical Scenario was launched at a national level in April 2023 by Secretary of Ministry of Energy, Water Resources and Irrigation, Government of Nepal.

Against this backdrop, the Policy Roadmap has been prepared by engaging with key energy stakeholders from the MAPs platform to develop a coherent strategy to implement 100% RE by 2050. This diverse group of stakeholders from government, civil society, business and academia provided their invaluable insights and expertise. The engagement process facilitated open discussions, brainstorming sessions, and consultations to gather a wide range of perspectives, ensuring that the roadmap is well-informed and aligns with Nepal's energy priorities.

Figure 1: Launch of Technical Scenario Document at National Level

This Policy Roadmap report encloses energy related excerpts from the Technical Scenario, more specifically the N-1.5 °C scenario with the aim to complement policy pathways for Nepal towards 100% RE which could help in meeting the national commitment while obtaining green and inclusive low carbon economic development. It also accounts for a thorough review of different strategies, policies and acts relevant for energy context in Nepal. By incorporating insights from the Technical Scenario, the roadmap enhances the feasibility and effectiveness of policy initiatives. The goal is to create a synergy between renewable energy targets, national commitments, and sustainable economic development. The document has been prepared through a collaborative and evidence-based approach.

The Policy Roadmap is expected to support the policy makers and RE practitioners by identifying key barriers to transitions to 100% RE pathway and proposes recommendations to achieve it. Based on the thorough research on energy related policies in Nepal alongside the consensus from the MAP members, major policy recommendations for household, transportation and industry sector are:

- Develop and integrate energy policies into different sectors such as transport, service, manufacturing, household, and agriculture to allow reinforcing RE development for widespread energy access.
- Provide enabling environment for investment in renewable technologies by private sectors.
- Prioritize onshore development of renewable technologies that could pave the way to achieve 100% RE by 2050.
- Increase electrification in the transport sector through expansion of a resilient power supply using renewable energy technologies while also focusing on phase-out of oil importation.

Through the 100% RE MAP project, the PRC and WWF Nepal are committed to support policymakers in developing a coherent strategy to achieve 100% RE by 2050.

1 COUNTRY OVERVIEW

1.1. Political Context

Nepal is a sovereign country nestled amidst Himalayas in South Asia. Spread in an area of 147,181 km^2, it is a landlocked country bordered by People's Republic of China to the North and by India to the remaining three directions. Nepal is administratively divided into 7 provinces, 77 Districts and 753 municipal units. The country has three tiers of government - a central government, 7 provincial governments and 753 local governments. Nepal's capital, largest city and major administrative center is Kathmandu.

Constitutionally, Nepal is a parliamentary democracy with a President serving as a ceremonial Head of State and a Prime Minister exercising the executive duties as Head of Government. Currently, Nepal is implementing its Fifteenth plan (2019/20-23/24) which was prepared with the long-term vision of fulfilling the shared national aspiration for "Prosperous Nepal, Happy Nepali" by making Nepal a high-income country by 2043. The plan targets to reduce emission from the energy sector by gradually increasing consumption of clean energy. The plan intends to boost the economy by investing in electricity generation.[2]

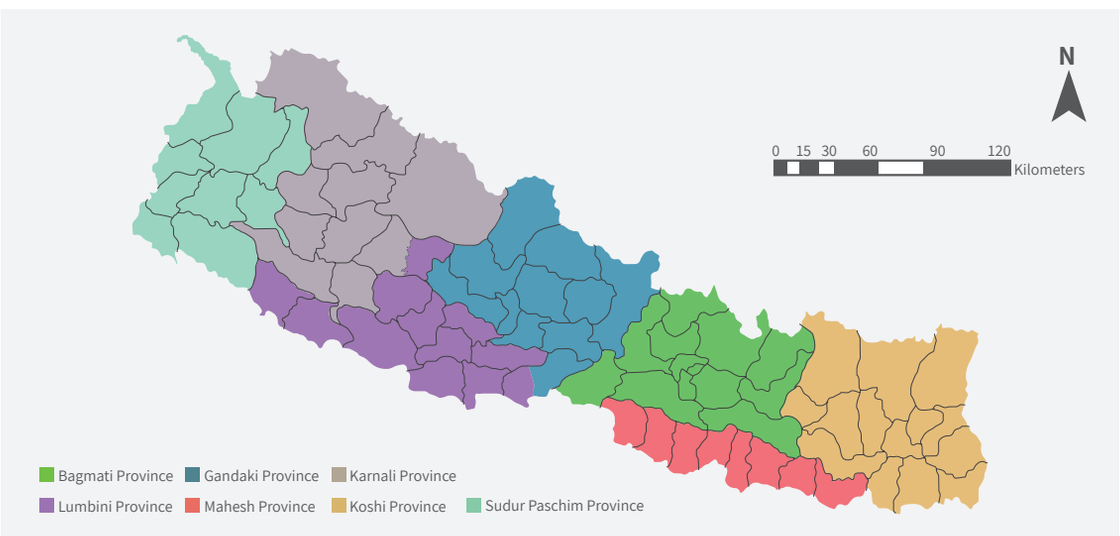

Figure 2: Map of Nepal with Seven Provinces

1.2. Demography

As per the National Population Census 2021, the total population of Nepal is 29,164,578[3] out of which, 66.17% live in the urban municipality areas. Nepal ranks 49th in the list of countries by population,[4] making it among the highly populated countries in the world. With a population density of 198 people per square kilometer, Nepal is a medium densely populated country in South Asia.[3]

1.3. Economic Context

The overall economic trajectory of Nepal has been mostly truncated owing to low levels of productivity and minimal infrastructural development. The preliminary estimates of national accounts for Fiscal Year (FY) 2021/22 project real Gross Domestic Product (GDP) growth (basic prices) at 5.84%.[4] The economy of Nepal is largely reliant on agriculture and remittance. In addition to the agricultural sector, which accounts for one- third of the GDP, the services sector also wields a significant contribution. The services sector, whose largest sub-sectors include real estate, trade, transport, communications, and education, contributes to 57.4% of GDP. The industrial sector plays a significant role, with its major components being manufacturing and construction, contributing 15.1% to the GDP. Tourism is another sector which is gradually emerging as a viable economic driver of the country. In 2018, overall economic activities associated with tourism contributed toward 7.9% of Nepal's GDP while its share in total exports was around 25%. It provided employment to 8.1% of the labor force which is comparatively much higher than other South Asian countries.[5] Nepal's economy was hit hard by the COVID-19 Pandemic. Movement restrictions in combination with an almost complete shut-down of tourism during the pandemic resulted in Nepal's first economic contraction at -2.4 in almost 40 years in FY 2019/20. A decisive vaccine roll-out and the reopening of borders have supported the economy's recovery, with growth estimated to have accelerated to 5.8% in FY 2021/22.[6]

1.4. Social Context

Nepal is a culturally rich and ethnically diverse country. It is a secular country, where people belonging to 10 religious categories and 126 caste/ethnic groups reside in harmony. As per the Multidimensional Poverty Index 2021, 17.4% of the Nepalese population are multi-dimensionally poor.[7] The literacy rate of the country's total population is 76.3% (male: 83.6% and female: 69.4%). Similarly, 51% of the population is still primarily reliant on traditional biomass for cooking.[3] The roadmap toward achieving 100% RE by 2050 will require major social transformations and behavioral changes. Most of the people are still reliant on traditional biomass for cooking in the rural areas. Information and incentive-based policies will help in overcoming the hurdles posed by the complex social dynamics of Nepal.

1.5. Energy Context

Nepal is still heavily dependent on fuelwood for meeting cooking energy demand in rural areas and imported fuels in meeting transport demand and cooking energy demand in urban areas. However, the shift to commercial energy (coal, petroleum products, and electricity) is evident and the RE sources are also increasing. Consumption of electricity has also increased at a good pace lately.[1] Thus the energy mix is getting cleaner.

The total electricity generation capacity in the country is around 2684 MW in FY 2022/23[8] with projections for 15000 MW by the year 2028. At present, the energy generation from hydropower has a seasonal surplus supply and is being traded bilaterally with India through Government-Government agreements and trading platform.

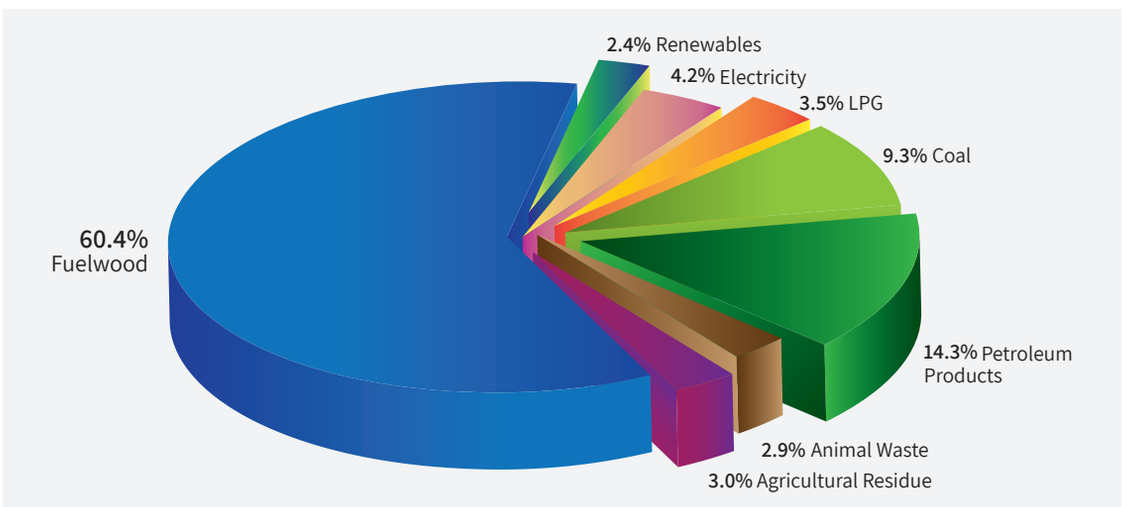

Figure 3: Energy Consumption by Fuel Types (WECS, 2022)

1.6. Environmental Context

Nepal ranks as the 95th largest country in the world in terms of land area. Although the country covers less than 0.1% of the total landmass of the Earth, it is geographically quite diverse and resplendent. Nepal has strict environmental protection policies in place. The Environment Protection Act (EPA) 2019 and Environment Protection Rules (EPR) 2020 serve as guiding documents for environment protection and rehabilitation. The Ministry of Forests and Environment (MoFE) serves as the focal ministry for issues related to environmental and climate change. The government has also established a nodal agency Alternative Energy Promotion Centre (AEPC), under the Ministry of Energy, Water Resources and Irrigation (MoEWRI) to develop and promote renewable/alternative energy technologies, in Nepal. The AEPC supports GoN to devise policies and develops support mechanisms for projects and interventions regarding clean and renewable technologies energy efficient technologies and carbon initiatives relevant to Renewable Energy Technologies (RETs) like solar, small/mini hydropower, bioenergy, waste to energy, wind, etc.

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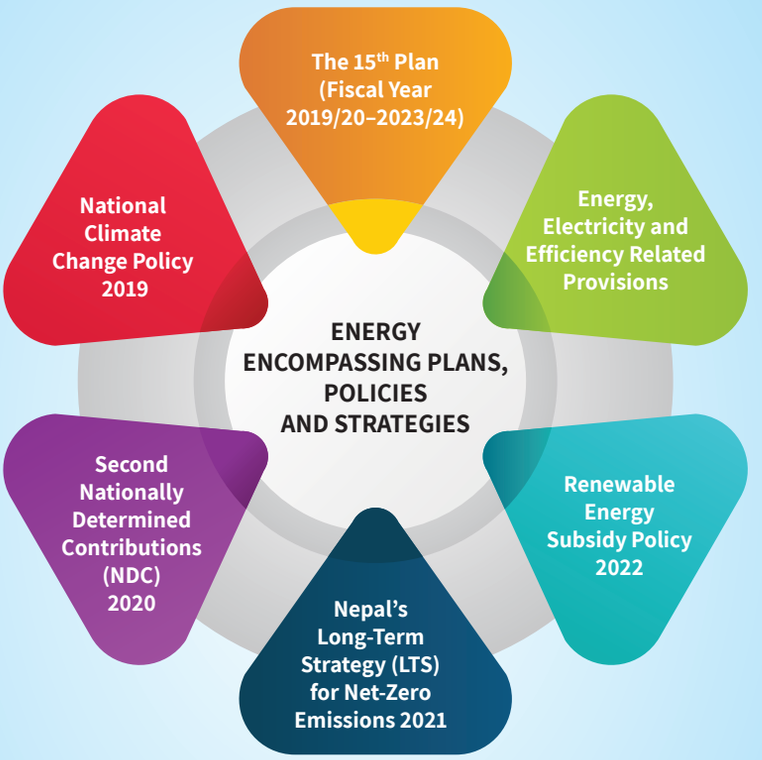
POLICY FRAMEWORK AND BARRIER ANALYSIS

2.1. | Policies/Plan/Strategies



The 15Th Plan (Fiscal Year 2019/20–2023/24)

The GoN has established socio-economic targets in its Fifteenth plan, which ends in mid-2024. The document defines various targets, with some until 2043/44. The plan classifies energy as hydropower and alternative energy in two different categories. In terms of hydropower, the plan aims to ensure energy security and efficiency through intensifying hydropower generation and consumption while also contributing to the balance of payment by increasing energy export and gradually substituting the import of petroleum products. The plan expects that the installed capacity of hydropower will have reached to 5,000 MW with 100% electricity access all over Nepal with per capita electricity consumption of 700 kw/hr.

Similarly, for alternative energy, the plan aims to ensure access to clean energy and to contribute to energy security by increasing energy efficiency in its production and utilization. The plan expects that with the generation of 13 MW from micro and small hydropower, 125.4 MW from solar power system, and 10 MW from wind energy, an additional 7% of the population will have access to electricity while also making energy available to 2000 small and medium enterprises. Additionally, the plan also expects that 200,000 household biogas plants, 500,000 improved stoves and gasifiers will have been installed with 40,000 MT of Liquified Petroleum Gas (LPG) substituted.[9]

National Climate Change Policy 2019

The National Climate Change Policy was promulgated with the objective of supporting the National Environment Policy of 2019 by providing policy guidance to various levels and thematic areas towards developing a resilient society by reducing the risk of climate change impacts. The policy has seven objectives that includes promotion of green economy by adopting the concept of low carbon emission development among all.

The policy recognizes the absence of uniformity in understanding the multi-sectoral issues of climate change among the inter-sectoral agencies and the lack of coordination among them. Additionally, it also recognizes the lack of studies, research and basic data about the impacts of climate change effect and potential loss or damage resulting from climate-induced disasters, failure to mainstream the climate change issues into overall development process, and the lack of institutional capacity, financial resources, technology and knowledge as the major problems in the area of climate change management.[10]

Second Nationally Determined Contributions (NDC) 2020

The GoN has submitted the second NDC under the Paris Agreement for the period 2021-2030, following Articles 4.2 and 4.11 of the Paris Agreement, and Decision 1/CP.21 paragraph 23 and 24, along with other relevant provisions. In the second NDC, Nepal has set more ambitious targets to reduce emissions with increased sectoral coverage i.e., Energy (cooking, residential, transportation); Agriculture, Forests and Other Land Use; Waste; Industrial Processes and Product Use. In addition to the sectoral activity-based targets till 2025 and 2030, it also includes policy targets for sectors where data and/or baseline information is not available such as for electric railroads, solid waste management and industries.

Particularly, for energy sector, the following conditional targets have been set to be implemented by 2030:

- Increase the reliable supply of clean energy, ensuring access to all;
- Increase the quantity (kw/hr), quality, reliability, and affordability of energy access from renewable sources;
- Strengthen transmission and distribution links to support upscaling of e-cooking, e-heating, e-transport and charging stations;
- Develop an enabling environment to provide power to Small and Mid-size Enterprises (SMEs) using distributed renewable energy generation sources;
- Promote public electric mobility through policy incentives, including subsidy policies and other financial mechanisms; etc.[11]

The cost of achieving Nepal's NDC conditional mitigation targets is estimated to be USD 25 billion; for which Nepal anticipates financial, technological and capacity-building support from global funds such as the Green Climate Fund. The cost of achieving unconditional targets is estimated to be USD 3.4 billion. This estimate only covers activity-based targets and does not include the cost of policies, measures and actions.

Nepal's Long-Term Strategy for Net-Zero Emissions 2021

The LTS is a comprehensive document that builds upon Nepal's wish to gain recognition for its mitigation contributions beyond its border through clean energy trade and highlights action plans to achieve net-zero emissions by 2045.[12] The document envisions bold policymaking, social transformation, and technological advancements that will lead to a carbon-neutral, inclusive, and climate resilient future. The document identifies strategies on a sectoral basis as follows:

- **Energy:** The LTS aims to power the industrial, commercial, and agricultural sectors with RE and hydrogen technologies. Furthermore, in the power generation sector, all electricity will be enerated from renewable sources, primarily hydropower and solar PV.
- **Industrial Processes and Product Use (IPPU):** With the expected growth of industries, the LTS recommends switching to RE and waste-related fuel, and raw materials such as limestone for the cement industry. Additionally, Nepal will explore the potential for Carbon Capture and Storage (CCS) technologies, beyond that possible through the forest sector.
- **Waste:** To reduce emission from waste, waste-water treatments technologies like methane gas recovery, incineration of waste for heat and power generation, and methane generation from anaerobic digester in wastewater treatment must be promoted.

- **Agriculture, Forestry, and Other Land Use (AFOLU):** LTS proposes switching to better cultivation practices, rice intensification system, better manure management, soil organic matter enrichment, soil management practices such as low soil tillage, adaptive and resilient varieties, and breeds, expanded adoption of controlled release of stabilized fertilizers, better enteric fermentation processes, and promotion of agroforestry and other sustainable agriculture systems. Further, Nepal must increase and maintain its forest cover, increase afforestation and achieve net-zero deforestation, adopt measures to decrease forest fire, scale-up sustainable forest management, private forestry practices, promote energy-efficient technologies and improve the monitoring and database systems.
- **Energy Trade:** Significant emissions reductions can be achieved outside of Nepal through Hydro and Solar power exports.

Apart from capacity needs, cost analysis reveals the need for significant investment to deliver GHG mitigation. In the With Additional Measures (WAM) scenario, the total costs of the sectors considered are estimated to be 46.4 billion USD from 2021 to 2030, 53.4 billion USD from 2031 to 2040, and 96.3 billion USD from 2041 to 2050.

Renewable Energy Subsidy Policy

The Renewable Energy Subsidy Policy of 2022 details out the promotion strategies and subsidy support for different RE technologies as follows:

- Small and Mini Hydropower (Including Improved Water Mills)
- Solar Home Systems
- Solar Mini-grid
- Solar Thermal
- Household Biogas
- Large Biogas
- Industrial Scale Commercial and Municipal Waste to Energy Technologies
- Biomass
- Wind Energy

In addition, the policy also focuses on the promotion of productive energy use to improve entrepreneurship and overall livelihood in the areas energized by RE technologies of various sizes.[13] The government has also developed the Renewable Energy Subsidy Delivery Mechanism in 2022 to facilitate the subsidy delivery in line with the provisions of the Subsidy Policy

Electricity and Energy Efficiency Related Policy Provisions

As per the Nepal Electricity Authority (NEA) Act 1984, NEA is made responsible for power supply by generating, transmitting, and distributing electricity in an efficient, reliable and convenient manner.[14]

The Electricity Act of 1992 envisions developing electric power by regulating the survey, generation, transmission and distribution of electricity and to standardize and safeguard the electricity services. The Act encourages private sector involvement in electricity generation. Generation, transmission, and distribution are licensed activities under its provisions and are restricted to a specific area. The government can authorize any person or entity for the generation, transmission and distribution of electricity.[15]

The Hydropower Development Policy of 2001 builds on the premises of the Electricity Act. The policy aims to implement small, medium, large and storage projects for hydropower development focusing on national interest, environment protection and maximizing benefits in the development of water resources of Nepal. The policy acknowledges the potentials of the country and understands the need of its optimum utilization in order to meet the domestic demand of electricity. The policy is important in view of hydropower development as an alternative to biomass and thermal energy.[16]

The Electricity Regulatory Commission (ERC) Act 2017 mandates the ERC to regulate the generation, transmission, distribution and trade of electricity.[17] The Electricity Regulatory Commission Rules 2018 outlines the procedure to implement the provisions mandated by the ERC Act.

2.2. Technology Needs and Barrier

The Technical Need Assessment (TNA) document was made public in August 2021 with an understanding that substantial technological resources are crucial for achieving net-zero emissions by 2045.[18] The identification of implementable mitigation technologies has been deemed vital for development and scaling up of the mitigation efforts. The document has prioritized the following technologies based on the sensitivity analysis of different technologies:

- **Energy:** Electric Cook Stove, Biogas, Bus Rapid Transit
- **Agriculture:** Urea Molasses Mineral Block, Alternate Wetting and Drying
- **Forestry:** Silviculture, Short Rotation Forestry

A Barrier Analysis and Technology Action Plan for Mitigation Technologies was prepared in 2021. It identifies sector-based barriers and proposes mitigation measures to overcome those barriers.[19]

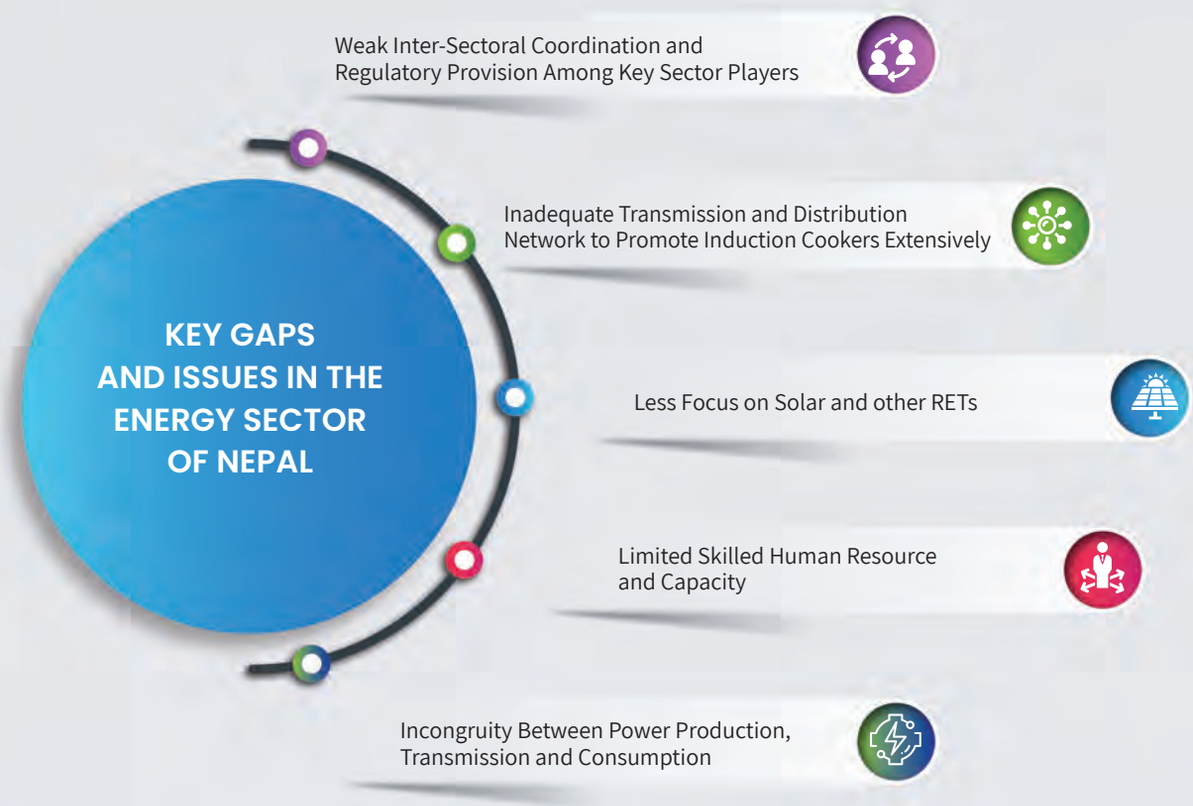
TABLE 1: BARRIER ANALYSIS

SECTOR	TOOLS/ TECHNOLOGY	BARRIERS	MEASURES
AGRICULTURE	Urea Molasses Mineral Block (UMMB) Technology	• Gap in national policies regarding GHG mitigation in livestock sector. • Strengthening existing agricultural commercialization policy. • High capital investment. • Lack of dedicated subsidy provision for the technology to cover underlying financial risks. • Information and communication gap.	• Commercialization of agriculture and livestock sector to make it more competitive & resilient. • Introduce finance and incentive mechanisms including subsidies and dedicated credit lines. • Develop an information system for a strong network. • Shift from forage-based to stall-fed (UMMB) livestock management.
	Alternate Wetting and Drying (AWD) Technology	• Financial gap to cover the upfront financing needs for technology. • Affordability of the farmers and insufficient knowledge. • Information and communication gap. • Need for specific policy measures regarding adoption, development & improvements related to technology. • Need for financial instruments including credits & subsidies to enhance the bank ability of the technology at the farmers' end.	• Introduction of farmer friendly technologies. • Provision of soft loans or subsidies to reduce upfront financing needs. • Development of an information system for strong network. • Establish local consumer group to promote water management systems and practices and engage them in policy formulation process. • Enhance financial capability of farmers through measures targeted toward better crop yield, storage facilities and marketing instruments.
FORESTRY	Silviculture	• Inadequate resource allocation. • More focus of the national policies on maintaining forest stands. • Need to develop better know-how of the technology among the experts and institutions. Need for an effective multi-stakeholder participation mechanism(s).	• Access and utilize finances from international mechanisms such as Reducing Emissions from Deforestation and Forest Degradation (REDD). • Introduce policies to enhance forest yield and carbon sink. • Establish local markets to support forest-based enterprises.
	Short Rotation Forestry (SRF)	• Inadequate investment in research and demonstration. • Missing linkages in the existing policies and plans to enhance and conserve forest carbon stock. • Inadequate data available on baseline situation of forest biomass. • Inadequate information regarding market system.	• Promote investments from government, non-government, private sectors & international funds. • Adopt specific strategies for enhancement and conservation of forest carbon stocks. • Conduct specific capacity building activities to increase technical capacity. • Perform market feasibility survey and establish local markets to support forest entrepreneurship.
ENERGY	Bus Rapid Transit (BRT)	• Policy gap in existing transport and urban policies to specifically address BRT technology. •High investment costs for the infrastructure and long gestation period inhibit investment confidence. High import tax and excise duty. • Lack of coordinated efforts among several agencies from the federal to local levels making decision-making process more bureaucratic. • Weak infrastructure for BRTs.	• Emphasis on efficient mass transportation by government. • Formation of separate policy with better policy measure to leverage private sector investment to build investor confidence. • Policy reform to reduce excise duty and taxes to encourage BRT. • Establish a separate institution with authority to deal with several institutions involved. • Development of infrastructures like dedicated lanes and flyovers for BRTs.
	Biogas	• High initial installation cost of biogas plant. • Need for a mechanism to re-channel the carbon revenue generated from operating biogas units to ensure sustainable operation of those units. • Need to strengthen existing maintenance services	• Focus on research and development (R&D) for new prototype of the biogas with lower cost. • Introduce soft loan schemes and micro-credits. • Promote better animal husbandry practices for better raw materials. • Provide skill development training & awareness.
	Electric Cook Stove	•Extra costs to upgrade to higher current supply and additional costs towards cooking utensils with induction base. •Need for policies to discourage LPG use and encourage the use of electric cook stoves.	• Enhance generation of electric power through development of additional hydropower projects. • Differential electricity costs to reduce burden at peak load. • Development of service and distribution centers for optimum use of the technology.

3

KEY GAPS AND ISSUES IN THE ENERGY SECTOR OF NEPAL

The policy level provisions detailed in Section 2 have created much groundwork for implementing action plans to promote RETs and transition to a carbon neutral economy. However, there are a few gaps and issues that must be addressed. While these issues and gaps expose an array of challenges, addressing these could provide opportunity to moving ahead with the ambitious energy transition



3.1. Weak Inter-Sectoral Coordination and Regulatory Provision Among Key Sector Players

Although the current policies and act seem ideal, the weak regulatory provision and practices can affect its implementation. Moreover, weak inter-sectoral coordination among key sectors such as forestry, agriculture, and industry including difficulty in the acquisition of public and private land are other issues. The concerned entities are more aware of their scope of work whereas there is a lack of orientation on proactively dealing with cross-cutting issues. Also, there is a lack of coordination mechanism among provincial and local governments to implement mitigation measures.

3.2. Inadequate Transmission and Distribution Network for Wide Promotion of Efficient Electric Stoves

Almost 90% of Nepali households are connected with a 5-ampere meter but at least a 15-ampere meter is needed for cooking using electric cooktops. Reliability is a main concern for people who want to switch to electric cooking. Industries also face similar situations. Because of inadequate transmission capacity, they have not been able to receive a reliable and sufficient supply of electricity.

3.3. Less Focus on Solar and other RETs

Even though government policies aim to generate electricity from solar and other RETs with a goal to contribute 5-10% in total energy mix, the priority is still on hydropower. However, considering the challenging terrain, it might have been more effective for the Power Purchase Agreements (PPA) to be based on methods like reverse auctions or location-based rates, rather than using a flat, one-size-fits-all approach. Further, lack of finance and limited innovation are major hurdles to upscale and deploy RETs at large scale.

3.4. Limited Skilled Human Resource and Capacity

Different tiers of governments are still developing their institutional capacity relating to human resources, technical know-how, financial resources and policy level arrangements. Development and retention of skilled human resources is getting difficult as many educated youths are seeking better futures abroad.

3.5. Incongruity Between Power Production, Transmission and Consumption

The electricity market is a monopsony in the country. Even though private sectors are in generation, NEA is the main institution responsible for transmission, system operation, distribution and trade. The private sector is not provided with access to transmission systems operated by NEA. This displays incongruity between power production, transmission and consumption, discouraging private sector to open up for investment.

4 POLICY ROADMAP

Considering the existing policy framework and projected scenarios for 2050, a Policy Roadmap has been prepared for the three priority sectors – residential, industry and business, and transportation in line with the Technical Scenario. With the anticipated continued annual GDP growth of 5% on average until 2025 and 7.5% thereafter until 2050, the energy demand is expected to grow constantly in all these priority sectors.[2] The residential sector will remain dominant in Nepal's energy demand, but the energy demand of the industry sector will increase constantly. By 2050, industry will consume at least four times more energy than in 2020, making this sector the second highest consumer after transport in all three scenarios. The energy demand of the transport sector will quadruple by 2050 under the REFERENCE scenario, whereas it will stabilize under WEM and the N-1.5 °C scenario. The main reason for the significant difference in growth projections is the high rates of electrification in the latter two pathways.

Figure 4: Projection of Total Final Energy Demand by Sector – Scenarios: Reference WEM, and 1.5˚C

The large efficiency gains achieved in the N-1.5 °C pathway is attributable to the high electrification rates, mainly in the cooking and transport sectors, because combustion processes with high losses are significantly reduced. The N-1.5 °C pathway will accelerate electrification of the heating, cooking, and transport sectors compared with those of the WEM pathway, and aims to replace more fossil and biofuels with electricity. Therefore, the electricity demand will already be twice as high as under the REFERENCE scenario by 2030 (31 TWh/a). By 2050, Nepal's electricity demand will increase to 62 TWh per year, compared with 60 TWh under WEM and 50 TWh under the REFERENCE scenario. Electricity will

become the major renewable 'primary' energy, not only for direct use for various purposes, but also for the generation of a limited number of synthetic fuels to substitute for fossil fuel in providing industrial process heat.

This roadmap focuses on achieving the ambitious target of 100 % RE by 2050 and is prepared to support the sectoral ministries and decision makers to plan and better prepare for it. The policy roadmap has been developed through intensive discussions and feedbacks received from various MAP Workshops, with the most recent ones being held on 23-24 February 2023 and 23-24 March 2023. The timeline for the policy development has been segregated into short term (within 1 year), medium term (1-5 Years) and long term (beyond 5 years).

4.1. Residential Sector

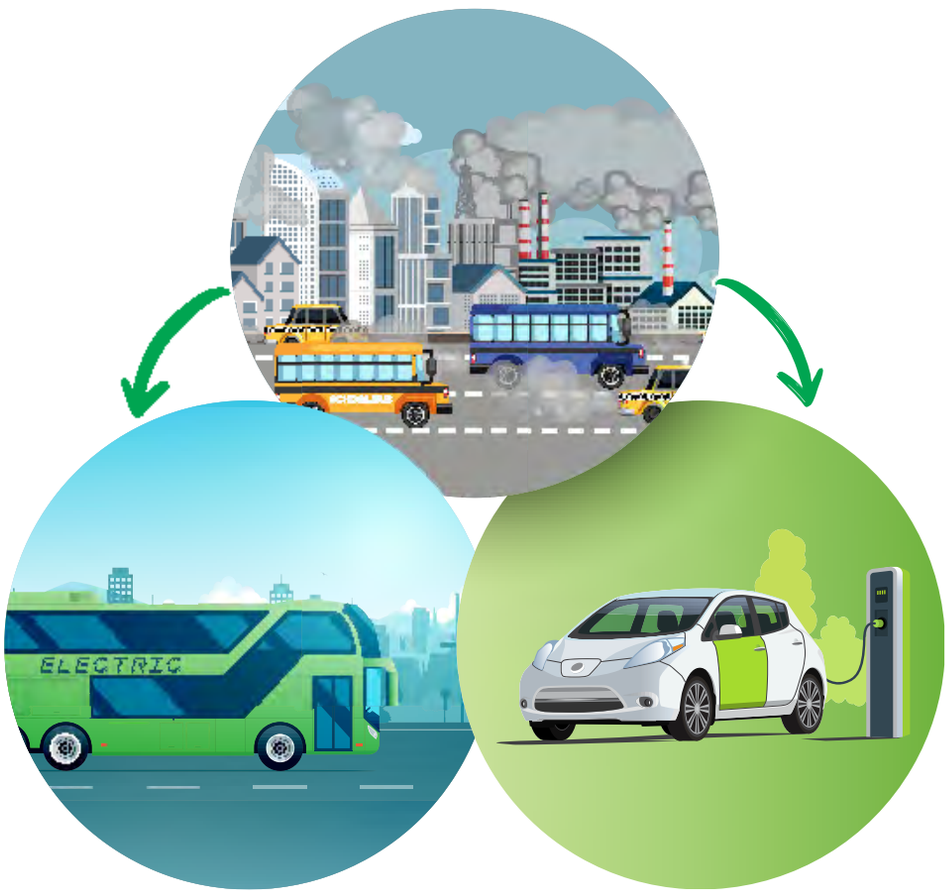
Over 94% of the Nepalese households have access to energy services where around 5.5% are connected to mini-grids and the rest are connected to the main grid.[20] Nepal is among the countries with the highest proportions of the population served by mini-grids; wherein, solar PV and mini-hydro systems have dominated the generation technologies used.[2] The current average electricity demands of Nepalese households is lower than those of Organization for Economic Development (OECD) countries. For instance, an urban household in Nepal consumes on average 836 kWh/a, whereas an urban household (apartment of 2 people) in OECD country (specifically Switzerland) consumes on average 3,025 kWh/a.

Similarly, energy demand in the Nepalese households is largely inclined towards cooking, where firewood and LPG are the main source of energy for rural and urban households respectively. On average, a five-member middle-class family in Nepal (average rural household size) uses seven LPG cylinders in a year. With the adoption of electric cooking, this decreases to three LPG cylinders a year (because they use both electricity and LPG for cooking). With a saving of four cylinders per year per household, the existing 515,000 e-cooking users avoided the importation of 29,252 MT of LPG in the financial year 2018/19 (6.8% less than the actual LPG imported that year, 429,609 MT). E-cooking (with electricity source from mini-grids in rural areas) makes for a cheaper and emission free energy source. A study in one municipality showed that cooking on induction stoves is almost 40% cheaper than cooking on LPG and consumed 1.22 kWh per day. [21] Assuming an additional 10,00,000 households will adopt e-cooking by 2025, the country will avoid the importation of 86,052 MT of LPG in 2025. Currently, local level governments lag in policy framework formulation which supports the increased utilization of electric cooking devices. The general awareness about the benefits of e-cooking is also lacking due to lack of information access which ultimately results to low acceptance of e-cooking devices in the supply chain. The phase-out of unsustainable biomass and LPG will play an important role in decarbonizing energy supply in Nepal in household context under N-1.5 °C scenario.

TABLE 2: POLICY ROADMAP FOR RESIDENTIAL SECTOR

Issues	Barrier/Challenges	Policy Measures	Time Frame			Responsibility	
			1 Yr.	1-5 Yrs.	5+ Yrs.	Primary	Secondary
Legal/Policy/ Regulatory	• No specific implementation policy/ guidelines • No specific policy to engage private sector. • Insufficient product quality control and assurance. • Contextualization of energy sector.	• Formulate guidelines on implementation modality of policies designed for household sector. • Encourage Private Sector involvement. • Enforce Quality Control mechanisms.				GoN, MoEWRI, NEA, AEPC	PGs, LGs, Media
Implementation/ Business Model	• Urban centric cooking business. • Market-based business models lacking.	• Promote cooking technologies for rural markets as well. • Market-based business model needed (Private sector return). • Promote prosumer concept.				MoEWRI, MoICS, AEPC	Private Sector
Finance	• High upfront cost of appliances. • Lack of financing mechanism • Lack of Insurance of cooking appliances.	• Reduce the cost of appliances by promoting mass consumption and subsidy mechanisms. • Find innovative financing and insurance mechanisms.				Ministry of Finance (MoF), Nepal Rastra Bank	Private Sector, Community Groups, Bank and Financing Institutions
Technical	• Poor state of energy distribution infrastructure. • Poor household infrastructure (wiring, switching, etc.) • Lack of operation and maintenance support within the country for large systems. • Focus on hydropower as a basic solution for all areas.	• Upgrade electricity distribution infrastructure. • Enhance after-sales service capabilities. • Product labeling and standards setting. • Improve household infrastructure. • Digital meter installation. • Intensify technological assessments in all local levels and promote technology diversification. • Emphasis should be laid on expansion of renewable energy other than hydropower.				MoEWRI, NEA, AEPC,	Universities, Research Institutions, Private sector associations, Technical Service Providers, RETs
Institutional Capacity	• Low institutional capacity to initiate behavioral change.	• Improve institutional capacity, mainly in the provincial and local levels.				AEPC, PGs, LGs	CSOs, Youth Group, Vocational Institutes
Social	• Social composition • Reluctance to change behavior. • Gender inclusiveness.	• Awareness-building. • Promote gender inclusiveness through campaigns and social incentives.				PGs, LGs	CSOs, Women's Group, Media

4.2. Transportation Sector



The transportation sector is the highest energy consumption sector in terms of petroleum products and accounts for 10.3% of the national total, largely dominated by motorcycles, followed by 4-wheelers such as cars and pick-up trucks. Public transportation via buses and mini-buses only account for 1% of all the registered vehicles.[1] The passenger transport demand is around 41 PJ/a while freight transport demand is 18 PJ/a as of 2020. It is assumed that the annual passenger kilometer will increase by 3% annually by 2050, while the freight transport will increase by 2% annually. Similarly, the growth of shares for cars is also assumed to increase with the expense of two-wheeler vehicles ultimately increasing the average energy intensity per kilometer.[2] The electrification of all kinds of vehicle fleets is necessary for complete decarbonization in the transportation sector.

The second NDC makes a commitment to ensure the sales of e-vehicles cover 90% of all private passenger vehicles sales by 2030. The government has provision of subsidies for the purchase of battery used in electric vehicles while the target also calls for switching to energy-efficient and new/clean energy vehicles through incentives as an immediate action.[22] However, based on the lifespan of motorcycles (10 years) and cars (20 years), the country-wide overall market share of electric vehicles may not exceed 5% by 2030 for both passenger and freight cars. Similarly, the infrastructure required for electric mobility, such as maintenance and services are underdeveloped across Nepal which is directly impacted by the resilience and reliability of the electricity supply. The N-1.5˚C scenario addresses these challenges and assumes the total decarbonization of the transport sector in Nepal by 2050.

TABLE 3: POLICY ROADMAP FOR TRANSPORTATION SECTOR

Issues	Barrier/Challenges	Policy Measures	Time Frame			Responsibility	
			1 Yr.	1-5 Yrs.	5+ Yrs.	Primary	Secondary
Policy	• Lack of proper and clear transportation policies on vehicles operating on clean fuel. • Lack of directives and strict enforcing mechanisms. • Policies promoting EVs are vague and inadequate.	• Incentivize on insurance premium of e-vehicles in public transportation (led by government), focus on mass transportation such as railways and EBRTs. • Decrease insurance premiums. • Make strong policy arrangements to stop import of fossil-fuel vehicles after 2030. • Remove legal barriers to convert fossil-fuel vehicles to electric vehicles. • Provide electricity tariff subsidy for EV charging.				MoPIT, DoTM	PGs, LGs
Technology	• Despite advancements on sustainable alternatives, fossil fuel-operated vehicles remain the predominant preference among consumers. • Efficient mass transportation lacking. • Sustainable options to make air transport clean not sufficiently explored.	• Control of sales of fossil-fuel operated vehicles (stepwise transition). • Introduce efficient recharging systems in every 50kms to promote EVs for long range transportation. • Develop train/BRT networks. • Long-term vision and strategy to make air transport green and sustainable.				DoTM	Private Sector, PGs
Research and Development	• Lack of adequate R&D to identify local needs and solutions.	• Promote R&D in energy efficient transportation, e-vehicle supply chain recycle/ reuse and safe disposal. • Development of curriculums for energy efficient and clean transportation in every level of studies.				Ministry of Environment, Science and Technology (MoEST)	PGs, Universities
Infrastructure	• Poor road infrastructure. • Low priority for sustainable urban transport.	• Improve quality of road infrastructure. This improves energy efficiency. • Sustainable urban planning (for example, pedestrian and cycle-friendly lanes). • Cable car/ Ropeway that is currently installed for tourism needs to be used for goods transport as well.				MoPIT, DoTM, Department of Roads and Railway, PGs	LGs
Institutional Capacity	• Lack of a powerful transportation management authority. • Lack of clarity on the role of Local Governments to promote sustainable transportation in the areas under their jurisdiction	• Institutional restructuring, clarity in institutional roles and responsibilities. • Introduction of mass transportation management authority. • Capacity development of cities.				GoN, MoPIT	DoTM, PGs, LGs, Media

4.3. Industrial Context

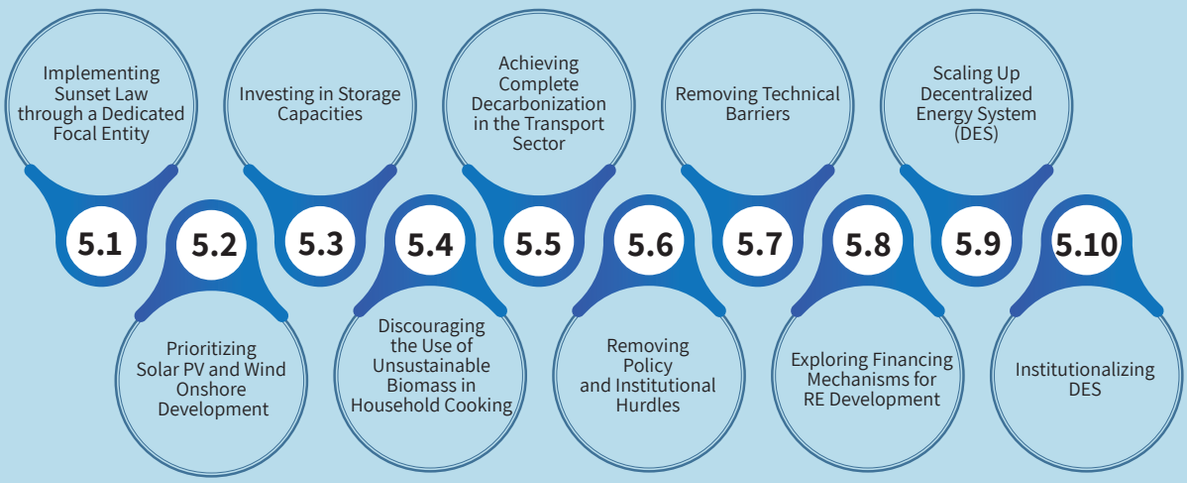
In the fiscal year 2020/21, the industrial and business sector contributed to the nation's GDP through eighteen sub-sectors. The wholesale and retail trade, repair of motor vehicles and motorcycles contributed most strongly (20.17%), with agriculture, forestry and fishing at a close second (20.15%). Similarly, construction (9.81%), financial and insurance activities (8.36%), transportation (8.24%), and real estate activities (5.53%) were among the top ranked sub-sectors contributing to the GDP. Similarly, the contribution of the agricultural sector and non-agriculture sector to the gross value added in the fiscal year 2019/20 was 25.8% and 74.2% respectively, where the contribution of the former is decreasing.[23]

The energy demand for fuel-based industrial process heat is largely dominated by bio-energy. Under N-1.5˚C, industries use new heating supply technologies, and direct electric heating such as radiators and heat pumps which will accelerate as an interim measure between 2025 & 2030. Similarly, electrification in the industry sector will be achieved through solar collectors, geothermal energy, electricity and hydrogen from renewable sources, substituting fossil-fuel and biofuel-fired systems.[2]

TABLE 4: POLICY ROADMAP FOR INDUSTRIAL SECTOR

Issues	Barrier/Challenges	Policy Measures	Time Frame			Responsibility	
			1 Yr.	1-5 Yrs.	5+ Yrs.	Primary	Secondary
Legal/Policy/ Regulatory	• Policy document not in place. • Energy auditing system. • Absence of regulatory framework for mandatory energy auditing system. • Absence of standard and labelling program.	• Documentation of mandatory benchmarks for strengthening regulatory performance measurement. • Effective implementation of the Industrial Enterprise Act. • Standards development for industry advancement. • Development and adoption of the method of energy testing and implementation of its recommendations.				Ministry of Industries, Commerce and Supply (MoICS)	MOF, AEPC, PGs, LGs, FNCCI, CNI
Implementation	• Assurance of raw material, labor, finance. • Monitoring and evaluation as prerequisites for establishment and smooth operation. • Quality Assurance Plan (QAP).	• Benchmarking. • Limits in Energy intensity and Carbon intensity. • Implementation of Minimum Energy Performance Standards (MEPS).				MoICS	MOF, FNCCI, CNI
Finance	• High capital expenditure. • Lack of incentives. • Inadequate market based business model.	• Dedicated fund (incentive, tax exemption, interest rebate). • Enabling environment for re-investment. • Dynamic insurance policies.				MOF	Banks, Cooperatives, CNI
Technical/ Human Resource (HR)	• Inadequate R&D. • Inadequate HR capacity to execute standard and levelling programs. • Technological advancement. • Employee turnover. • Push and pull strategies.	• Experience-sharing. • Testing facilities for electronic devices. • Financial and non-financial incentives. • Technology transfer. • Funding for research scholars.				MoEST	Industries, Universities, Training Centers
Institutional Capacity	• Lack of expertise. • Inadequate collaboration.	• On and off the job training. • Experience & skill sharing. • Institutional mechanism.				MoEST, PG, LG	MoICS
Socio Environment	• Regulatory EPA. • Poor monitoring and evaluation. • Social hurdles.	• Public mindset/ awareness / ownership/ consultation. • Include investment in RE in CSR (Corporate Social Responsibility).				MoEST, MoFE	CSOs, Local Government

5 POLICY RECOMMENDATIONS



A thorough review of the existing policies and inherent gaps provides an insight into future action plans necessary to achieve the targets committed by Nepal through its second NDC. Policies supporting and enabling deployment and integration of RE and energy efficiency must go hand in hand with a broader set of policies which ensure that industrial and other economic capabilities are aligned with the national priorities, as well as with other environmental objectives. The Thematic Report on Energy Transition published by the United Nations in 2021 states that there is no single policy that can achieve climate and development objectives in a socially sustainable manner, a set of mutually reinforcing policies, tailored to specific country contexts and objectives, must be placed at the core of the transition.[24]

It is assumed that Nepal will establish a secure and stable framework to deploy RE generation in the Technical Scenario. For Nepal to increase the energy access rate to 100%, it is crucial to build up and expand its power generation system, which ultimately requires new infrastructure (including power grids), spatial planning, a stable policy framework, and access to finance.

Currently, NEA and AEPC have been providing support for energy access under the leadership of MoEWRI. In the present scenario, private sector is free to produce electricity but there is no competition in the buying market. NEA is the sole authorized entity for trading, transmitting, operating and distributing electricity. There should be legal provisions to enable competition in the energy market. In another light, solar PV and wind power technologies are getting more affordable day by day. Nepal has significant solar resources, and wind potential to some extent. However, unstable policy frameworks conducive to private sectors lead to high investment risks and higher project development and installation costs relative to those in countries with more stable policies.

The N-1.5°C scenario is designed to calculate the efforts and actions required to achieve the ambitious objective of a 100% renewable energy system and to illustrate the options available to change the Nepalese energy supply system into a truly sustainable one. 100% renewable energy scenarios for electricity generation, energy demand, energy supply, and transportation require investments and policies that will enable them.[24] Moving forward, the following four methods of policymaking are suggested:

a) Deployment Policies: enhance the energy transition by accelerating the deployment of existing solutions while simultaneously innovating to address incomplete solutions. This includes:

- Push policies- binding targets, quotas, and obligations etc.
- Pull policies- pricing policies, public procurement, tradable certificates, and RE regulations.
- Financial and fiscal measures- tax incentives, subsidies, and grants.

b) **Integration Policies:** stimulate the modernization of energy services and planning in terms of medium- to long-term policy goals. It includes planning beyond the power sector i.e. transport, agriculture, industry, service, etc.

c) **Enabling Policies:** energy projects and transitions are implemented in such a way that all are benefited. Avoid or minimize dislocations for individuals, communities, countries, and regions .i.e. win-win approach.

d) **Structural Policies:** Adapt the socio-economic structure to the energy transition so that the participation of a wide group of stakeholders is ensured (economic policies, structural change, labor policies, skills development, reskilling) Some of the key recommendations to achieve 100% RE by 2050 that emanate from this understanding are outlined in the following subsections.

5.1. Implementing Sunset Law through a Dedicated Focal Entity

The targets committed by Nepal is a magnanimous one considering the present energy usage scenario of Nepal. Less than 27 years remain to achieve the targets of net-zero emission, which necessitates focused approaches. One of the imminent activities towards this would be to bring the sunset law for a specific period and implement all the energy projects as planned in NDCs within the sunset law period. A sunset law is a legal arrangement that is formulated for a limited time with a pre-determined expiry date. The proposed sunset law would most likely need to be effective until 2050 to achieve 100% RE. In this process, a focal entity should be identified within the existing institutional mechanism to oversee the implementation of mitigation measures. Much like how Nepal Reconstruction Authority facilitated to expedite post-earthquake recovery after the earthquake of 2015, such focal entity with empowered role provisioned by sunset law will enable the government to formulate action plans, allocate resources and ensure delivery through one window. A dedicated entity will mean that a single entity will be responsible to track the policy implementation status and recommend action plans to expedite their implementation. Such an entity will empower the government to impose legally backed provisions where incentive-based models fail. A focal entity empowered by legal provision will also establish the credibility of the cause among public.

5.2. Prioritizing Solar PV and Wind Onshore Development

The plans for large scale electrification are mostly focused on hydropower, which, may not always be appropriate for all parts of Nepal. With a rugged terrain and extreme weather patterns, Nepal also has a huge potential to harness large-scale energy from solar and wind technologies. Technology options for a particular area must be selected on the basis of availability of resources and ease of execution. It is effectively non-beneficial to construct long transmission lines to electrify a relatively small settlement that can easily be electrified by solar mini grids. Even though the government has set a target to meet a 10% energy mix through solar and wind, the PPA rate for Solar is unstable and IPPs see little incentive to invest in solar technologies.

Moreover, the ERC bylaw of 2021 and procedures for grid-connected alternative energy projects have provisions for buying electricity from solar and other alternative energy technologies but the feed-in tariff has not been fixed yet. The government must commit to promoting all forms of renewable energy, as the integrated results will only make it possible for mass-scale replacement of traditional energy option. The N-1.5°C scenario considers that the capacity for solar PV installations will increase substantially with an increase capacity to around 1,100 MW per year between 2036 and 2045; with 44% new renewable electricity production. Therefore, the solar PV and wind onshore development must be prioritized for Nepal to move forward towards 100% RE by 2050.[2]

5.3. Investing in Storage Capacities

Nepal currently operates a large fleet of run-of-river hydropower plants with no pump storage capacity. However, according to the Global Pumped Hydro Atlas, Nepal has 2,800 good storage sites.[25] With the high share of dispatchable hydropower, storage capacities to avoid curtailment for grid-connected solar PV will not be required until 2030. In the case of priority dispatch for solar PV, which will mean that the output of hydropower must be reduced to avoid production peaks under N-1.5°C scenario. After 2030, the penetration of solar PV will increase significantly, and additional storage capacity will be required. The utilization of this potential by implementing additional water reservoir storage capacities and pumped hydro storage (PHS) facilities will put Nepal in a comfortable position to integrate large amounts of variable solar PV power generation.[2] For any sector to meet its complete decarbonization target, improvement in its energy efficiency and storage are a must. Thus, it is important to note that storage capacities aid in strengthening resilience of energy markets and infrastructure.

5.4. Discouraging the Use of Unsustainable Biomass in Household Cooking

Firewood is the main source of energy in rural households while imported LPG dominates the semi-urban and rural households. At the other end of the spectrum, only 1% of all Nepalese households utilize electricity for cooking technologies. However, cooking with electricity (solar home systems or mini-grid context) using cooking appliances makes for a cheaper source in the long run. Phase out of the unsustainable biomass and LPG is particularly important in decarbonizing Nepal's household energy supply. The target, under analysis, is achievable considering that Nepal had replaced inefficient stoves with more efficient ones in the past which reduced the need for fuel for each cooking stove. Therefore, a staged transition towards 100% RE for cooking is assumed. On average, 3.3% of all fuel-based cooking applications will be gradually phased out per year and replaced with electric cooking appliances under the N-1.5˚C pathway. Burning LPG causes CO2 emissions, and its production is based on fossil gas, which must be phased-out by 2050 to remain within the global carbon budget to limit the global mean temperature rise to a maximum of +1.5°C.[2]

5.5. Achieving Complete Decarbonization in the Transport Sector

Nepal's transport sector is currently dominated by motorcycles, which account for 78% of all registered vehicles, whereas cars, pick-up trucks, and vans represent only 8% of the vehicle fleet. The three-wheeler vehicles, such as electric rickshaws and 'tempos', constitutes 6.5%, which is almost as large as that of cars. Similarly, just over 1% of all registered vehicles account for buses or mini buses. The remaining 6% includes construction and industry vehicles, such as tractors, cranes, and excavators. The scenarios developed in the Technical Scenario assumes the decarbonization of Nepal's transport sector wherein, additional modal shifts and a technology switch to electric mobility will lead to even higher energy savings of 75% (150 PJ/a) in 2050 under the N-1.5°C.[2]

The existing policies on energy efficiency standards for transportation sector should be strengthened to move forward with cost-efficient utilization of renewable energy. Thus, a focus on updating prevalent energy efficiency issues, more importantly, in the transportation sector is needed with initiatives to introduce newer fleets of highly efficient electric vehicles. Additionally, the infrastructure vital for electric mobility requires a lot to be addressed in terms of maintenance, service centers and charging stations throughout Nepal. The complete decarbonization of the transport sector would require increased electrification in the transport sector, phase-out oil alongside the expansion of a resilient power supply from the sustainable power generation technologies such as renewable energies.

5.6. Removing Policy and Institutional Hurdles

Although the government has prepared many policies to support the development of renewable energy, there are various gaps and institutional hurdles that make the existing policies difficult to implement. Some of the issues that need to be resolved are as follows:

- **An integrated policy framework** should be in place. The government should refrain from drafting inconsistent and unstable policies. The political leadership should also act sensibly on this matter.
- **Inter-sectoral coordination** must be strengthened among key sectors such as energy, environment, forestry, agriculture, land use, health, and social development.
- **Energy policies should be integrated** into the transport, service, manufacturing and agriculture sectors. Coordination between off-grid and grid-based entities must be increased.
- **Tariff distribution among grid-connected consumers must be scientifically redeveloped.**
- Scientific pricing mechanisms must also be developed for off-grid, isolated mini-grids, ensuring their sustainable operation.
- Open access and power wheeling need to be brought into practice.
- **Institutional capacity** of the entities responsible for implementing crucial plans and policies must be enhanced. Especially the federal and local governments must be well informed and enabled to handle the envisioned transition. There should be a **coordination mechanism in place** among public institutions in all three tiers of government.
- **The investment environment must be improved** to attract more investment in large-scale and sustainable energy technologies.
- **Regulatory provisions must be strengthened in distributed energy services.**
- **Policies must be revisited to facilitate interconnection of off-grid energy to the main grid.** With the current pace of grid expansion, many off-grid technologies will seek this provision in future.

5.7. Removing Technical Barriers

Currently, the technical reliability of energy systems is questionable, even among the grid connected urban centers of Nepal. Therefore, technical reliability should also be equally considered along with ensuring energy access sufficiency. Some of the areas where technical improvements are required include :

- The transmission and distribution systems must be made more robust. Frequent energy tripping is a normal occurrence in Nepal, which must be improved. Sufficient planning should be done for grid stability and voltage regulations so as to prompt people to embrace clean energy solutions in their households.
- Reducing the imbalances caused by intermittent injection i.e. irregular supply of electricity.
- Quality of services, reliability, operational safety and Operation and Maintenance (O&M) aspects of the Distributed Energy Services (DES) in off-grid and isolated mode should be improved to enable operation of high capacity of domestic appliances and to promote end-use for increased load factor.
- Energy audit and electrical safety audit for high energy consuming sector/institution should be enforced and monitored periodically.

5.8. Exploring Financing Mechanisms for RE Development

The financial aspect is a crucial consideration while making any plan or policy to achieve 100% RE, as lack of financial resources will render even the most benign plans ineffective. The following factors should be considered:

- **Investment and long-term financing options** should be made available. Integrating Bank and Financial Institutions (BFIs) in this mission will be crucial.
- **A well-planned viability gap fund should be created** to balance out higher per kW cost due to interconnection and distribution.
- High capital costs and the long-life cycle of existing transmission and distribution infrastructures that make it difficult to upgrade to more efficient infrastructure for effective integration should be reduced.

- The integration cost in the existing grid infrastructure should be reduced.
- Duplication in **support for DES from various agencies** should be checked. Projects built with sole objective of amassing support from various agencies won't be sustainable in long run.

5.9. Scaling Up Decentralized Energy System

The White Paper of the Government unveiled via MoEWRI plans to generate 15000 MW by 2028, with the generation mix of 30-35% Storage Hydropower, 25-30% peaking run-of-the-river (PROR) Hydropower, 30-35% run-of-the-river (ROR) Hydropower and 5-10% DES Renewables. The paper also aims to increase Per Capita electricity consumption to 1,500 kWh by the same time frame. The 5-10% renewable energy mix will mainly consist of energy derived from Solar PV, MHPs and Wind energy systems. To ensure systemic functionality, following actions should be considered:

- Small-scale renewables need to be grid compliant to ensure compatibility if they are to be integrated into energy grids.
- Institutional capacity and technology transfer needs should be prioritized to meet government targets and scale up DES effectively.
- Transmission and distribution infrastructures should be strengthened.
- Receiving global funding, particularly from Green Climate Fund (GCF) and Global Environment Facility (GEF), should be explored.

5.10. Institutionalizing DES

With the 3-tiers government structure in place under the federal structure adopted by the Constitution of 2015, it is very important to integrate planning among various government bodies in order to effectuate a seamless transition to 100% RE. Potential actions include:

- Develop Provincial Energy Plans as components of the national energy sector master plan.
- The government should conduct resource identification and planning with demand and supply projections. Local and provincial governments should be proactive in this regard.
- Integrate upstream and downstream river basin planning, including benefits and compensation.
- Plan institutional capacity with regard to terms of licensing, regulatory requirements, PPA, other technical assistance.
- Integrate waste management systems into the energy generation- technology transfer. Incentive mechanism and benefit sharing in PPP model for this should be clarified.
- Develop the human resources need to support the private sector, and local governments in the provinces to promote DES.
- Create appropriate policies to incentivize the deployment of DES streetlights.
- Provide incentives for energy usage in the agriculture sector (irrigation, drinking etc.).
- Encourage the unbundling of the distribution system with the NEA and integrate more renewables with proper technical specifications into the system.
- Establish a province-level system operator that allows DES as a long-term goal.
- Strengthen results-based incentives for DES generation and establish financing mechanisms with risk guarantees.

6 CONCLUSION

Nepal has ambitions to rapidly harness the enormous advantages of its vast domestic electricity-generating capacity. The ambitions also complement the country's commitment to remain cumulatively 'net zero' from 2022-2045 to support the global endeavours to combat the impacts of climate change. Despite Nepal's substantial potential to generate renewable energy, the energy mix is still dominated by traditional biomass and imported fossil fuels which have adverse impacts on the environment, health, and the national economy with the consumption pattern shifting towards unsustainability.

It is widely understood that energy plays a significant role in enabling Nepal to realize its economic growth potential and achieve poverty alleviation. Nepal holds large markets for renewable energy consumption – given that its solar resources, hydroelectric resources (and potentially wind resources) is tapped. However, owing to challenges, more specifically, weak regulatory provision and practices of the action plans; weak infrastructure affecting the generation, transmission and distribution of electricity; and limited skilled human resources and capacity have caused Nepal to experience an energy crisis of unprecedented severity caused by years of underinvestment and a sharp growth in energy demand.

RETs are essential commodities for economic prosperity and development in the current era. Micro-hydropower and solar energy projects have allowed electricity generation in rural corners of Nepal where connection to the national grid has almost been uncertain due to the country's rugged terrain and difficult topography. Such off-grid renewable technologies have contributed directly and indirectly by enhancing energy supply; particularly relieving the energy scarcity experienced by low-income population and have helped improved their livelihoods. The efforts from the government of Nepal to meet the energy related international commitments could be complemented with attempts to strengthen energy efficiency planning alongside significant potential for transmission upgrades.

Albeit ambitious, 100% RE by 2050 is achievable. **Technology options could be made context specific on the basis of availability of resources and ease of execution.** It's crucial to realize that economic logic and equity considerations must override personal and vested interests. Therefore, there must be an emphasis in achieving complete decarbonization of different sectors with staged transition. A proper scale-up for renewable energy solutions call for a comprehensive policy framework harmonized by a long-term strategy to create an enabling environment where accountability is ensured.

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100%RE
multi-actor
partnerships

The “Multi-Actor Partnerships (MAPs) for Implementing Nationally Determined Contributions (NDCs) with 100% Renewable Energy (RE) for All in the Global South” hereafter referred to as **100% RE MAP** is a three-year project commencing from 2020. Funded by the Federal Ministry of Economic Cooperation and Development, Germany (BMZ), the project aims to introduce and consolidate multi actor partnerships across varied stakeholders – government civil society, business and academia - with a vision of transitioning towards a 100% Renewable Energy Scenario in three countries – Nepal, Vietnam and Uganda. The project has three major projected outcomes, establishing the MAP platform, developing Policy Roadmaps including Technical Scenario for 100% RE by 2050, and international transfer and exchange of knowledge. In Nepal, the project is implemented by WWF Nepal and the Prakriti Resources Centre (PRC).

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