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Alternative renewable energy in Bhutan

Key findings and policy recommendations

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Key findings and policy recommendations

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Contents

Abbreviations and acronyms

ADB	Asian Development Bank
AREP	Alternative Renewable Energy Policy
BEA	Bhutan Electricity Authority
BPC	Bhutan Power Corporation Limited
CapEx	Capital Expenditure
CoD	Commercial Operation Date
DDG	Decentralised Distributed Grid
DER	Distributed Energy Resources
DGPC	Druk Green Power Corporation
DHPS	Department of Hydropower and Power Systems
DPP	Development Project Proposal
DPR	Detailed Project Report
DRE	Department of Renewable Energy
EDP	Economic Development Policy
EE	Energy Efficiency
EV	Electric Vehicle
FDI	Foreign Direct Investment
FiT	Feed-in Tariff
FYP	Five-Year Plan
GCF	Green Climate Fund
GESI	Gender Equality and Social Inclusion
GHG	Greenhouse Gas
GNH	Gross National Happiness
GNHC	Gross National Happiness Commission
GW	Gigawatt
HKH	Hindu Kush Himalaya
HV	High Voltage
ICIMOD	International Centre for Integrated Mountain Development
IRENA	International Renewable Energy Agency
IRR	Internal Rate of Return
ktoe	Kilotonnes of Oil Equivalent
kWh	Kilowatt Hour
LCOE	Levelised Cost of Energy
LPD	Litres Per Day
LV	Low Voltage
MoEA	Ministry of Economic Affairs
MSME	Micro, Small, and Medium Enterprise
MV	Medium Voltage
MW	Megawatt
NDCs	Nationally Determined Contributions
NTGMP	National Transmission Grid Master Plan
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PSH	Peak Sun Hour
R&D	Research and Development
RE	Renewable Energy
REC	Renewable Energy Certificate
REDF	Renewable Energy Development Fund
REMP	Renewable Energy Master Plan
RERAR	Renewable Energy Resource Assessment Report
RETs	Renewable Energy Technologies
RFP	Request For Proposal
RGoB	Royal Government of Bhutan
ROR	Run-Of-the-River
RPO	Renewable Purchase Obligation
SDGs	Sustainable Development Goals
SPV	Solar Photovoltaic
SWHS	Solar Water Heating System
TWh	Terawatt Hour

Executive summary

This report analyses the achievements in the field of renewable energy in Bhutan and outlines the following findings and recommendations so that the country is able to scale up its renewable energy capabilities.

1. Determination of alternative renewable energy plans and targets

Findings

- There are opportunities to develop periodic energy demand and supply projections to understand the future scenario; this will help in policymaking and planning.

Recommendations

- Prepare energy demand and supply projections to identify the renewable energy share in the energy mix. Invest in tools and data for a clear assessment of renewable energy needs and goals, and to arrive at evidence-based decisions. This will guide policy intervention and help the government set targets and commitments; it will also help in estimating the required financial and human resources and in mobilising the private sector and the required institutional structure.

2. Financial resource mobilisation

Findings

- The Renewable Energy Development Fund (REDF) and its operational modality need to be developed in line with long-term strategies, targets, implementation modalities, and instruments. For example, if the focus is on commercialisation, the operational modalities will be about credit financing, investment derisking, insurance, etc. to enable private investments in renewable energy.

Recommendations

- The AREP should incorporate the above findings in order to develop demand-driven mechanisms and modalities that can promote private-sector engagement in terms of participation as well as investment; this will also pave way for public-private partnership (PPP) models and credit and derisking funds, as well as facilitate tax and other incentives. Further, the DRE can collaborate with relevant local government extension offices to increase outreach, thereby strengthening the mechanisms that can effectively develop and deploy RE solutions.

3. Capacity development and private-sector engagement

Findings

- There is less than 1 MW of RE deployment in Bhutan, which reflects low local private-sector capacity. The current RGoB plans involve implementing over 300 solar photovoltaic (PV) on-grid rooftop and solar PV utility-scale projects.

Recommendations

- To support the RE market, it will be necessary to build overall capacity. This requires a well-thought-out policy relating to partnerships with academic institutions, which should be able to offer certified RE courses and specialised training stints. This will help develop capacity and create skilled manpower at the local level.

4. Augmenting hydropower

Findings

- Bhutan is endowed with RE (solar, wind, biomass) resources. One of the priorities of the DRE is to have proper rules and regulations in place regarding connections and meters. In this regard, it is promoting the prosumer (professional plus consumer) model; this allows it to broaden the energy mix, reduce stress on firm power, and contribute to national energy security by finding the right balance with the Bhutan Power Corporation Limited (BPC), the distribution company.

Recommendations

- The policies and regulations regarding connection capacity and meters need to be well defined, and appropriate incentives have to be offered to promote the generation and distribution of renewable energy; along with this, the prosumer model has to be promoted. Besides, the penetration capacity of the DRE's supply lines has to be clearly defined for the sake of stability and balance.

5. Beyond electricity access

Findings

- Almost all of Bhutan has access to electricity, but it is important to look beyond this access.
- The focus should be on energy, not merely on electricity. Productive end-use applications should be promoted and respective incentives offered.
- Preparing an inventory of least-cost RE technologies and solutions will be useful in identifying areas where RE interventions are necessary.
- More supportive regulations are required to increase productive electricity use. For instance, currently, the regulations on tariffs do not address irrigation tariffs.
- Since the current policy limits the growth of the renewable energy market to the institutional capability of establishing projects-pipelines by DRE, customer demand-based implementation methods are likely to be limited.

Recommendations

- Develop a major sectoral road map for the transition towards clean energy.
- Establish the least cost-based approach to identify appropriate RE technologies, offer incentives to promote productive energy use, and put in place regulations on electricity tariffs.
- Promote an ecosystem-based approach to establish or scale up green and resilient enterprises along with their value chains.
- The AREP should incorporate the above findings in order to develop demand-driven mechanisms and modalities that can promote private-sector engagement in terms of participation as well as investment. This will pave way for public-private partnership (PPP) models and credit and de-risking funds, as well as facilitate tax and other incentives. Further, the DRE can collaborate with relevant local government extension offices to increase outreach, thereby strengthening the mechanisms that can effectively develop and deploy RE solutions.

6. Mainstreaming gender equality and social inclusion

Findings

- The current ARE policy lacks the component of gender equality and social inclusion (GESI).

Recommendations

- Ensure GESI engagement and participation in key decision-making spheres throughout the project cycle – from inception to implementation and beyond.
- Take evidence-based policy actions to pave way for women-led and inclusive enterprises in order to facilitate and lead the energy transition as energy producers, energy brokers, and energy consumers.
- Develop targeted policies to ensure GESI. This will help in overcoming barriers related to high initial capital cost of clean energy, access to technologies, regulations/standards, skills, and incentives.
- Institutionalise GESI mainstreaming in energy-related governmental agencies by establishing a dedicated unit as an umbrella agency to implement all plans and programmes.

7. Standards, testing, and R&D

Findings

- In order to ensure quality control, more attention has to be paid to developing standards for various RE technologies. Besides, there is need for testing facilities.

Recommendations

- In terms of quality control in the RE sector, there is a need for standardisation and the establishment of an RE testing facility (in coordination with the Bhutan Standards Bureau). Besides, national standards need to be instituted to ensure uniformity across all aspects of procurement and implementation. In this regard, R&D should be seen both as a long- and short-term strategy. Local-level innovations also need to be encouraged – via support systems – in terms of setting up start-ups and challenge funds.

Biomass and hydropower are the principal sources of energy in Bhutan. Like in the case of other Hindu Kush Himalayan (HKH) countries, biomass accounts for approximately 67.5 per cent of Bhutan's total energy consumption (UNSD 2019), while hydropower constitutes one-third of its export revenue (IRENA 2019). In the future too, the latter is expected to play a significant role in meeting the country's electricity needs and in earning export revenue. But, for transportation and other purposes, the country still has to import fuel. It is in this context and because of the country's high dependence on hydroelectricity, as well as due to rising energy usage and falling prices of other renewable energy commodities that it has been deemed necessary to look into other renewable energy sources to diversify the country's energy mix and economy. Thus, in a concerted manner, the Royal Government of Bhutan (RGoB) has been exploring avenues of alternative renewable energy (ARE) sources. For this, the Department of Renewable Energy (DRE), under the Ministry of Economic Affairs (MoEA), is the nodal agency; it has been entrusted with the responsibility of developing sustainable energy channels and promoting renewable energy technologies (RETs). In this regard, DRE has been actively implementing the country's Alternative Renewable Energy Policy (AREP) of 2013.

Overall, in Bhutan, hydropower generation falls below 20 per cent of the installed capacity during the winter season, resulting in imports and higher electricity costs. So, to ensure energy security all through the year, Bhutan needs to diversify its fuel mix and retain its net-zero carbon emissions by using solar, wind, waste-to-energy, hydrogen, biomass, and biogas technologies. It is in this context that the Bhutanese government is revising the AREP of 2013.

SECTION I

Findings and recommendations

Alternative renewable energy development in Bhutan will only be effective if it is scaled up to a large extent. Efficient planning, proper target setting, evidence-based policies, and an encouraging environment are prerequisites for scaling up renewable energy. In order to expand the country's energy mix and increase economic diversity, it is vital to look into various clean and renewable energy sources. The following are the findings and recommendations of this study on achieving renewable energy sufficiency in Bhutan.

Determination of alternative renewable energy plans and targets

FINDINGS

- There are opportunities to develop periodic energy demand and supply projections to understand the future scenario; this will help in policymaking and planning.

RECOMMENDATIONS

- Prepare energy demand and supply projections to identify the renewable energy share in the energy mix. Invest in tools and data for a clear assessment of renewable energy needs and goals, and to arrive at evidence-based decisions. This will guide policy intervention and help the government set targets and commitments; it will also help in estimating the required financial and human resources and in mobilising the private sector and the required institutional structure.

Financial resource mobilisation

FINDINGS

- The Renewable Energy Development Fund (REDF) and its operational modality need to be developed in line with long-term strategies, targets, implementation modalities, and instruments. For example, if the focus is on commercialisation, the operational modalities will be credit financing, investment derisking, insurance, etc., to enable private investments in renewable energy.

RECOMMENDATIONS

- The AREP should incorporate the above findings in order to develop demand-driven mechanisms and modalities that can promote private-sector engagement in terms of participation as well as investment; this will also pave way for public-private partnership (PPP) models and credit and derisking funds, as well as facilitate tax and other incentives. Further, the DRE can collaborate with relevant local government extension offices to increase outreach, thereby strengthening the mechanisms that can effectively develop and deploy RE solutions.

Capacity development and private sector engagement

FINDINGS

- There is less than 1 MW of RE deployment in Bhutan, which reflects low local private-sector capacity. The current RGoB plans involve implementing over 300 solar PV on-grid rooftop and solar PV utility-scale projects.

RECOMMENDATIONS

- To support the RE market, it will be necessary to build overall capacity; this requires a well-thought-out policy relating to partnerships with academic institutions; these institutions should be able to offer certified RE courses and specialised training stints; this will go a long way in developing capacity and in creating skilled manpower at the local level.

Augmenting hydropower

FINDINGS

- Bhutan is endowed with RE (solar, wind, biomass) resources. One of the priorities of the DRE is to have proper rules and regulations in place regarding connections and meters. In this regard, it is promoting the prosumer (professional plus consumer) model; this allows it to broaden the energy mix, reduce stress on firm power, and contribute to national energy security by finding the right balance with the Bhutan Power Corporation Limited (BPC), the distribution company.

RECOMMENDATIONS

- The policies and regulations regarding connection capacity and meters need to be well defined, and appropriate incentives have to be offered to promote the generation and distribution of renewable energy; along with this, the prosumer model has to be promoted. Besides, the penetration capacity of the DRE's supply lines has to be clearly defined for the sake of stability and balance.

Beyond electricity access

FINDINGS

- Almost all of Bhutan has access to electricity, but it is important to look beyond this access. The focus should be more on energy rather than merely on electricity; this means promotion of productive end-use applications and offering respective incentives.
- Preparing an inventory of least-cost RE technologies and solutions will be useful in identifying areas where RE interventions are necessary. More supportive regulations are required to increase productive electricity use. For instance, currently, the regulations on tariffs do not address irrigation tariffs. Since the current policy limits the growth of the renewable energy market to the institutional capability of establishing projects-pipelines by the DRE, customer demand-based implementation methods are likely to be limited.

RECOMMENDATIONS

- Develop a major sectoral road map for the transition towards clean energy.
- Establish the least cost-based approach to identify appropriate RE technologies; offer incentives to promote productive energy use; and proper regulations on electricity tariff should be put in place. Promote an ecosystem-based approach to establish or scale up green and resilient enterprises, as well as their value chains..
- The AREP should incorporate the above findings in order to develop demand-driven mechanisms and modalities that can promote private-sector engagement in terms of participation as well as investment; this will also pave way for public-private partnership (PPP) models and credit and de-risking funds, as well as facilitate tax and other incentives. Further, the DRE can collaborate with relevant local government extension offices to increase outreach, thereby strengthening the mechanisms that can effectively develop and deploy RE solutions.

Mainstreaming Gender Equality and Social Inclusion (GESI)

FINDINGS

- The current ARE policy lacks the component of gender equality and social inclusion (GESI).

RECOMMENDATIONS

- GESI engagement and participation in key decision-making spheres should be ensured throughout the project cycle from inception to implementation and beyond.
- Evidence-based policy actions have to be taken to pave way for women-led and inclusive enterprises in order to facilitate and lead the energy transition as energy producers, energy brokers, and energy consumers.
- Develop targeted policies to ensure GESI; this will help in overcoming barriers related to high initial capital cost of clean energy, access to technologies, regulations/standards, skills, and incentives.
- Institutionalise GESI mainstreaming in energy-related governmental agencies by establishing a dedicated unit as an umbrella agency to implement all plans and programmes.

Standards, testing, and R&D

FINDINGS

- In order to ensure quality control, more attention has to be paid to developing standards for various RE technologies; besides, there's a need for testing facilities.

RECOMMENDATIONS

- In terms of quality control in the RE sector, there is a need for standardisation and the establishment of an RE testing facility (in coordination with the Bhutan Standards Bureau). Besides, national standards need to be instituted to ensure uniformity across all aspects of procurement and implementation. In this regard, R&D should be seen both as a long- and short-term strategy. Local-level innovations also need to be encouraged – via support systems – in terms of setting up start-ups and challenge funds.

SECTION II

Context

2.1 Background

The REEECH (Renewable Energy and Energy Efficiency Capability for the Hindu Kush Himalaya) programme of the International Centre for Integrated Mountain Development (ICIMOD) aims to improve access to modern, affordable, and reliable energy services and enhance the safeguarding of essential mountain ecosystem services in the HKH region. Energy poverty remains the central challenge to sustainable development efforts in this region. A broad range of barriers, including policy and regulatory obstacles, outdated technology, and a lack of capacity and finance, have prevented the region from taking full advantage of existing and potential renewable energy sources for decentralised sustainable energy solutions in off-grid mountain areas.

REEECH provides a coordination mechanism to foster South-South cooperation for improved access to decentralised sustainable energy solutions for the HKH region. REEECH contributes to 10 Sustainable Development Goals (SDGs) – covering 20 targets – related to energy, poverty, gender, economic growth, employment, health, water, industrialisation, climate change, and partnerships. To achieve these goals, it works on four thematic areas: knowledge management and awareness; inputs to policy development and implementation; capacity development; and promotion of investment, entrepreneurship, and innovation.

One of the objectives of the REEECH initiative is to support inputs to policy development and implementation of renewable energy solutions in the HKH region. Against this backdrop, REEECH has carried out policy and regulatory scoping for the HKH member countries. As the second working paper of a series, here we review the energy scenario, potential, targets, and gaps regarding the renewable energy sector in Bhutan. In this paper, we have made some policy recommendations for consideration by the Department of Renewable Energy (DRE) to promote renewable energy in Bhutan so as to meet its developmental goals and also to tap the unfolding opportunities in the future. In order to promote renewable energy and energy-efficient solutions in the mountain countries, the study adopted a responsive strategy that drew on regional experiences. Moreover, apart from describing the energy scenario of Bhutan, this paper has contextualised the unique energy needs of the HKH member countries. The recommendations presented here can be considered as an input to the ongoing process of revision of the Alternative Renewable Energy (ARE) Policy 2013 by the Royal Government of Bhutan (RGoB).

2.2 Methodology

The analysis was done using a mixed research method which included both qualitative and quantitative techniques. At various stages of the research process, the methodology gave priority to the gathering, analysis, and blending of both quantitative and qualitative data. While the qualitative approach lay emphasis on understanding the subtleties, actors, and institutions related to renewable energy development in Bhutan, the quantitative evaluation complemented the qualitative approach by critically analysing the primary and secondary data from multiple sources. The exploratory nature of this research – aimed at capturing Bhutan's energy scenario and making policy recommendations that can help the country meet climate goals and SDGs – involved case studies, interviews, pilot studies, and focus group discussions.

During the study, a detailed analysis was conducted of statistical reports of various governmental and non-governmental organisations of national and international repute. Specifically, policy and regulatory documents, as well as briefs published by the RGoB on the subject of energy, were scanned. While the primary data came in the form of different technical reports and documents on Bhutan's energy policy and regulatory guidelines, the secondary sources of information were online articles and reports published by the RGoB, UN agencies, and other international organisations; journal articles too were part of the exercise. All these have been cited in the Rrferences.

On 21 December 2021, the first policy stakeholder consultation meeting in this regard was held with officials from the Department of Renewable Energy, Bhutan Electricity Authority (BEA), and Bhutan Power Corporation Limited (BPC). Following this, in April 2022, a week-long visit was made to Bhutan in order to gather and consolidate essential data and information. A purposive sampling method was chosen to identify the relevant stakeholders working in Bhutan's energy sector. In this whole process, the study team met with senior government officials, domain experts from academic institutions, and independent researchers. Annex 1 carries a list of the key stakeholders who were interviewed during this visit.

2.3 Energy scenario

Hydropower is one of Bhutan's most important energy sources; it also accounts for one-third of its export earnings (IRENA 2019). However, during the lean seasons, particularly during winter, the overall hydropower generation dips below 20 per cent of the installed capacity, resulting in the import of electricity and an increase in its cost. According to the RGoB, this seasonal and drastic variation in power generation has primarily got to do with the impact of global warming on glaciers, which are the primary source of river water. Thus, this single-source dependence, rising electricity demand, and the falling prices of alternative renewable energy sources have led to an investigation of other clean and renewable energy sources in order to broaden the country's energy mix and diversify its economy.

2.3.1 Energy supply and consumption

Biomass and hydropower are the primary sources of energy in Bhutan. Figure 1 presents an overview of the country's energy supply and consumption patterns in the year 2019. In that year, the total primary energy supply of Bhutan is shown to be 71,461 terajoules, which is a 2 per cent increase from 2018. About 67.5 per cent of Bhutan's total primary energy supply is from biofuels and waste, while 18 per cent comes from oil and coal, and 14 per cent from electricity. The volume of energy exports, chiefly of hydroelectricity, is shown to be double the energy imports. In 2019, the total final energy consumption was primarily based on biomass, which accounted for nearly 69 per cent of the total energy consumption. Figure 2 presents data on the total final energy consumption by the various sectors of Bhutan.

The share of renewable energy, especially of biomass, in the total final energy consumption mix has been reducing over the years, chiefly due to switching from fuel wood. Figure 3 provides the percentage share of renewable energy in the total final energy consumption tally.

2.3.2 Energy security

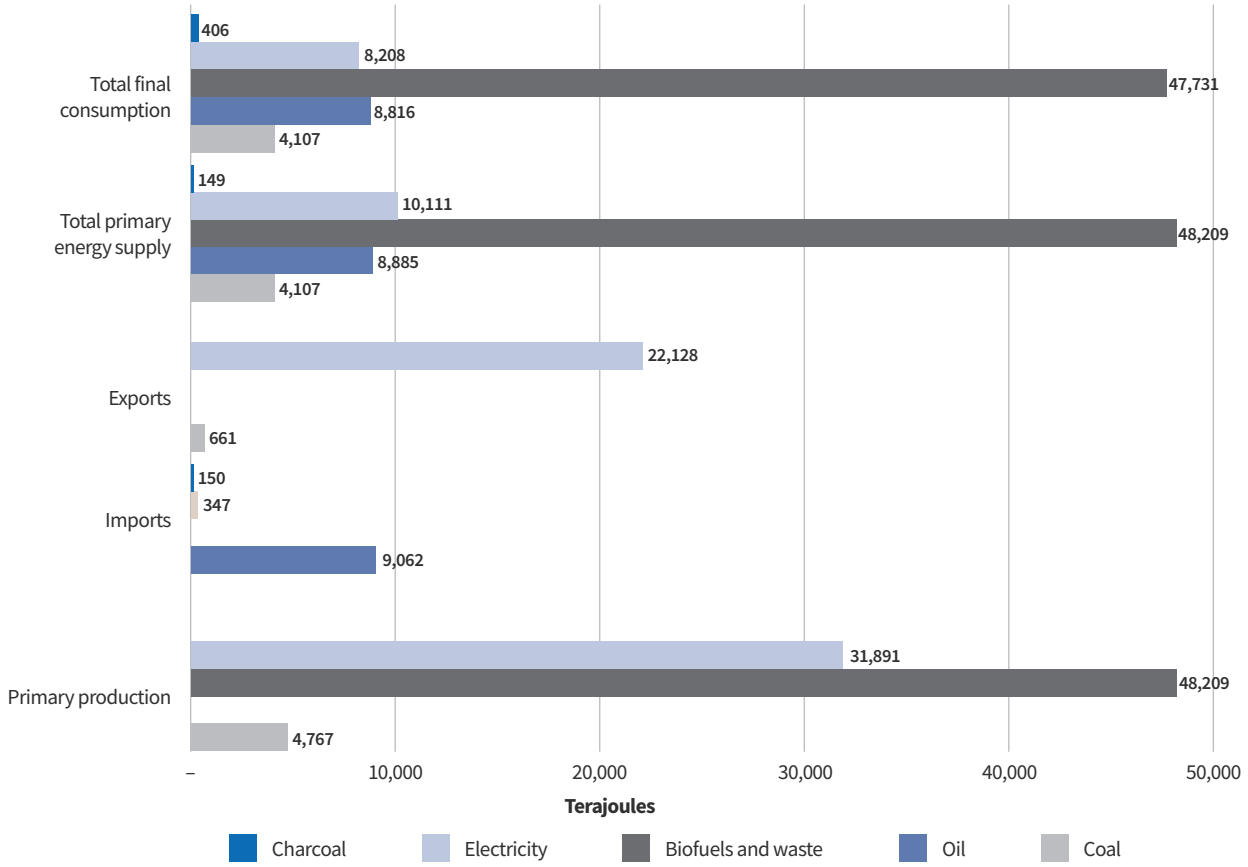
Bhutan has been importing electricity from India, especially during winter and also due to an increase in the rate of consumption. In 2018, 6 per cent of the total electricity consumed was imported (UNSD, 2019). So, for the sake of national energy security, there's a need to look for diverse energy sources, more so because of the uncertainties caused by climate change on river releases. As things stand, while Bhutan has significant hydropower resources and will continue to rely on them to satisfy its electricity needs and sustain its export power, it will also continue to import fuels such as petrol, diesel, LPG, kerosene, and aviation turbine fuel. In 2019, the import expenses on fossil fuels were 75 per cent of the electricity export revenue (MoEA, 2020). So, the Bhutanese government will have to establish mitigation and adaptation strategies in order to diversify its fuel mix and thus bolster energy security. Solar, wind, waste-to-energy, hydrogen, biomass, and biogas technologies might help Bhutan diversify its fuel mix and maintain its net-zero carbon emissions.

2.3.3 Access to electricity

Bhutan's electricity access rate improved from 61 per cent in 2006 to almost cent per cent in 2019, well ahead of the intended 2020 target. The country's primary energy source is on-grid hydropower, but the rugged geography of some rural areas makes grid extension uneconomical. As a result, the government has prioritised powering rural households with off-grid renewable energy technologies (GNHC 2019). Figure 4 shows the status of access to electricity in Bhutan.

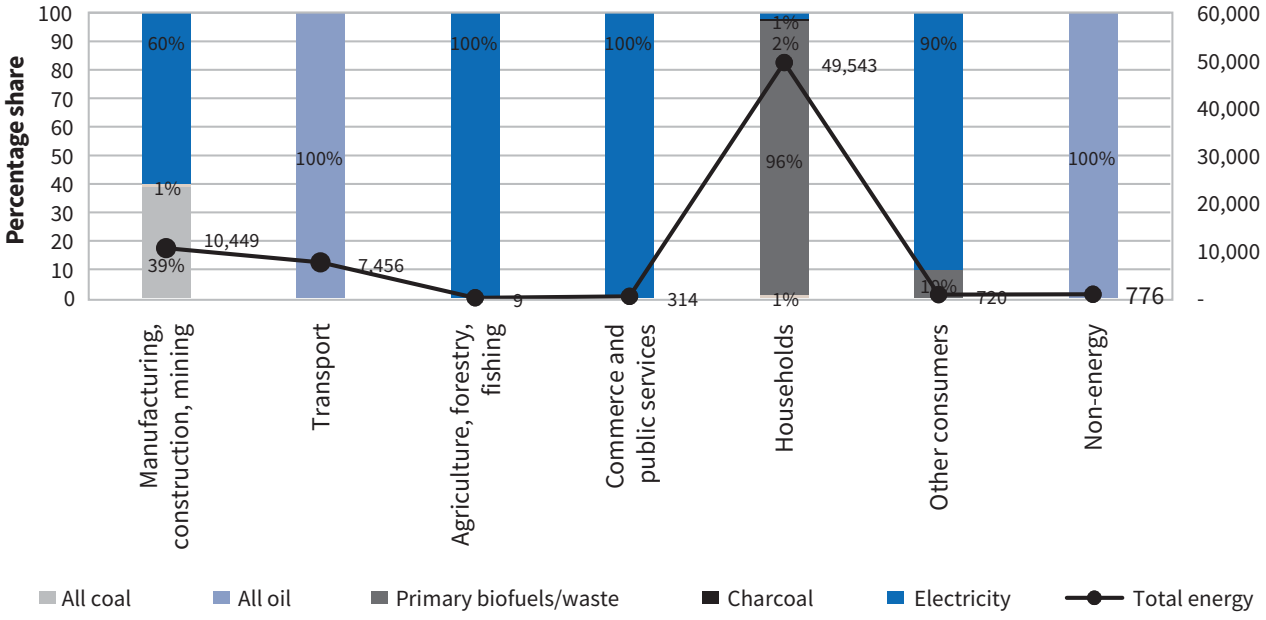
But the time has now come to think beyond electricity access and explore opportunities of clean energy transition; electricity then could be used to also create value-added products which can help in the growth of the economy.

FIGURE 1 **ENERGY SUPPLY AND CONSUMPTION PATTERNS IN BHUTAN IN 2019**



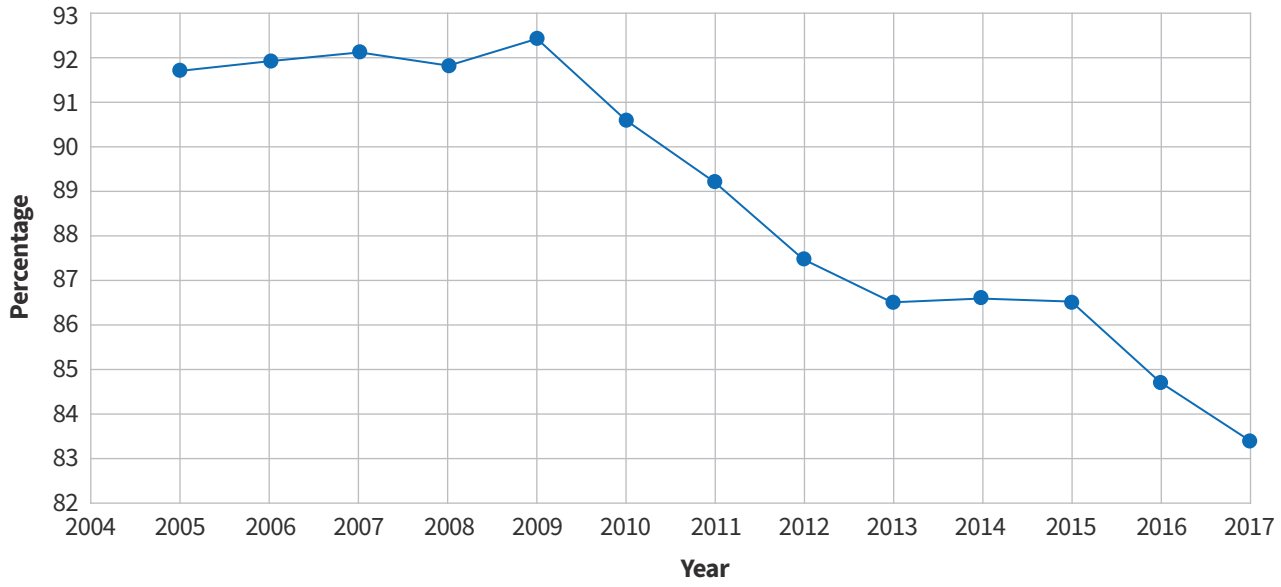
Source: UNSD, 2019

FIGURE 2 **SECTOR-WISE TOTAL FINAL ENERGY CONSUMPTION IN BHUTAN IN 2019**



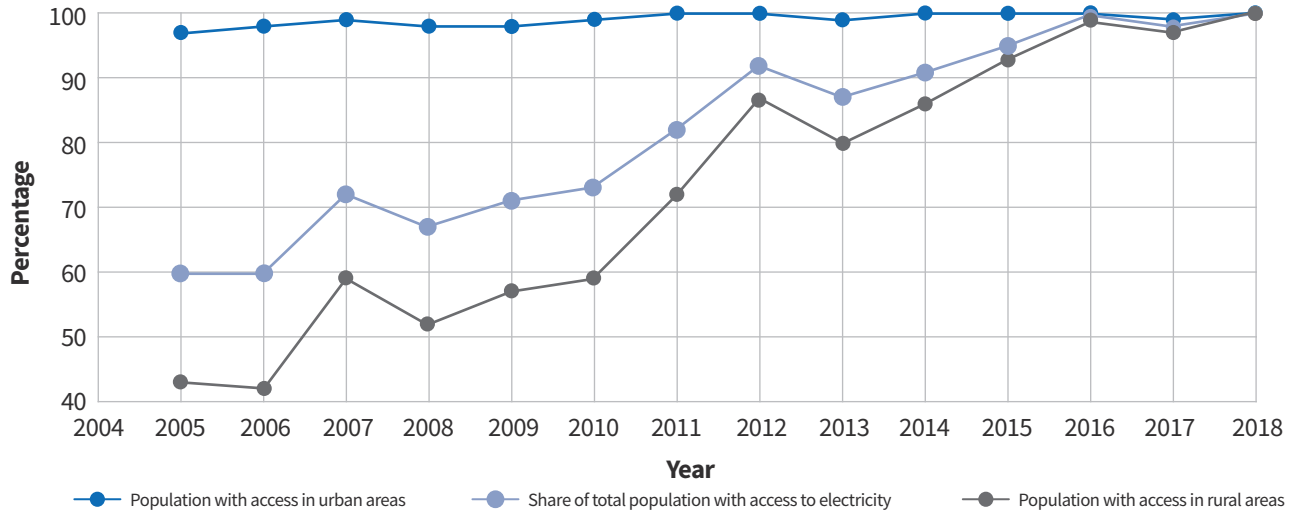
Source: UNSD, 2019

FIGURE 3 PERCENTAGE SHARE OF RE, INLCUDING BIOMASS, IN THE TOTAL FINAL ENERGY CONSUMPTION TALLY



Source: REEECH, 2021

FIGURE 4 STATUS OF ACCESS TO ELECTRICITY IN BHUTAN



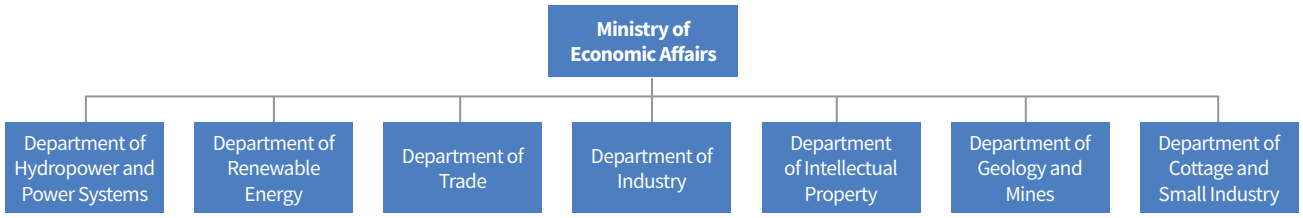
Source: REEECH, 2021

2.3.4 Renewable energy governance

The renewable energy sector of Bhutan is administered by the Ministry of Economic Affairs (MoEA). The MoEA is responsible for policy formulation, planning and coordination, and the implementation of energy-generation activities; it also deals with energy consumption, imports, and exports (IEEJ 2009).

Two energy-related departments come under the MoEA – the Department of Renewable Energy and the Department of Hydropower and Power Systems (DHPS) (Figure 5). The DRE is responsible for all matters related to renewable energy (MoEA 2022), while the DHPS is chiefly responsible for the efficient utilisation of the country's hydropower resources; its mandate is to create an enabling environment, plan effectively, and manage the entire sector. As for the policies and regulations related to the renewable energy sector, the following are the institutions that are in charge:

FIGURE 5 ORGANISATIONAL STRUCTURE OF THE MOEA, BHUTAN



POLICY

The MoEA and the Gross National Happiness Commission (GNHC) are responsible for policymaking.

REGULATION

The Bhutan Electricity Authority is responsible for developing the regulations, standards, codes, principles, and procedures related to the generation, transmission, and distribution of electricity.

OPERATION

The operations are in the hands of the Druk Green Power Corporation (DGPC) and the Bhutan Power Corporation Limited. The former is a development and generating company that operates and maintains hydropower assets, while the latter is a utility entity that is responsible for the transmission, distribution, and domestic sale of electricity.

SECTION III

Renewable energy

Hydropower is undoubtedly the most important renewable energy source in Bhutan, accounting for 33 per cent of the country's export revenue (MoEA 2020). However, despite Bhutan's 41 gigawatt (GW) hydropower potential and a technical potential of 26.6 GW, the country now only has 2.3 GW of built capacity (IRENA 2019). Meanwhile, since fossil-fuel prices are rising and river flows are being affected by climate change, the RGoB is looking into ways to harness ARE sources to meet the growing energy demand.

The DRE is the nodal agency for sustainable energy development and the promotion of renewable energy technologies (RETs). The department is responsible for the following primary functions:

- Planning, developing, issuing, and implementing policies and directives on renewable energy in coordination with associated ministries, agencies, and relevant stakeholders
- Establishing a centre of excellence for the development of RETs and recruiting the necessary human resources to promote and develop RETs and RE-related businesses
- Managing funding for the Renewable Energy Development Fund (REDF)
- Providing project and project developer facilitation at various stages of a project's life cycle
- Executing the Alternative Renewable Energy Policy (AREP) of 2013

3.1 Governmental priority to renewable energy

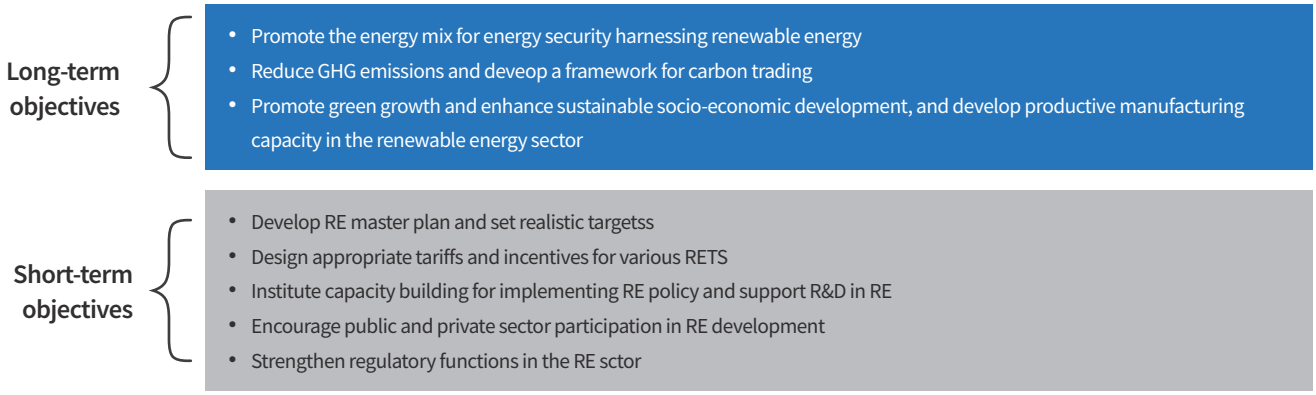
The RGoB accords the highest priority to Gross National Happiness (GNH) in the socioeconomic development of the country. GNH consists of four pillars and nine domains; these serve as the backbone for the whole of the RGoB's policymaking process. Currently, while evaluating suitable hydropower sites, the DHPS uses three of these pillars – Sustainable Socioeconomic Development, Cultural Preservation and Promotion, and Environmental Conservation – as well as five domains – Living Standards, Education, Health, Environment, and Cultural Resilience and Promotion. As a consequence, the RGoB has made the finding of renewable energy solutions one of its primary goals. The major policies formulated by the RGoB that focus on RE development in the country are as follows:

- Bhutan Sustainable Hydropower Development Policy, 2008
- Bhutan Energy Data Directory, 2015
- First Nationally Determined Contributions (NDCs), 2015
- Project for Formulation of Comprehensive Development Plan for Bhutan 2030, 2016
- Renewable Energy Master Plan (REMP), 2016
- Renewable Energy Resource Assessment Report (RERAR), 2016
- Economic Development Policy (EDP), 2016
- National Transmission Grid Master Plan (NTGMP) for Bhutan, 2018
- Twelfth Five-Year Plan (FYP) 2018–2023, 2018
- Hydropower Sustainable Development Plan, 2021
- Second Nationally Determined Contributions (NDCs), 2021

3.2 Renewable energy policy

The Alternative Renewable Energy Policy of 2013 was introduced with the objectives of: reducing the reliance on single-energy sources; addressing the matter of rising energy demand and fossil-fuel prices; maintaining energy security; preserving the environment; and developing the economy. The AREP focuses on both stand-alone and grid-connected applications. The short- and long-term objectives listed in the AREP are presented in Figure 6. A summary of the AREP RE interventions is presented in Table 1.

FIGURE 6 **SHORT- AND LONG-TERM OBJECTIVES LISTED IN THE ALTERNATIVE RENEWABLE ENERGY POLICY, 2013**



Source: MoEA, 2013

TABLE 1 **SUMMARY OF THE ALTERNATIVE RENEWABLE ENERGY POLICY, 2013**

RE interventions	Instruments	Implementation mechanism	Source of funds
Grid-connected small hydro systems	• Project pipeline developed and published • Royalty exemption for domestic off-take • Tax incentives*	Prospective developers bid on a project based on the RE master plan; project is awarded to those offering the lowest rate (domestic market) and the highest royalty (export)	• Government- • Private-sector investments
Other grid-connected RE systems	Tax incentives*	Shortlisting through request for proposal (RFP), followed by competitive bidding; project awarded based on the lowest tariff	• Government • Private-sector investments
Grid-connected self-identified systems	• Tax incentives* • Purchase guaranteed by renewable purchase obligation (RPO)	DRE to approve up to 5 MW based on the endorsed detailed project report (DPR) or the development project proposal (DPP)	• Government • Private-sector investments
Decentralised distributed grid systems	Tax incentives*	Competitive bidding	• Government • Private-sector investments
Stand alone systems	• To be defined as per the scheme or programme or availability of resources • Tax incentives*	As prescribed by DRE	• Government • Private-sector investments
Stand-alone solar thermal systems	• Under development (incentives, financial assistance) • Tax incentives*	As prescribed by DRE	• Government and donors
Fossil fuel substitution by green sources	Under development	Mostly research and development activities	• Government and donors

* Tax incentives: (a) Exemption of import duties and sales tax on the plant and equipment; (b) Except in the case of small hydropower projects, the developers, manufacturers, and system integrators of RE projects get business income tax exemption for 10 years and for an additional five years for remote areas, from the date of commercial operations; (c) Up to 25 per cent allowed as tax-deductible expenses on reinvestment; (d) RE-based R&D is deemed as a tax-deductible expense

Source: MoEA, 2013

The AREP 2013 promotes the following RE sources: solar, wind, bioenergy, geothermal, hydro (up to 25 megawatts [MW]); and waste-to-energy. The RE interventions are conducted in the areas of:

- Grid-connected systems
- Decentralised distributed grid (DDG) systems
- Stand-alone systems
- Fossil-fuel substitution through green energy sources like biofuel, and the use of electric and hybrid vehicles

The AREP (2013) instruments to promote the focused RE interventions and their respective delivery mechanisms are summarised in Table 1.

AREP 2013 is primarily focused on electricity generation. In this regard, it has entrusted the DRE with the responsibility of dealing with matters related to demand and project development and allocation (through competitive bids); it has to also play the role of a facilitator among various departments during project deployment except for projects allotted under the self-identified category. Besides, the policy protects investments from grid encroachments and provides project developers, manufacturers, and integrators with incentives such as tax exemptions. Currently, the AREP provides opportunities to:

- Mainstream the gender equality and social inclusion (GESI) agenda
- Focus on the promotion of productive end-use applications; provide incentives
- Promote RE technologies, such as the solar PV grid-connected system

Set up models based on customer demands; this will help the DRE to develop projects that are in tune with the market

Mobilise credit and set up de-risk funds in order to promote RE financing

- Establish technical and testing standards for quality control, customer protection, and for uniformity in terms of the implementation of RE technologies
- Promote green, resilient enterprises and create jobs

3.3 Targets and achievements

The AREP has set RETs-based electricity targets (Table 2) which are to be achieved by 2025. By that year, 20 MW of renewable energy, including 5 MW solar PV, 5 MW wind, and 5 MW biomass, are to be generated. Although the policy focuses on small hydro, it has not set a target for the technology. The policy has set RETs-based heat-generation targets of 3 MWth for biomass and 3 MWth for solar water heater systems for 2025. At present, 600 kW of wind-energy capacity has been achieved as part of the target. Meanwhile, a 180-kW solar PV plant, built at Rubesa village in the western district of Wangdue Phodrang, was commissioned in August 2021. The plant is the first of its kind in the country and has been producing and supplying electricity worth 263,000 units per year, which is enough to light up around 80–90 households (Lhamo 2021). This solar project has been integrated with a 600-kW wind farm at Rubesa. The 180-kW ground-mounted solar PV system is grid connected and employs local contractors and employees. The project has strengthened the status of Bhutan's energy security and has also created green employment; besides, it has demonstrated the viability of solar energy projects in the country (MoEA 2021b). Further, it is intended to stimulate new investments in solar PV systems and their accessory manufacturing industries. Some of the major achievements[1] of the RGoB in promoting renewable energy in Bhutan are listed below:

- Produced the Renewable Resource Assessment Report, 2016
- Developed the Renewable Energy Master Plan
- Prepared the Energy Efficiency Road Map, 2019
- Formulated the National Energy Efficiency Policy, 2019
- Devised the National Biogas Implementation Strategy, 2020
- Set up the Regulation for Grid Integration of Alternative Renewable Energy Sources, 2021
- Prepared the guidelines for exemption of licence for generation from decentralised RE below 500 kW capacity (draft stage)
- Prepared the guidelines for tariff determination of the Sephu Photovoltaic Power Plant, 2022 (draft stage)
- Set up a 600-kW wind farm and a 180-kW solar PV system at Rubesa
- Installed 8000 biogas plants
- Installed 30 solar water heating systems (SWHSs) of 500 litres per day (LPD) and 1000 LPD capacity

[1] Taken from a presentation by Deputy Executive Engineer, DRE Planning and Coordination Division, during a policy stakeholder workshop held on 28 April 2022.

3.4 Private sector in ARE

In Bhutan, the role of the private sector in renewable energy is rather small and undeveloped, and its participation in the energy industry as a whole has been minimal. But the RGoB's FDI (Foreign Direct Investment), Hydropower Development, and Renewable Energy Policies do have the provisions to promote private-sector involvement and investment in the energy sector. According to these policies, the private sector is allowed 51 per cent investment in renewable energy projects that are above 25 MW capacity. Various tax incentives have also been offered to private hydropower investors. For example, private project developers are exempt from corporate income tax for 10 years after winning commercial hydropower contracts. However, to attract private-sector investment in hydropower and other clean and sustainable energy sources, an enabling environment has to be put in place (ADB 2012). Presently, the small market size for solar and wind power has meant that the engagement of the private sector in this area has been quite minimal. However, it is expected that the RGoB programme to install over 300 rooftop solar PV on-grid systems and utility-scale solar PV systems will attract more private players in the future.

TABLE 2 **AREP 2013 TARGETS BY 2025**

Description	Targets
Solar PV	5 MW
Wind	5 MW
Biomass	5 MW
Others (excluding hydro)	5 MW
Solar thermal systems	3 MWth
Biomass energy systems	3 MWth
Promotion of electric vehicles	20% public and 10% private fleet

Source: IRENA, 2021

SECTION IV

Renewable energy opportunities

Bhutan's economy depends heavily on hydropower production and exports. It also has vast undeveloped hydropower resources and is the only South Asian country with abundant energy for export (ADB 2014). Thus, Bhutan has a critical role to play in the renewable energy sector of the overall HKH region. It has the capacity to respond almost instantly to high electricity demand and can also supply electricity when the solar and wind energy sectors need it (IEA 2021).

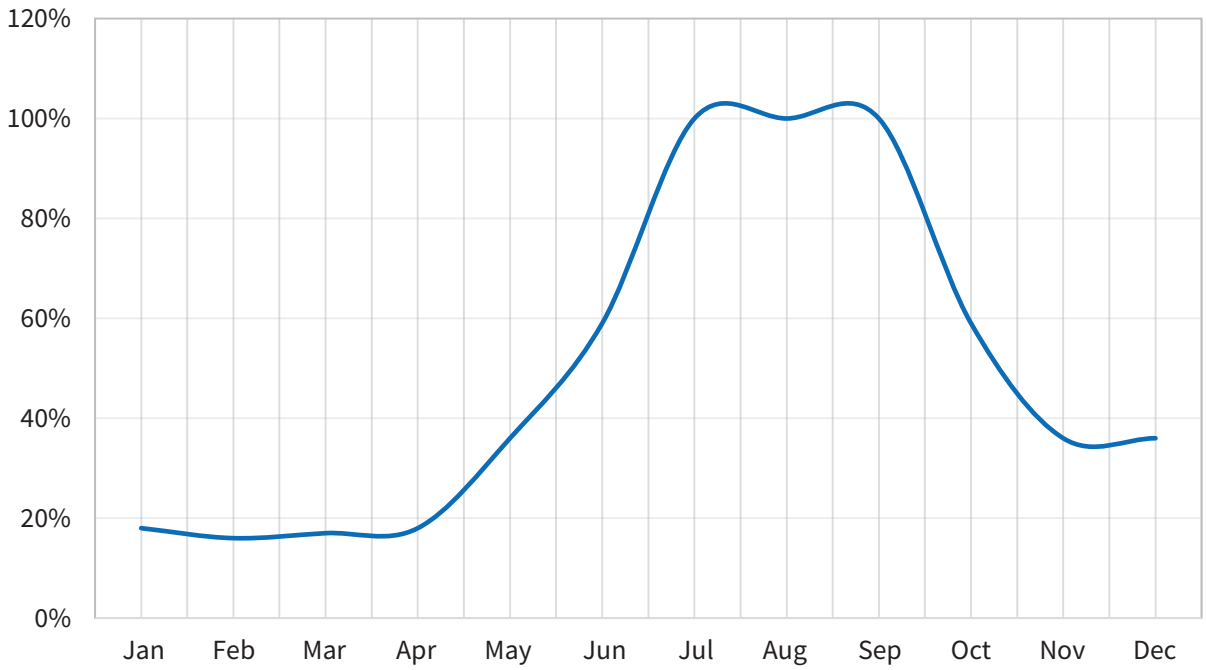
4.1 Augmenting hydropower

This section investigates the current challenges in electricity generation and distribution in Bhutan and also discusses the opportunities in store for ARE, especially by way of solar PV on-grid systems.

Electricity generation

The DGPC manages most of the electricity -generation structure in Bhutan. Since the hydropower plants in the country are run-of-the-river (ROR) type, there is wide seasonal variation and non-firm power. The seasonal variation in hydropower generation is reflected by the fact that it can be as low as 20 per cent for three months and 40 per cent for six months (Figure 7). This leads to a drop in export revenue and to an increase in power imports.

FIGURE 7 NORMALISED MONTHLY HYDRO GENERATION PATTERN OF BHUTAN

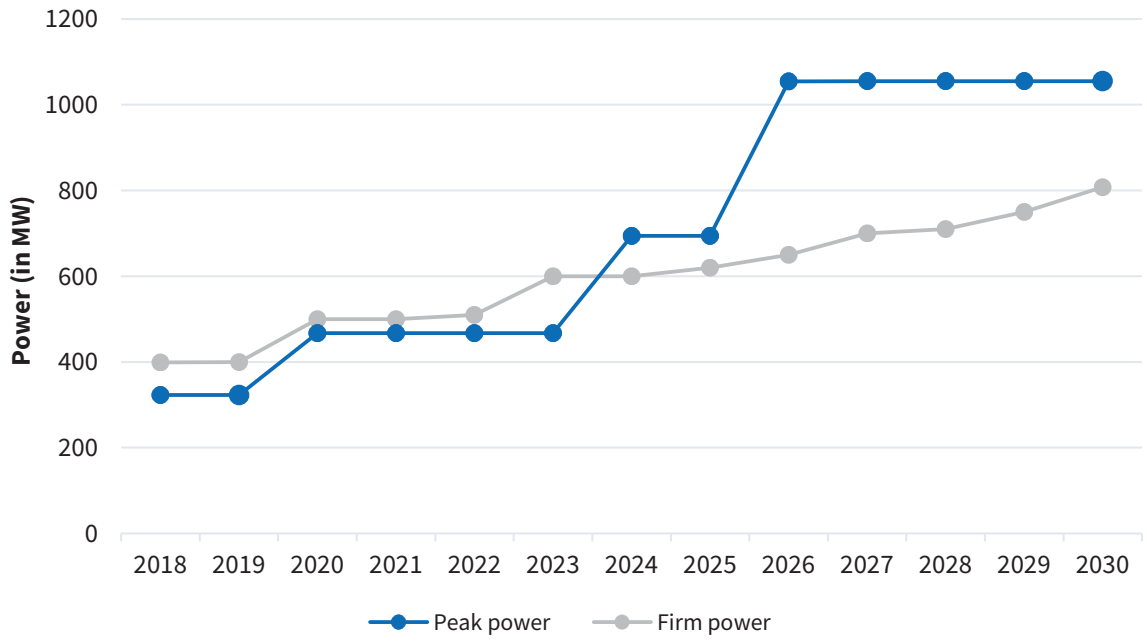


Source: DGPC, 2019

Further, when the internal demand grows, the peak power exceeds the firm power-generation capacity. Figure 8 presents the current and projected firm power and domestic peak demand. The graph is sensitive to the commissioning dates of the upcoming hydro projects and the potential increase in the energy transitions to displace fossil fuel – for instance, the promotion of e-mobility. It has to be also noted that though there is a projection that the firm power will be surplus to peak after 2023, this is subject to the timely commissioning of the upcoming hydropower plants (Annex 2). Any delays will mean that the domestic firm power-generation capacity will not be able to meet the peak power demand.

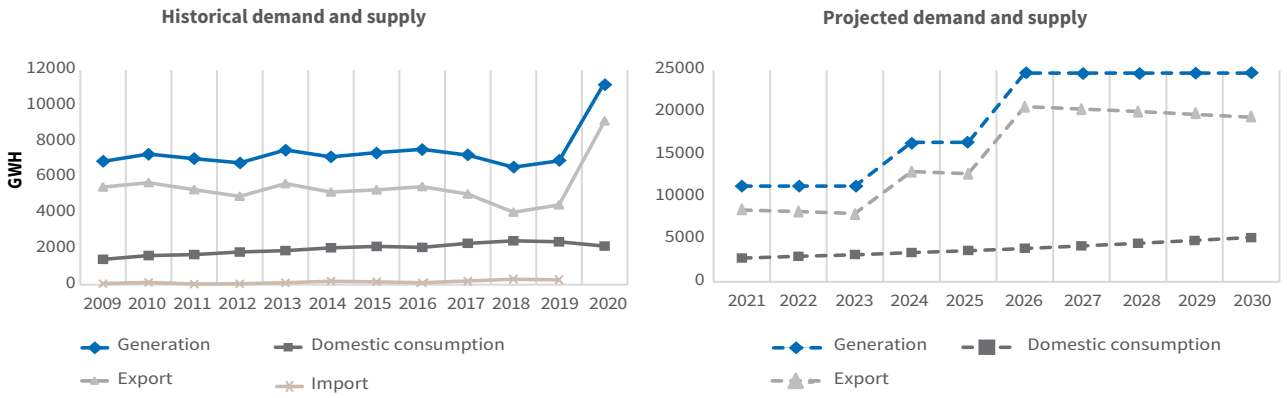
On the other hand, the overall annual energy supply is projected to remain in the surplus category. However, the export figures will vary depending on the generation and domestic consumption patterns (Figure 9). In 2020, 11,309 GWh were generated, out of which almost 81 per cent was exported, while 19 per cent was domestically consumed. In 11 years (2009–2020), domestic demand increased by an average of 5 per cent every year, and imports surged by nearly 400 per cent. But with the addition of the Mangdechuu 720-MW hydropower plant, the imports are likely to reduce. However, this demand-and-supply pattern is likely to be replicated in the future as well since new plants need to catch up with the new demand and maintain exports, as shown in the forecast below.

FIGURE 8 **PROJECTED FIRM POWER AND PEAK POWER (IN MW) OF BHUTAN**



Source: Peak demand projections were sourced from the DOHPS, 2008; the firm power projections are based on the commissioning of upcoming hydropower plants

FIGURE 9 **THE PATTERN OF DEMAND AND SUPPLY OF ELECTRICITY FROM 2009 TO 2019 AND THE DEMAND-AND-SUPPLY FORECAST FROM 2021–2030 FOR BHUTAN**



Source: JICA, 2019; BPC, 2020; the forecast is based on the commissioning of upcoming hydropower plants and demand projections

Distribution

The BPC is responsible for the transmission, distribution, and domestic sale of electricity. It has three customer categories: low, medium, and high voltage. In the 2020 annual BPC report, the electricity consumption share of these low voltage (LV), medium voltage (MV), and high voltage (HV) categories were in the percentages of 23, 5, and 72, respectively, while the revenue share was respectively in the percentages of 47, 5, and 48 (BPC 2020). Earlier, in 2019, the revision in tariff saw a 38 per cent rise in wheeling charges and an 11 per cent decrease in the electricity purchasing cost from the DGPC. Furthermore, the tariff rates for LV block III and bulk customer categories were permitted to rise by 3 per cent and up to 22 per cent for MV customers, while they decreased by 6 per cent for HV users (BEA 2019). As things stand, despite the fact that the overall tariff changes are projected to help the BPC's financials, more than a quarter of the electricity revenue is dependent on the yearly RGoB subsidies. (The unsubsidised and subsidised costs of electricity for the respective consumer categories are presented in Table 3 where the average weighted electricity subsidy has been estimated at Nu. 2/kWh.) Additionally, the BPC suffers significant distribution losses (JICA 2019), particularly in the LV and MV categories – from 2016 to 2020, these losses increased from 4 per cent to 8.9 per cent (Figure 10).

TABLE 3 THE BPC-APPROVED COST OF SUPPLY

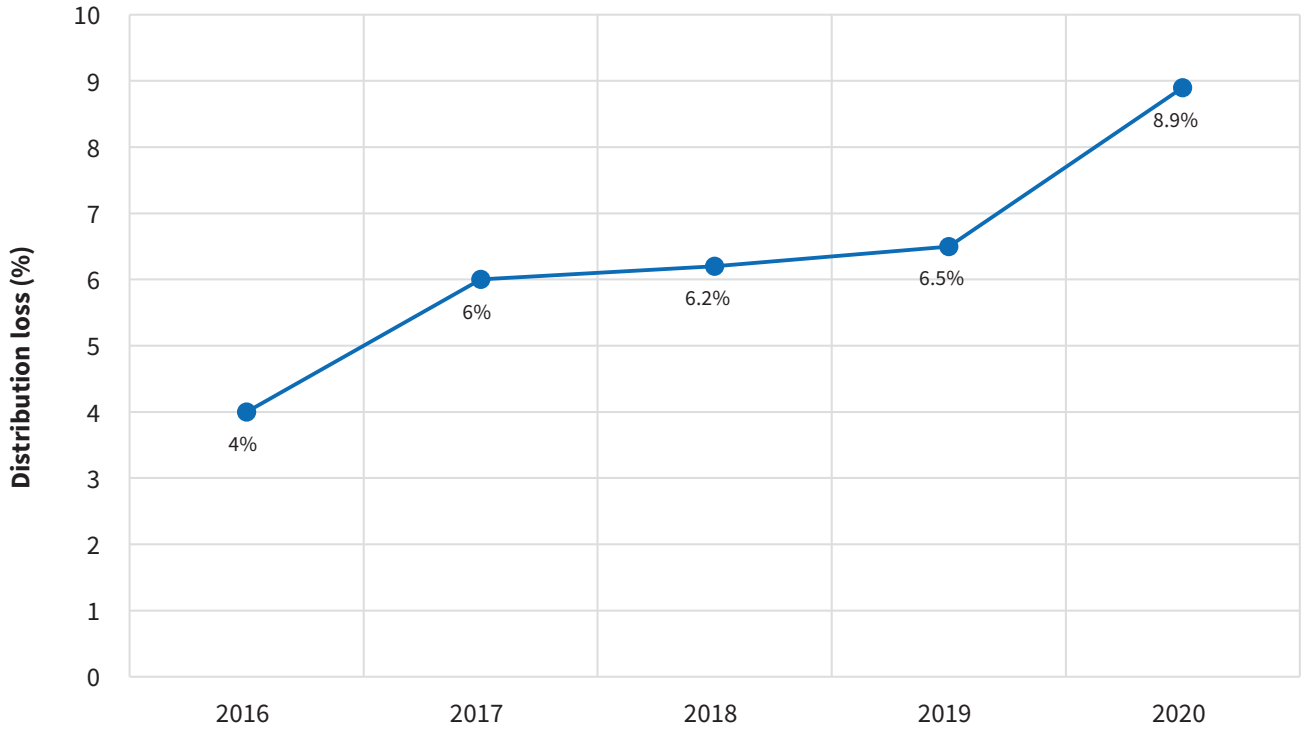
Consumer	Unsubsidised cost (Nu/kWh)	Subsidised cost (Nu/kWh)
High Voltage (HV)	2.26	1.5
Medium Voltage (MV)	5.15	2.24
Low Voltage (LV)	5.06	Ranges from 0 (100–200 units free) to 4.06 for the respective LV categories
Wheeling	0.27	0.27

Source: BEA, 2019

Solar PV on-grid

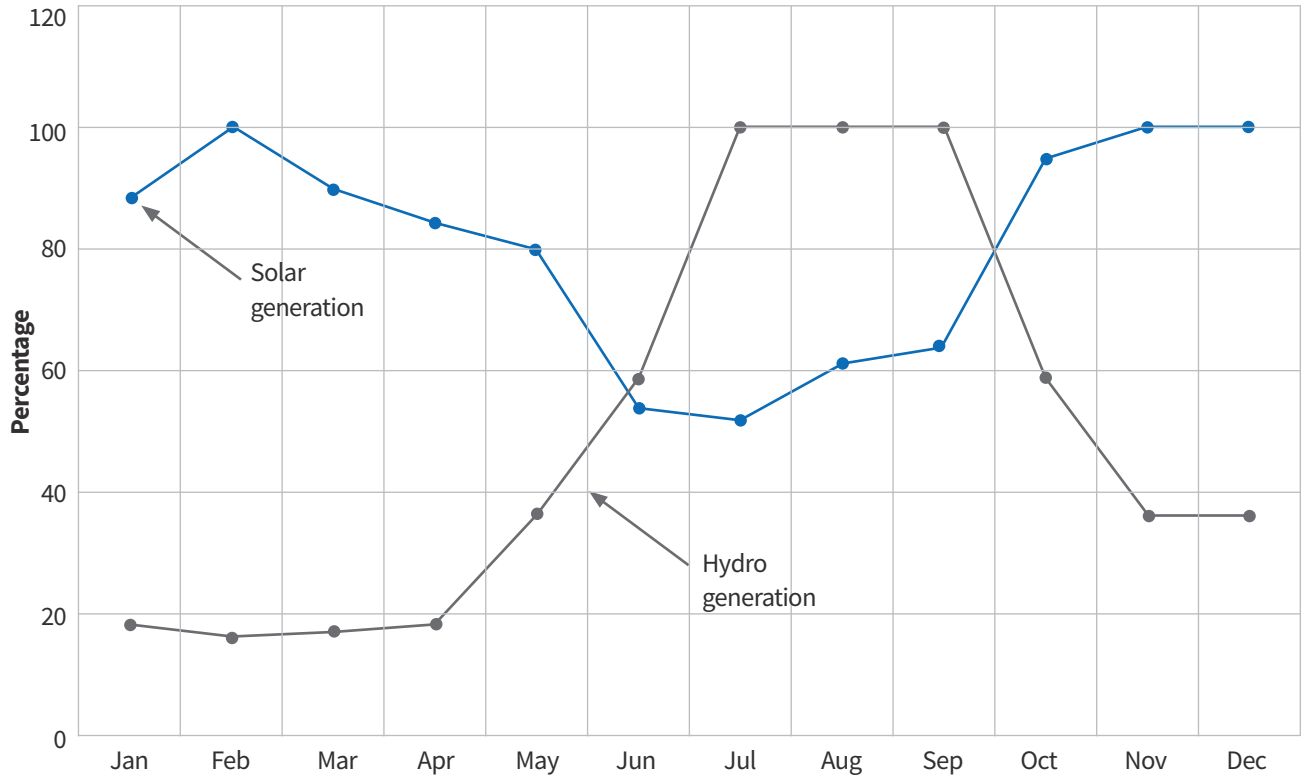
Given the challenges in the generation and distribution of hydroelectric power, the solar PV on-grid technology can be considered a potential solution. Indeed, it could complement hydropower well, particularly because of its falling prices and the maturity that the technology has attained. Besides, Bhutan has rich solar and wind resources – the Renewable Energy Master Plan of 2016 put the potential of solar and wind at 12 GW and 0.8 GW, respectively. More specifically, the countrywide volume of solar radiation ranges from 4.4 to 7.4 peak sun hours (PSHs), which is better than many countries globally (IRENA 2019). Then there is the significant fact that during the lean hydro seasons, solar power can be an invaluable replacement (Figure 11).

FIGURE 10 ANNUAL RATE OF DISTRIBUTION LOSS



Source: BPC, 2020

FIGURE 11 NORMALISED SOLAR AND HYDRO GENERATION PATTERNS OF BHUTAN



Source: Authors, calculation; the monthly generation trends of hydro and solar were normalised to the maximum rate of generation to develop the graph

Further, given the demand–supply situation, the variation in tariff prices, and the dependence on subsidies, the integration of solar PV on-grid presents the following opportunities:

- Since the components of solar PV on-grid are modular, it can be installed in a short time to meet the rising domestic demand and maintain the firm power generation at the demand point will help reduce transmission and distribution losses
- Solar PV systems can help in improving the power quality of the distribution lines
- Such complementary generation sources can help reduce import dependence
- The prosumer market will lessen operation and management liabilities and can attract capital expenditure (CaPex) for new power plants

Learning from the HKH region

Some of the countries in the HKH have made great strides in adopting, executing, and scaling up renewable energy technologies. Bhutan could learn from these countries, but while doing so, it should shape the technological solutions to its own specific context and needs. Given below are some examples of solar PV on-grid regulations from India and Nepal:

1. **Grid penetration:** Identifying the maximum allowed capacity penetration of solar PV on-grid to the utility to ensure grid stability. For example, in Nepal, the maximum allowed decentralised RE penetration is 10 per cent of the country's total installed generation capacity, while in India the penetration categorisation is on the lines of: low (<4 per cent); medium (4–10 per cent); and high (>10 per cent) (Deloitte 2016).
2. **Connection capacity:** Identifying the minimum and maximum connection capacities to the respective meter categories. Given below are the permitted connection capacities for Nepal.

Allowable solar PV sizes	Category	Meter connection
0.5 kWp to 10 kWp	Residential	230 V
>10 kWp to <500 kWp	Institutional	440 V
>500 kWp to <1000 kWp	Commercial	11 kV

Along with the connection guidelines, the designing of appropriate business models is critical for scaling up the rooftop solar PV technology. As for the government's role, it should create the appropriate market structure, set standards, and provide clear incentives to tackle the complex problems related to rooftop solar technology. All this involves innovative

policymaking, which requires proactive governmental action and community involvement.

A number of policy measures and regulations are at play in the rooftop solar sector. There are three important instruments involved in the designing of rooftop solar PV business models: the ownership structure, the structure of revenue streams, and the fiscal strategies or incentives such as accelerated depreciation, low-interest loans, and income tax credits – these can bridge the cost-to-revenue gap (GERMI 2016).

In India, the business model for rooftop solar has been developed through time-based on-system ownership and engagement with external stakeholders. There, grid-connected rooftop solar PV business models are classified into three types: self-owned, third-party owned, and utility-based.

Self-owned systems produce electricity for on-site usage or export it to the grid, and the end users are encouraged to invest in the systems in the following three ways: captive (off-grid), gross metering, and net metering. On a grid-connected rooftop solar PV system, the direct current power generated by the solar panel is converted to alternating current energy by the power-conditioning equipment. Depending on the local requirements, it is supplied to the grid by 33 kV/11 kV three-phase lines or 440 V/220 V three-/single-phase lines. Typically, the rooftop owner invests in the equity portion of a self-owned business, while a commercial bank provides financing for the debt portion. Annex 3 provides an overview of the rooftop solar PV policies of selected HKH states in India.

- Captive (off-grid): All the electricity generated by the rooftop systems is used by the rooftop owner who owns and operates the system.
- Gross metering: The grid-connected rooftop solar PV systems that feed the whole amount of electricity generated to the grid are known as gross metering systems. In this arrangement, feed-in tariffs (FiTs) are paid in return for the electricity they provide for the grid.
- Net metering: The excess electricity generated from the rooftop solar PV system is fed into the grid, and the system owner is credited against the units fed.

Third party-owned rooftop solar business models allow the third party to lease the rooftop from the owner and generate power to sell to the grid or the owner via a power purchase agreement (PPA) or a solar lease. The third party may also lease the complete system from the rooftop owner to substitute utility-based electricity.

Other off-taker arrangements in India include selling the electricity generated by the rooftop solar PV systems to distribution companies under various obligation such as: central/state policies and plans, distribution licensees for meeting the renewable purchase obligations (RPOs), third parties under open access arrangement, group captives under open access arrangement, and the renewable energy certificate (REC) mechanism.

Financial viability

In this study, a financial analysis was carried out for a 100-kWp rooftop solar PV system in Bhutan using technical and financial assumptions (Annex 4). It showed that presently, the cost of a rooftop solar PV system – backed by 15 years of project financing and incentives such as accelerated depreciation and levelised cost of energy (LCOE) – can be as low as 1.6 Nu/kWh with 12.9 per cent internal rate of return (IRR). This estimated LCOE is competitive with the current weighted average electricity subsidy cost of 2 Nu/kWh[2].

4.2 Beyond electricity access

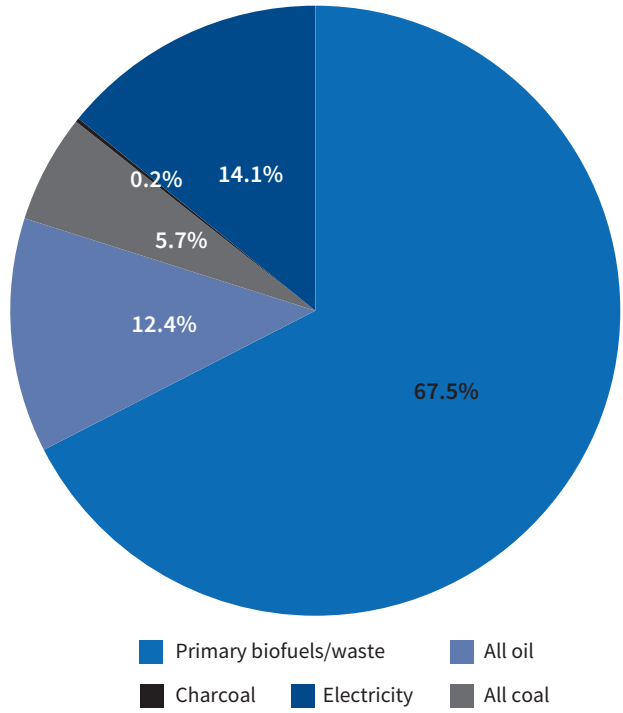
Bhutan has made significant progress in promoting alternative renewable energy sources. However, policy commitments are still being met and have not yet resulted in genuine investments or a thriving market and industry. The current policy framework prioritises electricity access while paying little attention to energy transition and productive energy use. Beyond electricity access, there are opportunities to consider in terms of energy transition, improving livelihoods, promoting green, resilient enterprises, and creating jobs.

Fuel transition

In 2018, approximately 67.5 per cent of the total primary energy supply in Bhutan came from biomass, followed by 14.1 per cent from hydroelectricity, and 12.4 per cent from all oils (Figure 12). In the case of electricity, almost all of Bhutan has access to it; however, traditional biomass still contributes around 96 per cent when it comes to cooking and heating in both rural and urban households (ESCAP 2022). In fact, the electricity services in the household sector are significantly low (merely 2 per cent). This presents an opportunity to transit towards clean fuel or other resource-efficient solutions in order to decrease the use of traditional fuel sources.

[2] The subsidy weighted average was calculated based on the projected energy consumption (BEA 2019).

FIGURE 12 FUEL SOURCES IN THE TOTAL FINAL CONSUMPTION TALLY



Source: UNSD, 2019

The transport industry of the country runs on oil imports. Currently, a high percentage (approximately 75 per cent) of the hydro export revenue is spent on importing fossil fuels (MoEA 2020). Here, there is an opportunity to gradually switch from oil to domestically generated electricity. However, this requires an in-depth study across the value chain in terms of the existing electricity infrastructure, supply chain, and the demand forecasted for e-vehicles. The study also ought to investigate areas such as energy transition, biomass technologies, energy efficiency, and green hydrogen. This will be key to formulating an appropriate road map for RE solutions. Meanwhile, the RGoB has initiated efforts to replace 70 per cent of fossil-fuel vehicles with electric vehicles (EVs) by 2035. This is being done by introducing financial incentives as well as by investing in the charging infrastructure (Lhaden 2022).

The coal import of the country goes to the industrial sector alone. Here, too a similar transition can take place by introducing clean-fuel technologies and energy-efficient projects to reduce the dependence on fossil fuels – for example, the use of biomass pellets as replacement for coal in the brick industry. In fact, ICIMOD has been piloting such technologies in the Nepalese brick industry in order to reduce the use of coal. Thus, it is evident that there is an opportunity to move towards clean fuel which can also create value-added products, enhance the country's economy, and improve the overall balance-of-payment status.

Least-cost RE options to improve livelihoods

An inventory of technologies based on the least-cost approach can be prepared and promoted based on the local context. Established renewable energy technologies such as solar irrigation, solar water heaters, solar dryers, improved cooking stoves, and biogas can be promoted to improve efficiency and productivity or to supplement the existing electricity supply. The improved energy outcome will help bolster livelihoods, support enterprises, as well as add to social welfare in terms of health, agriculture, drinking water, and education services.

Further, interventions can be made in areas with electricity access to create conditions for improved energy income, which can lead to economic development. During a site visit to the Shaba village in Paro, it was found that the farmers there were unable to irrigate over 50 per cent of their fields due to water shortage in the irrigation canals. Though the village is electrified and has ample water resources, its electric pump for water lifting was not in use. On further investigation, it was found that low level of technological awareness, lack of finances for irrigation, and difficulty in accessing technology were some of the key barriers there.

Promotion of green, resilient enterprises

Mountain enterprises are highly exposed to changes in climate and other shocks. Almost 95 per cent of the registered businesses in Bhutan (van Wees 2019) are micro, medium, and small enterprises (MSMEs). Under a collaborative study carried out by ICIMOD and the International Renewable Energy Agency (IRENA) on resilient enterprises and renewable energy in the HKH region (Figure 13), it was identified that they are exposed to several internal and external shocks that can hinder their growth. Thus, it is critical for the MSMEs to have business strategies that focus on resilience building through innovative technologies, partnerships, funding, and skill enhancement.

The study also pointed out the fact that while RE technologies have matured and have become cost competitive and well established, they are not often tailored for productive end use across the value chains. With an enabling ecosystem in place, renewable energy can indeed enhance livelihoods, offer value-addition opportunities, improve enterprise resilience, and support several development objectives related to gender, food security, health, and employment. Thus, along with access to affordable, reliable, and appropriate renewable energy services, it is equally important to have targeted interventions in the form of training, education, apprenticeship, and the honing of financial, technical, and business skills, as well as

by way of access to finance and the establishment of supportive social policies; all this will help reduce gender inequities, promote entrepreneurship, and facilitate the achievement of poverty-alleviation goals.

The following areas of intervention, identified by ICIMOD in its needs assessment report[3], can be looked upon to strengthen the contribution of renewable energy resources to value-chain and enterprise development while ensuring the transition to a gender-sensitive and inclusive green economy:

ADOPT AN ECOSYSTEM APPROACH TO SHAPE THE SUSTAINABLE ENERGY CONTRIBUTION TOWARDS ENTERPRISE DEVELOPMENT

By developing a local ecosystem, local communities and enterprises should be empowered to utilise RE solutions in order to improve the competitiveness and resilience of their value chains. Such an ecosystem rests on the pillars of a tailored policy environment, access to financing, end-user-oriented technology solutions, capacity development, and multi-stakeholder partnerships. The programmes and initiatives deploying RE solutions in the mountain context are strongly encouraged to adopt an ecosystem approach to support local-enterprise development, improve resilience, and bring socioeconomic benefits to all.

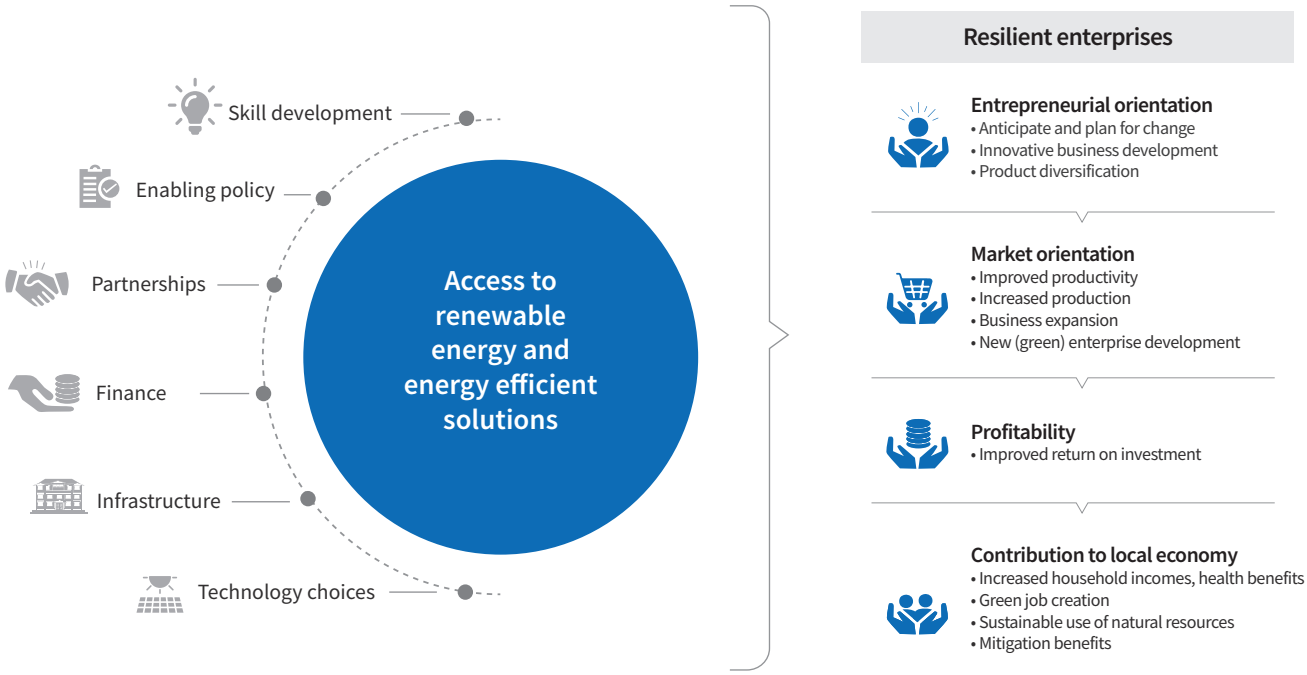
INTEGRATE SUSTAINABLE ENERGY MEASURES IN POLICY AND PLANNING FOR DEVELOPMENT

Policy and planning efforts to strengthen value chains and enterprises need to be tailored to the relevant contexts. Incentives for the productive end use of RE solutions need to be strengthened whereby local enterprises become the key agents of change. Given the cross-sector nature of mountain value chains, different sectoral development plans (such as in agriculture and tourism) would benefit from integrating sustainable energy as a prominent pillar. Accordingly, there is a need to involve energy and non-energy ministries and other public bodies.

CATALYSE ACCESSIBLE FINANCING FOR END USERS AND ENTERPRISES

Access to affordable and tailored financing is a critical part of the ecosystem for deploying renewable energy; this enhances the competitiveness and resilience of value chains and enterprises. There is a need to mobilise public and private capital from multiple sources, tailor financing products for end users and enterprises, layer multiple instruments, and deploy responsive financial intermediaries such as cooperatives that can play a crucial role in improving access in remote mountain contexts. The financing products should cover energy technology as well as efficient and productive end-use appliances.

FIGURE 13 **ECOSYSTEM APPROACH FOR THE PROMOTION OF GREEN, RESILIENT ENTERPRISES**



ICIMOD and IRENA Study

[3] Needs Assessment: Renewable Energy Solutions for Enterprise Development in the Hindu Kush Himalaya, ICIMOD.

SUPPORT TECHNOLOGY INNOVATION AND ADAPTATION PROCESSES

Technology innovation and adaptation processes are crucial for linking RE solutions and energy-efficient productive appliances with local end-user and value-chain needs. The value chains for the same goods and services are likely to be uniquely configured to the local conditions in order to meet diverse energy needs. Targeted measures are needed to facilitate the process of participatory technology innovation and adaptation, as well as that of end-of-life management.

BUILD CAPACITY ACROSS VALUE CHAINS OF MOUNTAIN PRODUCTS AND SERVICES

To accelerate renewable energy adoption and its impacts on value chains and enterprises, adequate capacity needs to be developed across the ecosystem actors in the various value chains. Capacity development has to be an ongoing activity focused on skill regeneration and upgradation.

IMPROVE THE DATA AND INFORMATION BASE ON ENERGY FLOWS IN VALUE CHAINS

The data on energy requirements for adding value to the products and services of MSMEs is extremely limited. For the value-chain development of such products and services, understanding the existing energy flows is critical for effective policymaking and planning and for assessing alternative energy sources.

LEVERAGE PARTNERSHIPS TO DELIVER TRANSFORMATION

The key stakeholders identified through the needs assessment exercise include governments, the private sector, technology providers, financing institutions (e.g., industry associations), and local communities. Each plays a specific role in developing the ecosystem for enhancing the contribution of renewable energy towards enterprise development.

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Annexes

Annex 1: List of stakeholder interviews

Department of Renewable Energy

- Mr Phuntsho Namgyal, Director
- Ms Dawa Zangmo, Chief Engineer
- Mr Galey Dorji, Deputy Executive Engineer
- Ms Chime Wangmo, Deputy Executive Engineer
- Ms Dechen Dema, Deputy Executive Engineer
- Ms Damchu Dema, Executive Engineer

Bhutan Electricity Authority

- Mr Samdrup K. Thinley, Chief Executive Officer
- Mr Nima Tshering C., Director

Annex 2: Details of upcoming hydro projects[4]

Upcoming Projects	Capacity (MW)	Annual Generation (GWh)	Expected CoD
Punatsangchuu-II	1020	4667	2024
Nikachhu	118	505	2024
Punatsangchuu-I	1200	5585	2026
Kholongchhu	600	2599	2026

[4] https://kuenselonline.com/pii-needs-2000-workers-to-meet-july-2023-deadline/
https://kuenselonline.com/barrage-construction-at-pi-could-take-four-years/
https://kuenselonline.com/kholongchhu-project-likely-to-start-in-earnest-from-april/

Annex 3: Overview of the rooftop solar PV on-grid policies of selected states in India

State	Policy guidelines	Target segment
Andhra Pradesh	Net or gross metering option available for tariff equal to the average pooled power purchase cost. Up to 20 per cent subsidy on capital cost for residential systems of <=3 kWp.	Only three-phase connections
Chhattisgarh	Net or gross metering and energy banking options available with feed in tariff at INR 4.35/kWh.	All consumers
Gujarat	Gross metering with and without accelerated depreciation at INR 9.63/kWh and INR 10.75/kWh respectively.	All consumers
Haryana	Net and gross metering along with energy banking for one year.	All consumers
Karnataka	Net and gross metering at INR 7.2/kWh and INR 9.56/kWh with and without subsidy respectively.	All consumers up to 1 MW categorised by supply voltage
Kerala	Capital subsidy up to INR 39,000 and net metering.	All consumers
Rajasthan	Net metering, tariff-based competitive bidding with and without accelerated depreciation at INR 7.5/kWh and INR 6.63/kWh respectively.	All consumers
Tamil Nadu	Performance-based incentive of INR 2/kWh for initial two years, INR 1/kWh till year four and INR 0.5/kWh up to year six.	All consumers categorised by supply voltage
Telangana	Net or gross metering option available for tariff equal to the average pooled power purchase cost or average cost of service of the distribution company.	All consumers
Uttar Pradesh	Gross and net metering scheme along with exemption on wheeling and cross-subsidy surcharge.	All consumers up to 1 MW categorised by supply voltage
West Bengal	Net metering and energy banking for one year.	All consumers

Source: Solar policy documents of various Indian states; Goel, 2016

Annex 4: Sample rooftop solar financials and assumptions

Financial indicators	
NPV	6.2 Nu million
IRR	12.9%
LCOE	1.6 Nu/kWh
System Size	
Capacity	100 kWp
Capital investment	4.0 Nu million
Estimated annual generation	142,350 kWh
Financial Assumptions	
Project life	25 years
Debt	100%
Interest rate	7%
Tenure	15 years
Depreciation rate	50% in 1st year
Tax rate	30%
Inflation rate	6%
Discount rate	6%
Tariff rate	2.65 Nu/kWh
Tariff escalation	8%

About ICIMOD

The International Centre for Integrated Mountain Development (ICIMOD), is a regional knowledge development and learning centre serving the eight regional member countries of the Hindu Kush Himalaya – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and based in Kathmandu, Nepal. Globalisation and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. We support regional transboundary programmes through partnership with regional partner institutions, facilitate the exchange of experience, and serve as a regional knowledge hub. We strengthen networking among regional and global centres of excellence. Overall, we are working to develop an economically and environmentally sound mountain ecosystem to improve the living standards of mountain populations and to sustain vital ecosystem services for the billions of people living downstream – now, and for the future.

REGIONAL MEMBER COUNTRIES

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