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URJA NEPAL

RENEWABLE ENERGY INTEGRATION IN NEPAL

May 2022

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ADB	Asian Development Bank
AEPC	Alternative Energy Promotion Center
BAU	Business-as-Usual
BOOT	Build Own Operate and Transfer
BFI	Banking Financial Institutions
C	Celsius
COD	Commercial Operation Date
COP26	United Nations Climate Change Conference of Parties 26
CREF	Central Renewable Energy Fund
CTEVT	Council for Technical Education and Vocational Training
DoED	Department of Electricity Development
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement and Construction
ERC	Electricity Regulatory Commission
FEC	Final Energy Consumption
FY	Fiscal Year
GHG	Greenhouse Gas
GoN	Government of Nepal
GLOF	Glacial Lake Outburst Flood
GSEEP	Grid Solar Energy and Energy Efficiency Project
GW	Giga Watt
HPP	Hydropower Project
IC	Installed Capacity
IEA	International Energy Agency
IEE	Initial Environmental Examination
INDC	Intended Nationally Determined Contribution
INPS	Integrated Nepalese Power System
IPP	Independent Power Producers
IRENA	International Renewable Energy Agency
km	Kilometer
KUKL	Kathmandu Upatyaka Khanepani Limited
kV	Kilo Volt
kW	Kilo Watt
kWh	Kilo Watt Hour
LACOE	Levelized Costs
LDC	Least Developed Countries
LTD	Limited
MoEWRI	Ministry of Energy, Water Resources, and Irrigation
MW	Mega Watt
MVA	Mega Volt Ampere
NEA	Nepal Electricity Authority
NPR	Nepalese Rupees
OIBN	Office of Investment Board Nepal
PFS	Planned Energy Scenario
PPA	Power Purchase Agreement
PV	Photo Voltaic
PVT	Private
RE	Renewable energy

RES	Renewable Energy Sources
RET	Renewable Energy Technology
RFP	Request for Proposal
RoR	Run-of-River
RPGCL	Rastriya Prasaran Grid Company Limited
SREP	Scaling-up Renewable Energy Project
SASEC	South Asia Subregional Economic Cooperation
TEC	Total Energy Consumption
UNFCC	United Nations Framework Climate Convention
USD	United States Dollars
USAID	United States Agency for International Development
VAT	Value Added Tax
VRE	Variable Renewable Energy
VRES	Variable Renewable Energy Sources
VGF	Viability Gap Funding
WB	World Bank

CHAPTER 1: BACKGROUND

Renewable Energy (RE) is defined as energy that comes from technologies using natural resources which replenishes itself over time. Most RE technologies use non-fossil fuel resources which often do not result in greenhouse gas (GHG) emissions. Among the various Renewable Energy Sources (RES) identified to date are wind, solar, biomass, and geothermal. RES which can be integrated into the grid as distributed generation or utility scale generation have been proven to be a key energy supply source. The integration of RE in today's generation portfolio offers major advantages, including reduced or avoided climate change impacts, inexpensive generation, fuel diversity, and decreased reliance on expensive and often imported petroleum-based fuels. However, RES bring the unavoidable challenge of intermittency, which reduces power system quality, efficiency, reliability, while also adding new issues including load management safety and security. The smooth transformation to a renewable integrated power system is facilitated through advanced technology, including energy storage, integrated planning, adequate power evacuation infrastructure, and demand side management, and by associated policy changes.

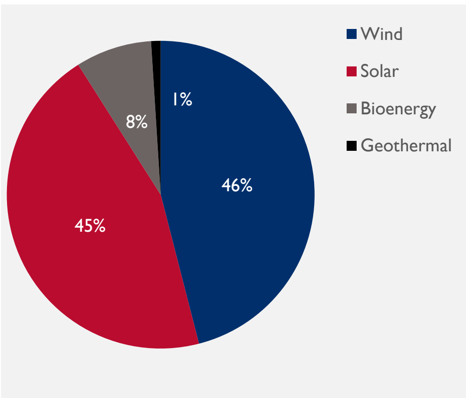
The development of a reliable, sustainable, and low-cost electricity system presents global challenges, including the advancement of modern electricity technologies, the diversification of the generation portfolio, and the ageing of existing infrastructure, have attracted the attention of policy makers and industrialists throughout the world. Increased scrutiny has resulted in greater zeal to implement measures to combat climate change and global warming, including decarbonization of the energy sector. Recently, approximately 200 countries came together at the United Nation Climate Change Conference (COP26), pledging their support to four principal activities/areas: the reduction and mitigation of emissions, reducing climate impacts, using climate financing to help developing countries deliver on their climate goals, and multilateral collaboration to act rapidly and with increased dedication.

THE GLOBAL CONTEXT

According to International Renewable Energy's latest statistics,[1] the global renewable generation (excluding hydropower) capacity at the end of 2020 was 1,588 Giga Watts (GW) – with wind having the largest share of the global total (733 GW), closely followed by solar (714 GW). Other renewables included bioenergy (127 GW), geothermal (14 GW) and marine energy (500 MW[2]). Figure 1 illustrates the share of various RE resources in the year 2020.

In 2020, the global generation capacity from non-hydro RE sources increased by 17.8 percent when 240 GW of capacity was added. As shown in Figure 2, solar and wind energy has dominated the sector, jointly accounting for 92 percent of new capacity additions in fiscal year (FY) 2020.

Figure 1 RE generation capacity by source

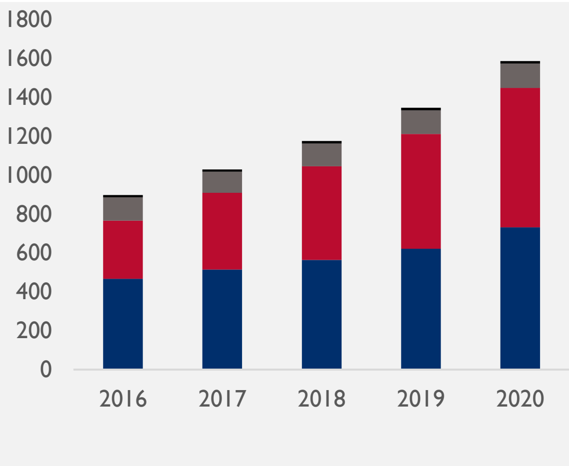


[1] *IRENA. 2021. "Renewable Capacity Statistics 2021."*

[2] *MW: Megawatts*

The share of modern renewable energy[3] in global final energy consumption (FEC) has increased by only 2.5 percent since 2010, staying below 11 percent in 2018. The future RE trend analysis based on the scenarios developed by International Renewable Energy Agency (IRENA)[4] show an increase in the RE share in FEC to 17 percent and 25 percent by 2030 and 2050 respectively in a business-as-usual (BAU) scenario. However, in a more rigorous energy transformation scenario, this share could increase to 28 percent by 2030 and 66 percent by 2050 – a six-fold increase over today's figure, and two-and-a-half times larger than the BAU scenario.[5]

Figure 2 Renewable power capacity growth in GW



Recent years have seen increased support to developing countries to produce clean, renewable energy through international financial flows – which has reached USD 14 billion in FY 2018.[6] Of the total flows, solar projects received 26 percent, geothermal 8 percent, wind 5 percent, and other renewables 34 percent.

With respect of per capita RE capacity, developing countries have shown remarkable progress, with 219 Watts per capita RE in the year 2019 – an increase of 7 percent over the previous year – with per capita solar and wind capacity contributing 22.2 percent and 11.3 percent, respectively.

THE NATIONAL CONTEXT

Nepal has a long history in off-grid electrification using RES, particularly in rural areas where access to the grid is limited. Although the country also has recently gained momentum in the integration of utility-scale RE -- especially solar -- the numerous Power Purchase Agreements (PPAs) which have been concluded on the basis of those projects are insufficient to meet national targets.

The Government of Nepal (GoN) has set an ambitious goal of achieving a 99 percent electrification rate by the year 2030. However, Nepal's energy sector is dominated by hydroelectric sources, which require a minimum of five years to reach commercial operations. Sedimentation in Nepal's rivers also poses significant challenges to the development of hydropower projects (HPPs). Hydropower resources also pose multiple operational challenges as well as undeniable environmental challenges, as depicted in Table 1. Over and above these challenges, Nepal's power system depends largely on the Run-of-River (RoR) type hydropower plants, and these require the import electricity from India to meet seasonal variation in demand and supply. Reduced generation, which is compounded by increased

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[3] Modern renewable energy excludes traditional uses of bioenergy, which if included in this share would bring the share of all renewable energy in total final energy to 18%.
[4] The "Transforming Energy Scenario (TES)" describes an ambitious, yet realistic, energy transformation pathway based largely on renewable energy sources and steadily improved energy efficiency (though not limited exclusively to these technologies). This would set the energy system on the path needed to keep the rise in global temperatures to well below 2 degrees Celsius (°C) and towards 1.5°C during this century. The "Planned Energy Scenario (PES)" is the primary reference case, providing a perspective on energy system developments based on governments' current energy plans and other planned targets and policies (as of 2019), including
[5] Global Renewables Outlook 2020
[6] This figure is 35 percent lower than in 2017, but still 32 percent higher than in 2010.

demand during winter months, continues to pose serious concerns for electricity load management in Nepal.

TABLE 1 CHALLENGES TO THE DEVELOPMENT OF HYDROPOWER RESOURCES

OPERATIONAL CHALLENGES	ENVIRONMENTAL CHALLENGES
• Investment risk due to high construction cost, longer payback period, sunk costs, and unstable policy and regulations	• Flooding due to heavy rainfall
• Requirement of intensive human and financial resources	• Environmental concerns due to water sediments, GLOF, climate change, earthquakes, etc.
• Time and cost overruns	• Impacts on aquatic, riparian, and terrestrial ecology
• Involvement and acceptance issues at local/community level	

Because the development of Nepal's hydropower resources remains one of the nation's signal priorities, there is little doubt that it will remain the centerpiece of Nepal's energy strategy for decades to come. Nevertheless, it is also essential for the GoN to integrate other RES in order to meet the objectives set by the GoN to achieve a diversified energy mix. To achieve its national targets and international commitments, Nepal should leverage its hydropower resources, complemented by other renewable energy sources to provide reliable, affordable, and accessible modern energy to every household. Nepal has huge potential to develop low carbon economy through its ample abundance of RES such as solar energy, biomass, mini/micro hydro, wind energy etc. These resources also offer the opportunity to enhance energy security and environmental sustainability.

OBJECTIVE AND STRUCTURE OF THE REPORT

This report presents a high-level analysis of interventions and activities that require immediate action to scale up RE integration in Nepal and is divided into four chapters.

Chapter 1 lays the context for RE in Nepal, presenting both national and global developments.

Chapter 2 provides a deep dive on RE initiatives in Nepal, focusing on targets, plans, and policies, existing legal requirements, various agreement modalities including power purchase agreements and net-metering contracts, and the power purchase rates prevalent in the country. In addition, this chapter describes the status of utility scale RE projects, including the existing business model adopted for RE project development.

Chapter 3 sets out the opportunities and challenges that will be faced by the existing power system as it integrates variable renewable energy sources (VRES). In this chapter numerous opportunities are identified which are unique to Nepal. However, since Nepal's grid scale RE integration is only in its early stages, the opportunities and challenges section highlights the generic challenges while reducing possible future challenges posed by an increasing share of RE projects.

Finally, Chapter 4 identifies some areas for intervention, especially those requiring immediate action to scale up VRE projects to achieve the GoN's national renewable energy targets.

CHAPTER 2: RENEWABLE ENERGY INITIATIVES IN NEPAL

A decade ago, the RE landscape of Nepal looked quite different, with RES being largely limited to off-grid applications. With the falling costs and a more widespread knowledge of RE technologies, the intervening years have witnessed a greater degree of interest among stakeholders in grid-tied RE technology deployment.

This chapter focuses on the recent plans, policies, and targets set by the GoN. It also describes the existing legal, contractual, and other requirements which have been imposed for the development and integration of RE projects. A brief overview of the multiple business models adopted in Nepal to develop RE projects is also presented.

TARGETS, PLANS AND POLICIES

On the planning side, the GoN has recognized the need for RES to play an increasingly important role in securing energy security and diversifying the energy mix. The GoN has, through various policy initiatives, now set targets and issued plans to achieve these goals. While the target are not yet synchronized across various policy documents, they nevertheless clearly indicate that RE integration is now one of the GoN's priority area of intervention.

Table 2 highlights recent targets, plans, polices, and activities specified by various GoN bodies pertaining to grid-tied RE-based generation. In addition, a bill for an RE Act is also under discussion among stakeholders.

TABLE 2 RECENT TARGETS, PLANS AND ACTIVITIES IN RE

POLICY DOCUMENT	PUBLISHING ORGANIZATION	ACTION/ACTIVITIES/TARGET
Nepal's Long-term Strategy for Net-zero Emissions, October 2021	GoN	• Strategic action to achieve net-zero emission by 2045 include the development and integration of VRE into the power system • Milestones include: - 2.1 GW of grid-connected solar power plants - 1.1 GW of off-grid isolated RE energy systems
Budget Speech of 2078, 2021	Ministry of Finance	• Net-metering and net-payment modalities are to be adopted to expand generation from RE sources and to diversify energy generation away from purely hydropower • The Nepal Electricity Authority (NEA) to buy electricity generated from solar plants developed by private entities, and provision will be made to expand transmission network to the generation site [Point 324]
Grid Connected Alternative Electricity Development Related Working Procedure-2078[7], April 2021		• This is among the latest guidelines issued by the GoN for the connection of alternative energy source-based electricity generation to the national grid • The NEA to buy electricity generated from projects, with the electricity purchase rate to be set by the Electricity Regulatory Commission (ERC) • This document reflects multiple technical and procedural requirements for connection to the national transmission network, including as the need to apply to the NEA and to obtain from the Department of Electricity Development survey, generation, and transmission licenses

[7] *The older version which was released in 2018 has been superseded by this new version released in 2021.*

TABLE 2 RECENT TARGETS, PLANS AND ACTIVITIES IN RE

The Fifteenth Plan (Fiscal Year 2076/77 - 2080/81), 2020	National Planning Commission	• RE based generation capacity targets have been set for 216 MW, 4,000 MW and 5000 MW for FY 2023/24, FY 2029/30, and FY 2043/44 respectively • Ratio of RE in total energy consumption to be increase from 7% in 2018/19 to 12% in 2023/24 • Provisions are included related to connecting micro/mini hydro, solar, wind, biomass, and other alternative energy projects to the national transmission network, provided that the transmission network has reached the project area • The net-metering and net-payment modality is to be promoted to connect RE rooftop energy systems into the national transmission network • The Alternative Energy Promotion Centre (AEPC) is to be established as Centre of Excellence in RE domain • Provisions are to be made for the development of energy funds for provincial and local bodies
Second Nationally Determined Contribution (NDC), 2020	GoN	• Generation capacity to be expanded to 15,000 MW by 2030, of which 5-10 % will be from RE sources • An enabling environment is to be developed for the adoption of distributed RE technology by small and mid-sized enterprises
White Paper, 2018	Ministry of Energy, Water Resources, and Irrigation (MoEWRI)	• Out of 15,000 MW generation capacity planned to be integrated by 2028, 5 - 10% of the mix should be from alternative energy sources • RE projects are to be integrated into the national transmission system based on the net-metering and net-payment modality Grid-connected roof-top systems will also be eligible under this modality. • Activities are to be designed and undertaken to enhance the capacity of local and provincial governments to expand RE development Activities would include policy making, planning and technology transfer. • RE funds will be established for the purpose of managing and incorporating finances received from national and international sources, as well as any funds received from carbon trade • A 'One province, one mega project' program to be established, under which Province 2 is to plan for least 200 MW of solar PV system • 'Every settlement, an energy settlement' program is also to be created, under which GoN will form of challenge fund for all local bodies to finance up to 50% of investment for solar PV project with 100-500 kW capacity Generated electricity under this scheme is to be used for community activities, with excess energy to be injected into national grid under net metering modality. • A power purchase (PPA) based arrangement is to be established for the connection of micro hydro, solar, biomass, wind projects into the national grid.
National Energy Crisis Mitigation Plan, 2016	MoEWRI	• The electricity generation mix is to comprise of at least 10% contribution from alternative energy sources (including solar, wind, etc.) by 2026 Polices are to be made effective to reach the target • The "take-or-pay" modality (currently for 25 years for HPPs) is to be adopted for solar and wind energy projects A special rate for power purchase will be established NEA, and any resulting financial burden to NEA to be compensated by the GoN • Subsidies and access to concessionary financing is to be provided for roof-top and commercial solar PV system greater than 200W

TABLE 2 RECENT TARGETS, PLANS AND ACTIVITIES IN RE	
	The net-metering arrangement shall also be made for solar PV systems greater than 500 MW existing near the national grid. A benchmark rate of NPR.9.61/unit is to be set for excess electricity fed into national grid. • The net-metering arrangement is to be made for biomass based electricity generation (especially co-generation. • A Value Added Tax (V.A.T) subsidy of NPR. 5 million per MW is to be given for all the projects to be constructed within the fiscal year 2025/2026.

EXISTING LEGAL REQUIREMENTS, AGREEMENT MODALITY AND POWER PURCHASE RATE

Two recently issued policy documents promulgated by the GoN provide insights and some guidance for developers involved in grid-connected utility scale projects.

The MoEWRI released the "Grid Connected Alternative Electricity Development Related Working Procedure, 2078" in 2021, which is the latest guideline for the development of alternative source-based electricity generation projects intended to be connected to the national grid. Based on the rated capacity of the project, the guideline categorizes the alternative energy projects into two separate categories — with all projects less than 1 MW in capacity belonging to the first category, and projects greater than 1 MW being the second. In addition, separate provisions and conditions have been included for utility and rooftop solar projects. The guideline provides information on licensing requirements, power purchase rates, and other rules and conditions applicable for projects to be connected to the national grid. The guideline also states that power purchase rates of these projects will be determined by the ERC, and depending on the technology, the rates could be different.

In 2019 the ERC issued "Bylaws Relating to Terms and Conditions to be Abided by Person Licensed to Purchase and Sale of Electricity, 2076.", which lists procedures and conditions regarding application procedures for PPAs, and for the determination of power purchase rates for power purchasers and sellers.

Based on these two guiding documents, Table 3 below summarizes the latest provisions for grid-connected alternative energy projects in Nepal.

TABLE 3 PROVISION FOR GRID-CONNECTED ALTERNATIVE ENERGY PROJECTS

CATEGORY (CAPACITY)	APPLICATION TO NEA	SURVEY LICENSE FROM DoED	GENERATION AND TRANSMISSION LICENSE FROM DoED	AGREEMENT MODALITY	RATE
All alternative energy projects with capacity less than 1 MW (other than	Required[8]	Not clear[9]	Not clear[9]	Not clear[9]	-NPR 7.30/unit, without annual escalation

[8] *While submitting the application, the project developer must also present electricity generation license obtained from concerned legal agency.*
[9] *A form of license is required, but it is not clear if this license is same as the one issued by DoED.*

TABLE 3 PROVISION FOR GRID-CONNECTED ALTERNATIVE ENERGY PROJECTS

CATEGORY (CAPACITY)	APPLICATION TO NEA	SURVEY LICENSE FROM DoED	GENERATION AND TRANSMISSION LICENSE FROM DoED	AGREEMENT MODALITY	RATE
household roof-top solar PV system)					
All alternative energy projects with capacity exceeding 1 MW (other than household roof-top solar PV system)	Required	Required[10]	Required	PPA based	-Not more than NPR.7.30/unit -ERC to determine the rate -Competitive bidding is also allowed.
Household roof-top solar PV system	Required	-	-	Net metering based	NPR.7.30/unit, without annual escalation

Source: Grid Connected Alternative Electricity Development Related Working Procedure-2078 and Bylaws Relating to Terms and Conditions to be Abided by Person Licensed to Purchase and Sale of Electricity- 2076

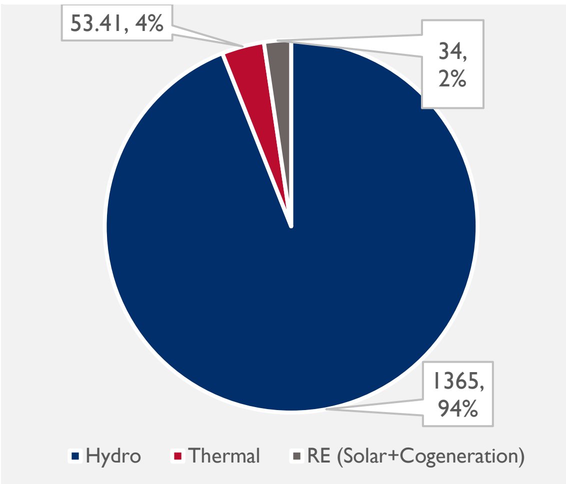
The ERC is still in initial years of operation, and it will take time for it to fully grow into its posers and take full ownership of its responsibilities. In a meeting[11] with ERC members, it was announced that a new PPA tariff for VRE plants will be formulated by ERC soon. Until the new tariff is made official, it is planned to keep the current PPA rates at NPR 7.30/unit.

STATUS OF UTILITY SCALE RE PROJECTS

As of FY 2021, a total of 1,452 MW of generation capacity has been integrated into the Integrated Nepal Power System (INPS) – with 31 MW solar power plants and a single cogeneration plant of 3 MW capacity – accounting only ~2% of NEA's total installed capacity (see Annex 1 for list of grid-connected RE projects).

The pace of RE integration does seem to be accelerating - NEA has signed PPAs with 13 different RE power plants (12 solar plants and 1 cogeneration plant), comprising a total capacity of 55 MW from different IPPs as shown in Annex 2. NEA expects to add these to the national grid during the upcoming

Figure 3 Integrated Nepal Power System Capacity until mid-July 2021



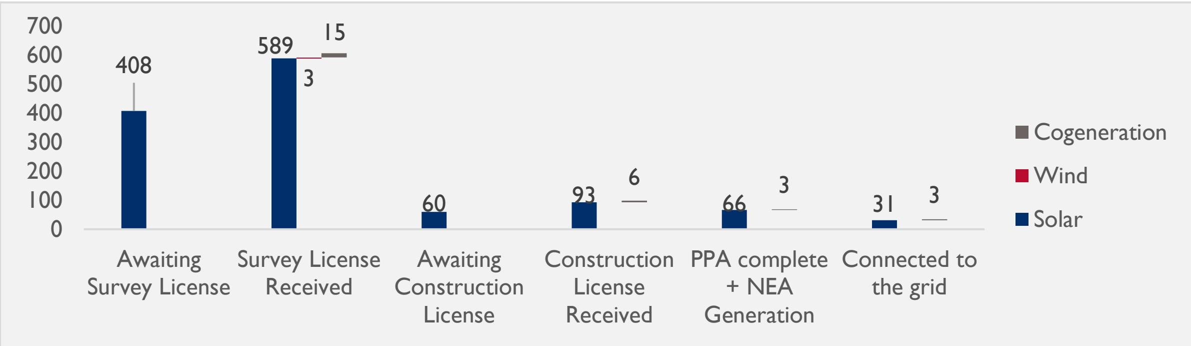
[10] *Initially awarded for a period of one year, which can be renewed based on work progress and other reasons.*
[11] *Based on a meeting between ERC and Urja Nepal.*

FY 2021/22. NEA also expects to add another 14 MW of solar power during FY 2021 from its own generation portfolio. If such addition goes according to plan, a total of 66 MW of solar power will be added to the national grid by the end of FY 2021/22. Furthermore, there are a number of other RE power plants in various stages of development as listed in Annex 3.

Figure 4 provides a complete picture of RE projects that are currently connected to the national grid and other RE projects that are in various stages of development.

Recent targets set by INDC, and a White Paper highlights the total installed capacity (IC) to reach 15,000 MW with 5-10 percent RE share by 2030 from the base case of 1,452 MW IC with 2 percent RE share as of mid-July 2021. To achieve even the minimum target i.e., 5 percent RE, the IC should increase on average by 80 MW each year.

Figure 4 Existing and pipelined RE projects with installed capacity in MW (as of December 21, 2021)



As illustrated in Figure 4, the list is dominated by solar power plants, with other RE technologies existing only on the margins. A total of 23 (588.9 MW capacity) solar projects have received a survey license and another 16 (92.97 MW capacity) have received a construction license from DoED) (list updated on December 21, 2021). Similarly, one cogeneration plant (15 MW) has received a survey license and another two (3 MW each) have received a construction license. With respect to other RE sources, only a single wind power plant (3 MW) has received a survey license. An additional 23 and 9 solar projects (of 407.9 MW and 59.59 MW capacity) have also applied for a survey license and a construction license, respectively.

EXISTING BUSINESS MODELS ADOPTED FOR RE PROJECT DEVELOPMENT

Previously, because utility-scale solar plants were not financially attractive for private players, financial support-based mechanisms were used to leverage private sector investments. More recent trends, however, include projects owned and developed by private players that are being developed on their own without any financial support such as grants or subsidies. For smaller sized RE projects connected to the grid, net-metering arrangements are also present. Based on ownership and contractual arrangements for purchasing power, business models for grid connected RE development can be broadly classified into three categories.

UTILITY LED MODEL

NEA has already developed multiple grid-tied solar projects — some of which are also supported by development partners. At the end of FY 2019/20, NEA owned a total of 1.35 MW of solar projects connected to the grid. The projects are: Simikot (50kW), Gamadhi (50kW), and Battar (1.25 MW), a larger utility scale project supported by the World Bank (WB) under Grid Solar Energy and Energy Efficiency Project.[12]

The Grid Solar Energy and Energy Efficiency Project (GSEEP) is being carried out by the Planning and Technical Services Department under Distribution and Consumer Services Directorate of NEA. The project is supported by a credit (USD 130 million) from the WB and counter financing (USD 8 million) provided by the GoN.[13] This project has two components: development of a solar farm in Nepal, and the reduction of NEA distribution losses. The objective of the solar component of the project is to establish total of 25 MW of solar farms on seven different lands owned by NEA and for that purpose, USD 54 million has been earmarked.[14] The projects will be executed using the Engineering Procurement and Construction (EPC) model, and the electricity generated will be injected into NEA substations.[15] By the end of FY 2019/20, only 1.25 MW plant at Battar, in Nuwakot was connected to the national grid. Another 15 MW was targeted for connection by September 2020, while the remaining projects in other locations (with capacity of 8.75 MW) are still carrying out their Initial Environmental Examinations (IEE).[16]

INDEPENDENT POWER PRODUCERS LED MODEL

The NEA has also been purchasing electricity from solar PV plants owned by IPPs based on Power Purchase Agreements (PPA) between IPPs and NEA. In 2013, a 680 kW Solar PV project owned by Kathmandu Upatyaka Khanepani Ltd (KUKL) became the first non-NEA owned solar project to be connected to the national grid under a Power Purchase Agreement.[17] Since then, several PPAs for larger utility scale solar plants have been signed by NEA.

PPA-based arrangements can be further sub-divided into two categories, the first being arrangements in which projects are developed by IPPs and are supported by grants. The second category includes projects developed by IPPs using private financing and loans from domestic Banking Financial Institutions (BFIs) which are not supported by any subsidy/grants.

PPA-BASED PROJECTS SUPPORTED BY GRANTS

Utility Scale Grid-Tied Solar Projects with Viability Gap Funding (VGF) scheme: In 2016 the GoN received a grant in the amount of USD 20 million from the Scaling Up Renewable Energy Program in Low Income Countries (SREP) of the Climate Investment Funds.[18] The objective of the grant involves developing a business model for the deployment of RE technologies with private sector participation. The fund is administered by the ADB through SASEC Power System Expansion Project, and Project Management Directorate in NEA is executing the project. Out of USD 20 million, USD 18.5 million will be used to promote utility-scale grid -tied solar PV projects through Viability Gap Funding (VGF)[19]

In 2018, NEA called a global tender under the VGF modality, inviting national and international developers to provide competitive bid price for supply of solar powered projects to be installed at various substations across the country. Under the program, the developer will be responsible for

[12] *NEA. 2020. "A Year in Review - Fiscal Year 2019-20."*
[13] *NEA. 2020. "A Year in Review - Fiscal Year 2019-20."*
[14] *World Bank. 2020. "Disclosable Version of the ISR - Nepal: Grid Solar and Energy Efficiency-P146344-."*
[15] *NEA. 2014. "Grid Solar Energy Efficiency Project."*
[16] *NEA. 2020. "A Year in Review - Fiscal Year 2019-20."*
[17] *NEA. 2014. "A Year in Review - Fiscal Year 2013-14."*
[18] *ADB. 2016. "$20 Million Grant to Spur Private Sector Solar Power Investment in Nepal." The Asian Development Bank.*
[19] *NEA. 2020. "A Year in Review - Fiscal Year 2019-20."*

construction, finance, design, engineering, procurement, construction, commissioning and overall operation and maintenance of the project.

Under the VGF approach, a VGF grant funds the difference between an IPP's bid price for the cost of producing electricity and the minimum price that NEA is willing to pay purchasing the electricity. The PPA agreement is for 25 years and the IPPs are required to provide fixed quoted rates for producing electricity up to a specified period (initially set for June 2022). During this period, the difference between NEA's intended purchase rate of NPR 6.50 and the rate provided by the selected developer will be covered by VGF. At the end of the term, the tariff rate will be fixed at NPR 6.50 per unit for the residual period. Five developers were selected to construct and operate solar projects, with a cumulative capacity of 24MW by the end of FY 2018/19.[20] By May 2021, out of the 5 selected developers, 4 developers have signed PPAs with NEA, totaling 19 MW in capacity.[21]

PPA-BASED PROJECTS WITH PURELY COMMERCIAL ARRANGEMENT

Under this arrangement RE projects are built by private developers without any access to financial supports such as grants and subsidies. These RE projects were first developed under pursuant to the GoN's National Energy Crisis Mitigation Plan of 2016, which targets 10% of generation to be from alternative renewable source such as wind and solar projects. The plan even provides that these projects will be eligible for take-or pay PPA models with special PPA rate of NPR 9.61 per unit.[22] In response, in the same year, NEA published a Request for Proposals (RFP) from potential developers for the supply of solar powered electricity at NPR 9.61 per unit for cumulative capacity of 64 MW to be installed at various locations. However, the PPA rate had to be revised, as a Directive was issued by Ministry of Energy (now MoEWRI) which fixed the rate to not exceed NPR 7.3 unit.[20] In total, NEA selected 22 locations, out of which only 8 PPAs have been signed. The projects will be developed under Build Own Operate and Transfer (BOOT) model.

More recently, a PPA-based commercial arrangement has been used. Following directives issued by the MoEWRI, a PPA is signed between NEA and IPPs at a posted rate of NPR 7.3/unit for a period of 25 years on take-or-pay basis – with no provision for tariff escalation. The project developer builds, owns, and operates the project, and before the end of 25 years, the developer can submit application to renew the generation license. As discussed in previous section, for projects greater than 1 MW, going forward, the ERC is also authorized to set the PPA rates.

NET-METERING BASED MODEL

Recently, the NEA has also agreed to allow its customers to inject electricity generated from their sources into the national grid on the basis of net-metering scheme. The net-metering scheme can be separated into two categories:

Rooftop residential and commercial PV systems with net metering scheme: Under this arrangement, consumers connected to national grid can install RE sources in their premises and generate their own electricity. Generated electricity can offset electricity purchased from NEA and in the event of surplus generation, that power can also be sold to NEA. A net-meter will be installed by NEA to measure electricity consumed by the consumer and to measure surplus electricity injected

[20] *NEA. 2018. "Directive on Grid Connected Alternative Electricity Generation Development."*
[21] *Based on interview with NEA.*
[22] *MoEWRI. 2016. "National Energy Crisis Mitigation Plan 2016." Ministry of Energy, Water Resources, and Irrigation.*

into the national grid. An annual contract for net-metering must be signed between NEA and the consumer willing to sell surplus power.

Grid-tied energy efficient solar water pumping and irrigation: Under this approach, excess electricity can be sold by the water pumping and irrigation projects (consumers) to NEA under the net-metering arrangement. The activity, led by Energy Efficiency and Loss Reduction Department of NEA, aims to improve the quality of electricity supplied for irrigation and drinking water projects. Three projects were successfully completed under this scheme by the end of FY 2019/20.

CHAPTER 3: DRIVERS AND CHALLENGES FOR UPSCALING RE IN NEPAL

DRIVERS TO UPSCALE RE INTEGRATION

In addition to the GoN's goals of decarbonizing generation and otherwise addressing climate change issues, there are several other drivers of increased RE development in Nepal – ranging from improving energy security and resiliency to diversification of energy generation. Each of these are described below.

ENERGY SECURITY

Nepal's energy sector is heavily dependent on imported fossil fuel and biomass-based energy sources. Within power sector, hydropower is the predominant source of electricity generation, followed by imported electricity. There is growing evidence that points to possible changes in Nepal's hydrology owing to climate change, and this makes hydropower highly susceptible to climate change induced impacts. Recently, Nepal has also witnessed major floods, Glacial Lake Outburst Flood (GLOF) and landslides.

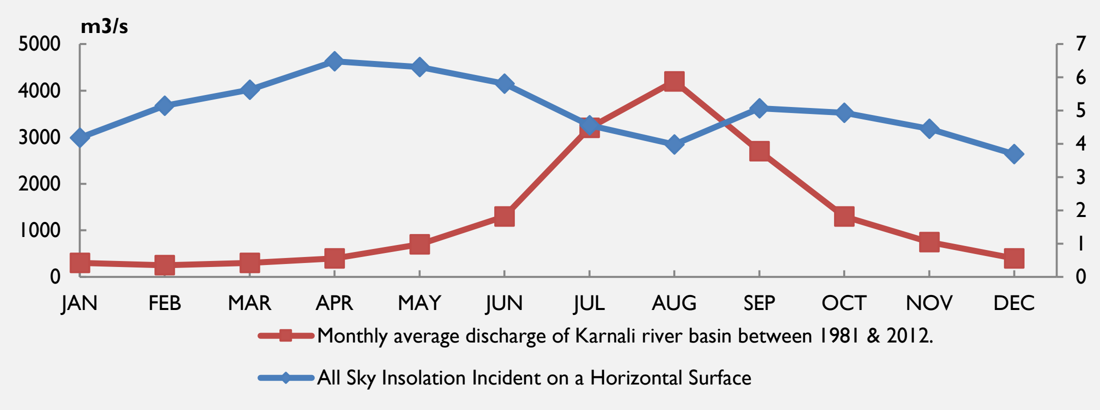
Relying on imports or a specific technology such as hydropower to meet Nepal's electricity demand may put Nepal at risk of supply constraint and price volatility, thereby aggravating the nation's energy security. By incorporating more renewables in the generation mix, the power generation profile can be diversified, and energy security improved. A utility-scale or distributed renewable energy generation portfolio coupled with an energy storage technology such as batteries can further ensure reliability of the system in situations where hydro-based generation maybe be negatively affected. Charged batteries can provide power to the system, allowing for fluctuations in the generation technology. In addition, batteries it can provide backup power in the event of an outage. The other energy storage advantages to the power system include stabilization of electricity prices, mitigation of RE curtailment and management of demand changes.

COMPLEMENTING GENERATION CHARACTERISTICS

One of the unique characteristics of a Nepal's rivers is that the water discharge available is seasonal, consisting of wet and dry seasons. Renewables can complement hydropower generation during dry seasons when there is less water available. This is even more relevant in Nepal, where there will be is little or no seasonal storage available in the medium-term. Today the majority of Nepal's HPPs are Run of River (RoR) HPPs.

Figure 5 illustrates the monthly average discharge of Karnali river basin, and Nepal's solar insolation during the same period. It clearly depicts that during winter (dry) season when the discharge available for hydropower plant is lower, solar insolation is greater; whereas in rainy (wet) season. solar insolation is lower, but water discharge is greater. This shows that solar energy is not a substitute of hydropower, in fact it is a complementing solution.

Figure 5 Graphical illustration of Karnali river basin discharge and solar insolation



Source: Power Data Access Viewer, NASA.[23]

LIMIT GREEN HOUSE GAS (GHG) EMISSIONS

Modern RE power plants have much shorter gestation periods than do HPPs. Nepal's hydropower dominance can go far to reduce the use of unsustainable and inefficient traditional energy sources, including firewood, agricultural residue, and cow dung cake, which accounts for around 70 percent of national energy, and fossil fuel-powered electricity imported from India through utility scale integration of RE technologies in INPS. The replacement of such energy sources with RE alternatives can also help the nation to achieve its commitment pledged under the United Nation Framework Convention on Climate Change (UNFCC). In addition, Nepal has huge potential to develop low carbon economy through its ample abundance of RE resources.

CHANGING ECONOMICS OF RENEWABLE AND ALTERNATIVE ENERGY TECHNOLOGIES

The electricity costs from RE power generation continue to drop. During the past decade there has been a significant reduction in the price of solar and wind power technologies. According to a study conducted by IRENA,[24] the global weighted-average levelized cost (LCOE) for onshore wind, offshore wind and utility-scale solar photovoltaics fell by 56 percent, 48 percent, and 85 percent respectively between 2010 and 2020. However, for the same period, the global weighted-average LCOE for hydropower increased by 18 percent from USD 0.038/kWh to 0.044/kWh. The electricity costs for renewable technologies are also lower than the cheapest sources of fossil fuel. On the basis of this information, it can be deduced that the low generation cost of renewable and alternative energy technologies could bring the overall cost of generation of the INPS down, making cheaper electricity available for consumers.

ACCESS TO CLIMATE FINANCE

In FY 2019/20, global climate finance in the amount of 632 billion USD was available for activities related to RE sector.[25] With even more stronger pledges expected from developed nations to combat climate change impacts, significant climate financing should also be available in the future for countries,

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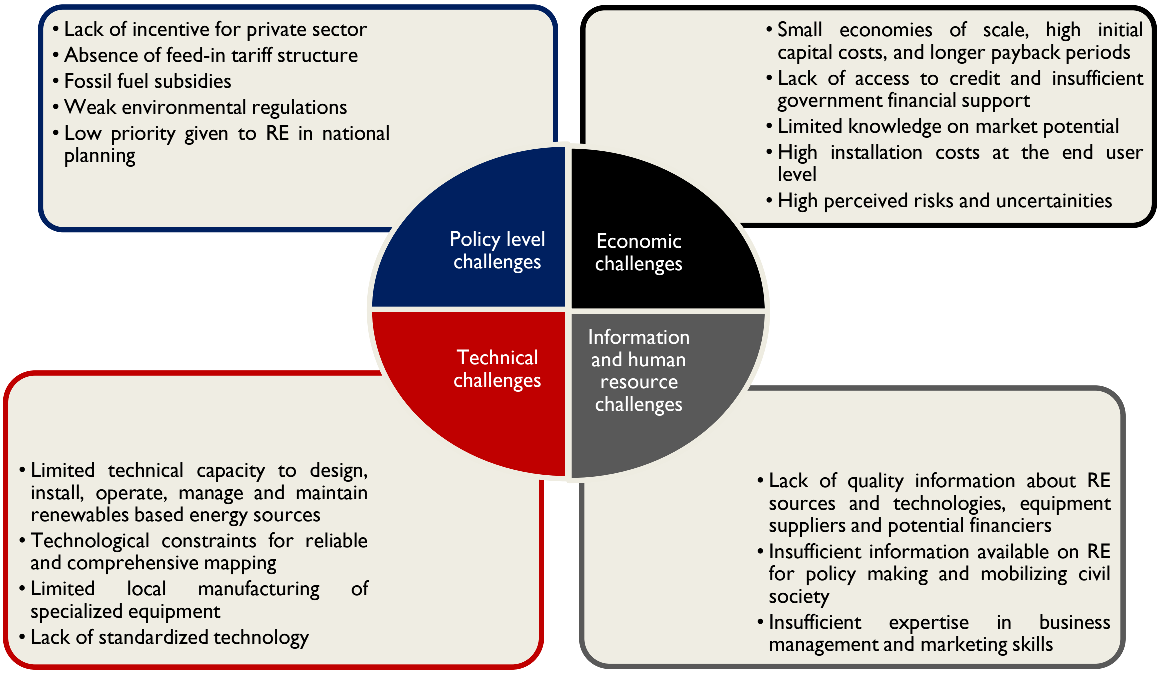
[23] *Khatiwada, Kabi R., Jeeban Panthi, Madan L. Shrestha, and Santosh Nepal. 2016. "Hydro-Climatic Variability in the Karnali River Basin of Nepal Himalaya" Climate 4, no. 2: 17.*
[24] *IRENA.2020. "Renewable Power Generation Costs 2020."*
[25] *Climate Policy Initiative. 2021. "Preview: Global Landscape of Climate Finance 2021."*

including Nepal, that are negatively affected by climate change. Nepal now has an opportunity to tap into climate finance and leverage it into GHG mitigation technologies such as renewables.

CHALLENGES THAT LIMIT UTILITY-SCALE RE INTEGRATION

Focusing on the opportunities RE has to offer, the world is moving rapidly to adopt RE sources for electricity generation. Nevertheless, challenges to the integration of RE remain at multiple stages, including policy, technical, economical and resource management. Some of the challenges imposed by RE development/integration in South Asian countries are illustrated in Figure 6.

Figure 6 Challenges caused by RE integration[26]



Analyzing the present situation of Nepal, discrete stakeholders already involved in RES development have faced particularly daunting Nepal-specific challenges, including those set out below:

POLICY LEVEL CHALLENGES

1. The Renewable Energy Subsidy Policy, 2073 provides multiple types of subsidies for RE projects. The targeted beneficiaries, most of which are off-grid and mini-grid small scale projects rather than utility-scale projects – demonstrate a lack of incentive for potential large-scale private investors.
2. The process of obtaining licenses and permits to develop RE projects in Nepal – starting from obtaining a survey license, generation license, initial assessments (EIA/IEE), connection agreement to PPA – is time-consuming and bureaucratically heavy, which leads to construction delays which always increase project costs.

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[26] *Shukla, A.K., Sudhakar, K. and Baredar, P., 2017. "Renewable energy resources in South Asian countries: Challenges, policy, and recommendations. Resource-Efficient Technologies," 3(3), pp.342-346.*

3. With respect to RE tariffs, currently there is a single rate of NPR. 7.30 per unit – a number that was derived from existing tariff for RoR hydropower which does not take into consideration technology specific factors – is applied to all RE projects.

ECONOMIC CHALLENGES

1. The capital costs of RETs are relatively high, and as such, require adequate financial support. However, owing to the risks and uncertainties associated with its project implementation, the maturity of RE business models, and market insecurity generally, financial institutions in Nepal are not yet motivated to support investments in such technologies.
2. While there are several programs supported by development partners and donor agencies through grants and credits, they are generally focused on facilitating small scale off-grid and mini-grid projects, not on-grid large-scale projects.
3. The nation's only financial intermediation mechanism in the RE sector – Central Renewable Energy Fund (CREF) – which is responsible for effective delivery of subsidies and credits to renewable projects. is facilitating small scale projects through subsidies rather than credit mechanisms. In fact, due to lack of fund allocation by GoN, the credit line component of CREF has stayed unfunctional since its establishment.

TECHNICAL CHALLENGES

1. The conflicting results of two reports – one by the World Bank (WB)[27] and the other by AEPC[28] -- show a lack of information on potential sites for large-scale RE projects and demands actual and detailed potential mapping from the GoN.
2. Exact data on how the LCOE and its contributors have changed over the time in Nepal cannot be found due to limited technical capacity to conduct detailed research in that area.

INFORMATION AND HUMAN RESOURCE CHALLENGE

1. The inclusion of modern RE technologies in the syllabus designed for engineering and technical courses at universities and colleges of Nepal has not been prioritized.
2. The Council for Technical Education and Vocational Training (CTEVT) – an organization focusing mostly on vocational trainings – still lacks specialized training in different areas of renewable energy technologies.
3. Due to limited technical know-how at the local level, and indigenous communities lack a deep understanding of RETs, government subsidies, or prospective financial partners.

Furthermore, RES bring unique characteristics which are quite distinct from those of conventional generators, as described in Table 4.[29] The integration of RE to the existing power network demands power system flexibility – defined as the ability to always balance supply and demand of a system effectively. It can therefore bring new challenges when integrated in the electricity supply mix.

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[27] *World Bank. 2017. "Solar Resource and Photovoltaic Potential of Nepal. The World Bank/ESMAP."*
[28] *AEPC. 2008. 'Solar and Wind Energy Resource Assessment in Nepal.'*
[29] *IRENA. 2018. "Variable Renewable Energy Integration in Central America" [Slide deck]*

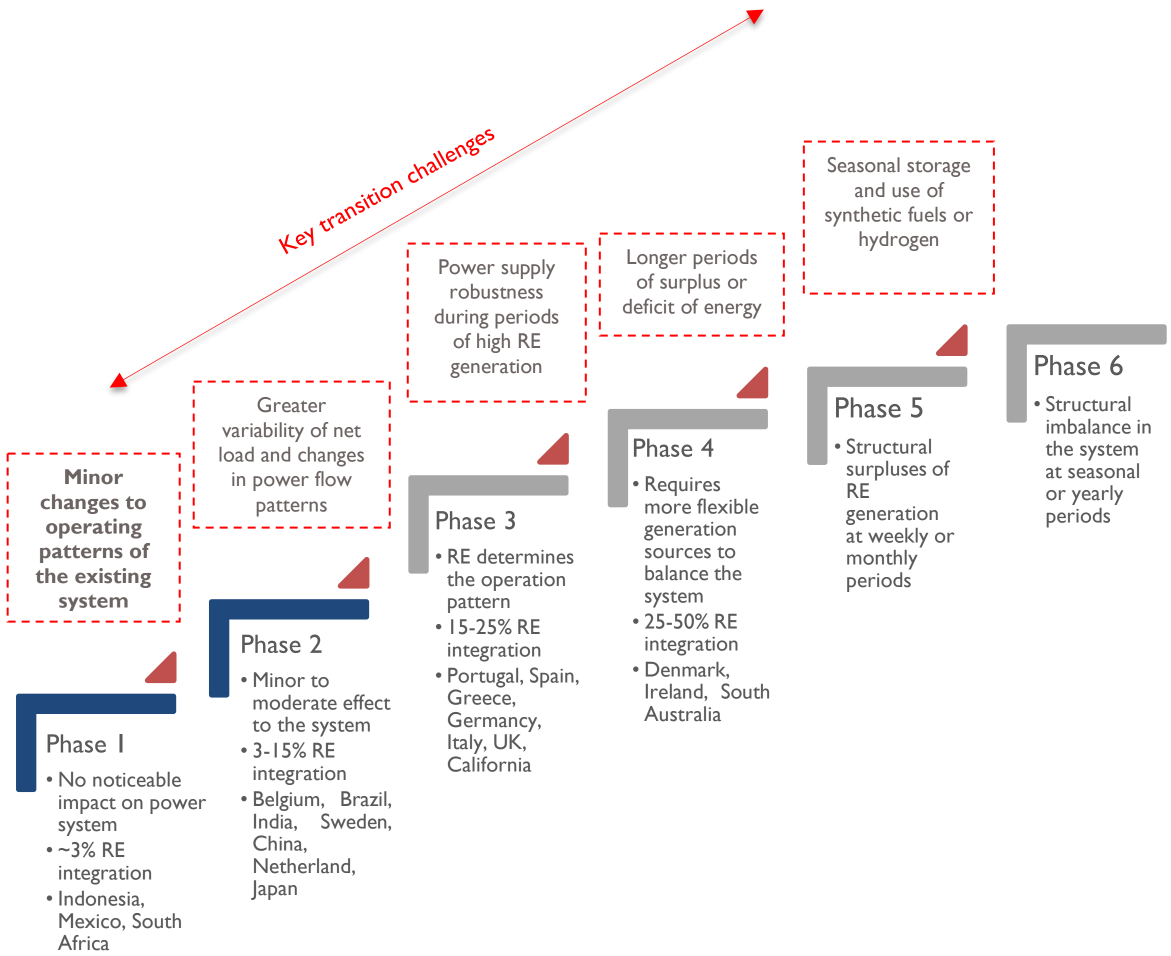
TABLE 4 TECHNICAL CHARACTERISTICS OF VRE	
VRE CHARACTERISTICS	IMPACT ON SYSTEM PROPERTIES
Non-synchronous technologies: use of power electronics device for interfacing decouples power source from grid dynamics	System inertia Frequency and voltage response
Distributed and location constrained: depends on availability of REs	Voltage control Transmission capacity
Uncertainty: difficult to forecast with perfect accuracy	Flexibility
Variability: output depends on resource availability, which is impact by weather patterns.	Flexibility Firm capacity

The International Energy Agency (IEA) has developed a common framework for system flexibility, classifying RE integration levels into six different phases based on its impact in the overall power system. Figure 7 identifies the phase-wise impacts of RE integration,[30] together with key transition challenges,[31] RE integration levels,[32] and multiple international examples.

Nepal is in Phase 1— the earliest stage of RE integration. As such, the impact on power system is not yet great.[33] However, owing to its commitment to increase RE share in the generation portfolio, Nepal will soon reach Phase 2, and this will cause minor-to-moderate impacts on the system. The INPS should be able to manage the key transition challenge – changes to operation pattern – which will be faced in near future.

30 IEA. 2019. "White Paper"
31 IEA. 2019. "Status of Power System Transformation."
32 World Energy Council. Renewable Energy System Integration in Asia.
33 Based on consultation with LDC, NEA.

Figure 7 Phases of RE integration

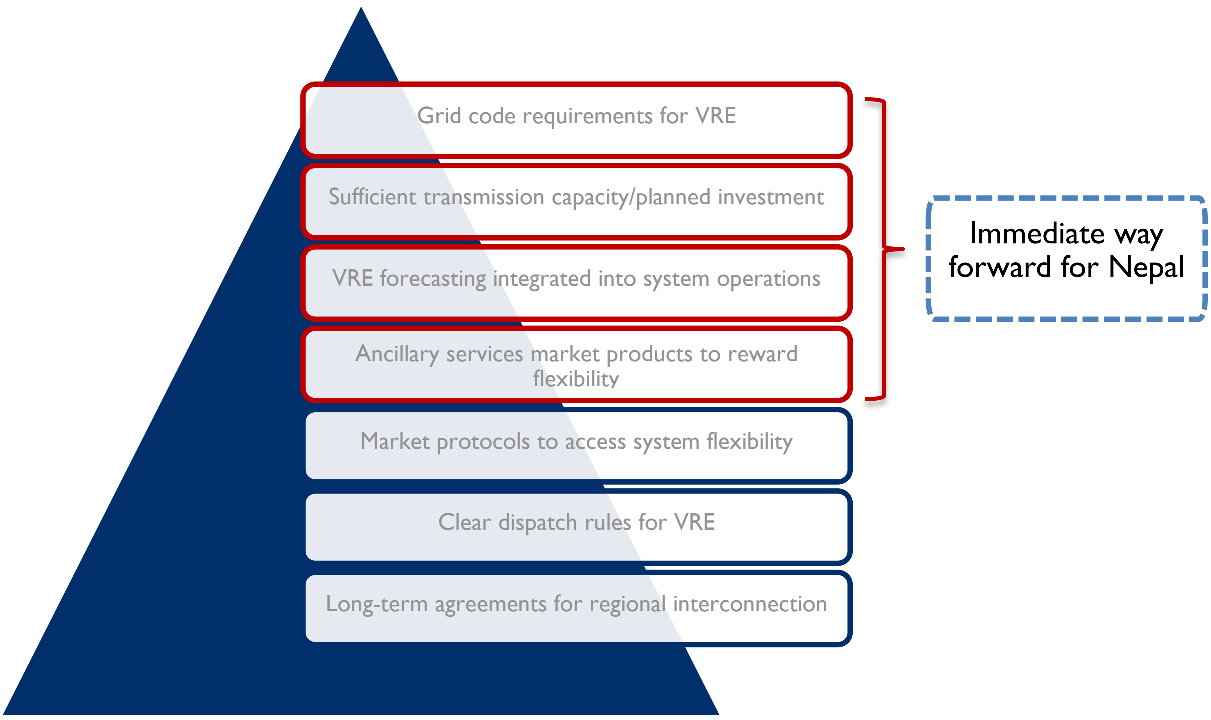


CHAPTER 4: INTERVENTION AREAS

As power systems around the world continue the energy transition, power system flexibility will become an ever-greater global priority. A range of operational, policy and investment-based interventions are available to improve the flexibility of modern systems, thereby facilitating cleaner, more reliable, more resilient, and more affordable energy.

Nepal is in Phase 1, with less than 3 percent VRE and without any noticeable effect on its system. However, the large amount of VRE projects is planned or in pipeline indicates that INPS should be prepared for higher levels of penetration in near future. The readiness of a system – from a system operation perspective – to integrate VRE was evaluated in a study[34] conducted by USAID, based on the seven factors identified in Figure 8. These seven characteristics are used to assess the general level of system maturity to respond to the challenges associated with higher shares of VRE and advance through the phases. Based on high level analysis by the Urja Nepal team, the way forward is for Nepal to rapidly increase its system flexibility. The analysis took into consideration the level of INPS maturity and international experiences from four countries – two from phase 1: Vietnam and Columbia and two from phase 2: India and The Philippines (Annex 4).

Figure 8 Factors to access maturity of a power system for VRE integration



[34] *USAID. 2020. 'Scaling Up Renewable Energy Projects. Grid Integration Series: Impact of Variable Renewable Energy in System Operation.'*

Table 5 depicts the current generation mix of Nepal, together with its RE targets, challenges associated with utility-scale VRE integration, and intervention areas that require immediate implementation. Each of the identified areas, as well as leading regional practices, are discussed in detailed in the following section.

TABLE 5 HIGH LEVEL SITUATIONAL ANALYSIS WITH INTERVENTION AREAS FOR NEPAL	
GENERATION PORTFOLIO (HYDRO-DOMINANT)	**Hydro: 94%** Thermal: 4% **VRE: 2% (31 MW solar + 3 MW cogeneration)**
RE TARGET	5 – 10 % generation from non-hydro renewables by 2030
CHALLENGES	• Limited transmission capacity. • Limited cross-border trade. • Limited ancillary service market. • Dated grid code; VRE sources not considered. • Limited local technical capacities. • Requirement of energy storage to implement more VRE. • Grid stability analysis to integrate new VRE plants.
INTERVENTION AREAS	• Revise the grid code to facilitate VRE integration • Study transmission expansion and identify transmission projects to integrate VRE resources • Create a comprehensive framework for VRE forecasting • Create a framework for the ancillary market

REVISION OF THE GRID CODE TO FACILITATE VARAIBLE RE INTEGRATION

Nepal's grid code, commonly referred to as "the NEA Grid Code," a binding technical and procedural document followed by all grid users, was issued in 2005. The NEA Grid code, which has been overtaken by technology and electricity sector evolution, requires immediate revision if VER is to be effectively incorporated into the grid.

A comprehensive, up-to-date grid code that addresses the unique aspects of VRE will allow the network operator – however that institution evolves – to provide clear legal rules and technical requirements for wind and solar plant operators when integrating with the country's electricity networks. An IRENA report[35] presents a detailed analysis which demonstrates the grid code's essential role in successfully integrating large-scale VRE into a network. By considering all major components of the integration – technology, operation, and regulation – a robust grid code will ensure secure electricity service for consumers while adapting to new technologies and operational practices as they mature. While it is evident that each grid code is unique to a given nation, it is also true that the development of such an important electricity sector tool requires a strong understanding of leading regional and international practices. In Nepal's context, gaining significant experience from Indian grid code would be beneficial – owing to its system maturity in VRE integration as well as future reference for regional harmonization of grid code. However, considering case study of a country with similar size and generation profile as that of INPS would be more relevant, for e.g., Vietnam, Lao PDR[36], The Philippines, etc.

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[35] *IRENA. 2016. 'Scaling up Variable Renewable Power: The role of Grid Codes'.*
[36] *This report could not include case study of Lao PDR as its grid code was not available in public domain.*

Box 2: Case Studies

Vietnamese Grid code

Vietnam has adopted an enhanced grid codes for VRE, particularly solar and wind power plants, defining the technical requirements to maintain active power within stipulated frequency band and reactive power within permissible system voltages.

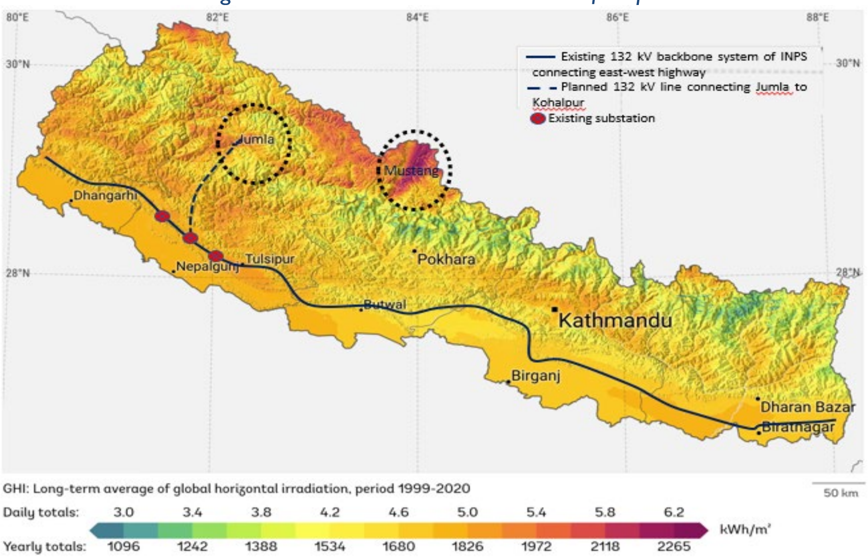
Philippine Grid Code

The Philippines updated its grid code in 2016 to include provisions for VRE interconnection along with comprehensive VRE forecasting framework thus providing strong enabling environment for VRE integration. The grid code has set out very detailed technical and operational requirements for both small and large scale solar and wind power plants.

PREPARE TRANSMISSION EXPANSION PLAN AND IDENTIFY TRANSMISSION PROJECTS TO INTEGRATE VRE

A robust transmission system is the backbone of every nation's electricity sector, as it provides connection between generators and consumers. Figure 9 shows solar insolation distribution throughout Nepal, as well as the existing 132 kV backbone system of INPS. Two sites – Jumla and Mustang, as highlighted in dotted circle, with high global horizontal irradiation – have been selected for a high-level analysis.[37] Although both sites lack access to the national transmission system, construction of 132 kV double circuit line from Jumla to Kohalpur is currently in the planning stage. No such planning has yet been undertaken in Mustang. These facts clearly demonstrate that the transmission system will be bottlenecked if NEA seeks to upscale VRE sources integration in a timely way.

Figure 9 Global horizontal irradiation of Nepal



Source: Redrawn from https://solargis.com/maps-and-gis-data/download/nepal

[37] *Based on consultation with System Planning Department, NEA.*

Nepal has two transmission system master plans, one developed by NEA and the other by Rastriya Prasaran Grid Company Limited (RPGCL). Each plan prioritizes hydropower generation projects and neglects comprehensive planning to integrate VRE sources. When one takes into account the GoN's generation targets, it is clear that a solid and integrated planning process is essential to serve the purpose. The transmission expansion plan must be built in a timely way and be robust enough to support future capacity additions.

The Green Energy Corridor of India[38] has been developed using leading international practices as well as the experience gained during the project's installation. The details of the Green Corridor, which can be accessed by the NEA are set out in Box 1.

Box 1: Green Energy Corridor of India

The Green Energy Corridor of India is a comprehensive scheme for the evacuation and integration of VRE in India. The project is being implemented in eight renewable rich states – Tamil Nadu, Rajasthan, Karnataka, Andhra Pradesh, Maharashtra, Gujarat, Himachal Pradesh, and Madhya Pradesh – by respective state transmission utilities. The project aims to install 9,767 circuit km transmission lines and substations with total capacity of 22,689 MVA to evacuate more than 20 GW of large-scale renewable power. As of 31 October 2021, 8,405 circuit km transmission lines and 15,268 MVA capacity substations has been constructed.

CREATE A COMPREHENSIVE FRAMEWORK FOR VRE FORECASTING

Wind and solar forecasts are critical to reducing the uncertainty that surrounds VRE generation. An accurate forecast, the development of which can be challenging, not only supports the safe and reliable operation of the grid, also encourages cost effective operation by improving the scheduling of generation and reducing the use of reserves. VRE forecasting is essential to integrating VRE into the grid. When system operators fail to or inaccurately forecast VRE, the grid may experience lower reliability and higher cost, even when VRE penetration is modest. The consequences include VRE curtailment, frequency, and voltage deviation due to over- or under-generation, negative market prices, price volatility, and dropped load.

Currently NEA is transitioning to a more comprehensive generation planning tool (WASP to OptGen) with the technical assistance provided by the World Bank. This transition will allow the incorporation of the best available VRE forecasting services and facilitate the development of a robust and resilient generation plan. USAID has recommended solutions[39] informed by leading international practices for countries such as Nepal that are new to VRE or have not implemented a comprehensive VRE forecasting program.

[38] *https://mnre.gov.in/green-energy-corridor*
[39] *https://www.usaid.gov/energy/auctions/vre-forecasting*

Box 2: Recommendations based on leading practices

- Develop policies, regulations, and grid codes to comprehensively address VRE forecasting and related activities in system operations.
- Implement short-time block and short lead time forecasting to increase accuracy
- Invest in high quality weather forecasting services
- Use centralized VRE forecasting with the forecasting services/software from an experienced vendor

CREATE A FRAMEWORK FOR ANCILLARY SERVICE MARKET

Ancillary services are functions utilized by grid operators to maintain a reliable power system. The services required to manage increased variability and uncertainty caused due to VRE penetration include, but are not limited to, addressing demand-supply imbalances, system recovery after a power system fault, retaining proper flow and direction of electricity, synchronized regulation, contingency reserves, black-start functions, and flexibility reserves.

With the advancement in energy sector and integration of RE into the INPS, the need for an ancillary service market to alleviate system variability and uncertainty increases. Nepal currently has no market framework for ancillary services is in place. Nepal should now take the initial steps to develop the ancillary market by taking into account the experiences from regional and international leading practices.

Box 3: Case Studies

Vietnam

- Ancillary services in Vietnam include frequency regulation, spinning reserve, quick start, voltage adjustment, must-run operation reserves to ensure electricity system security and black start.
- The Vietnamese Grid Code has a very detailed provision for ancillary services – from technical requirements to principles of determining demand for it and the process of registering such services.

ANNEX

ANNEX 1: LIST OF RE CONNECTED TO THE GRID AS OF JULY 31, 2021						
S. N.	COMPANY NAME	PROJECT NAME	LOCATION	DEVELOPER	CAPACITY (KW)	GRID CONNECT DATE
1	NEA-owned	Simikot	Simikot, Humla	NEA	50	1988
2	NEA-owned	Gamgadhi	Gamgadhi, Mugu	NEA	50	1988
3	Kathmandu Upatyaka Khanepani Board (KUKL)	KUKL Solar	Kathmandu Valley	IPP	680	2012
4	Surya Power Company Pvt. Ltd.	Bishnu Priya Solar	Nawalparasi	IPP	960	2017
5	Ridi Hydropower Development Company Ltd.	Butwal Solar Project	Rupandehi	IPP	8,500	2020
6	NEA	Grid Solar Energy and Energy Efficiency Project	Battar, Nuwakot	NEA	11,000	2020
7	Everest Sugar and Chemical Industries Ltd.	Everest Cogeneration Electricity Project	Mahottari	Sugar Industry	3,000	2021
8	Eco Power Development Company Pvt. Ltd.	Mithila Solar PV Electric Project	Dhanusha	IPP	10,000	2021
Total RE connected to the grid as of July 15, 2021					**34,240**	

ANNEX 2: LIST OF RE POWER PLANTS WITH PPAS

S. N.	COMPANY NAME	PROJECT NAME	LOCATION	CAPACITY (KW)	EXPECTED COD
1	Solar Farm Pvt. Ltd.	Belchautara Solar Project	Tanahun	5,000	2021/22
2	Api Power Company Ltd.	Chandranigahpur Solar Project	Rautahat	4,000	2021/22
3	Api Power Company Ltd.	Parwanipur Solar Project	Parsa	8,000	2021/22
4	Api Power Company Ltd.	Dhalkebar Solar Project	Dhanusha	1,000	2021/22
5	Api Power Company Ltd.	Simara Solar Project	Bara	1,000	2021/22
6	Sagarmatha Energy and Construction Pvt. Ltd.	Dhalkebar Solar Project	Dhanusha	3,000	2021/22
7	Gorkha Cogenial Energy and Pvt. Ltd.	Lamahi Solar Project	Lamahi	3,000	2021/22
8	Global Energy and Construction Pvt. Ltd.	Duhabi Solar Project	Jhapa	8,000	2021/22
9	National Solar Power Company Pvt. Ltd.	Grid Connected Solar PV Project (VGF)	Nawalparasi	5,000	2021/22
10	Nepal Solar Farm Pvt. Ltd.	Som Radha Krishna Solar Farm Project (VGF)	Kaski	4,000	2021/22
11	First Solar Developers Nepal Pvt. Ltd.	Bhrikuti Grid-tied Solar Project (VGF)	Kapilvastu	8,000	2021/22
12	Saurya Bidhyut Power Pvt. Ltd.	Grid Connected Solar Project, Nawalparasi (VGF)	Nawalparasi	2,000	2021/22
13	Indushankar Chini Udhyog Ltd.	Indushankar Chini Udhyog Ltd.	Sarlahi	3,000	2021/22
Total RE power plants with PPA				**55,000**	

Source: NEA Power Trade Department

ANNEX 3: DIFFERENT RE PROJECTS IN PIPELINE (WITHOUT A PPA) UPDATED 21 DEC, 2021[40]

S.N.	RE TYPE	NO. OF PROJECTS	CAPACITY (KW)	STAGE OF DEVELOPMENT	LICENSE ISSUING INSTITUTION
1	Solar	23	588.900	Survey License received	DoED
2	Wind	1	3,000	Survey License received	DoED
3	Cogeneration	1	15,000	Survey License received	DoED
4	Solar	5	41,800[41]	Construction License received	DoED
5	Cogeneration	1	3,000[42]	Construction License received	DoED
6	Solar	33	407,900	Awaiting Survey License	DoED
7	Solar	9	59,590	Awaiting Construction License	DoED
8	Solar	1	250,000	Awaiting Survey License	OIBN

[40] *DoED. 2021. Department of Electricity Development. https://www.doed.gov.np/*

[41] *List of solar projects with construction license in the DoED website totals 92.97 MW. ~51 MW capacity out of such total are included in Table 10 (list of RE power plants with PPAs)*

[42] *List of cogeneration plants with construction license in the DoED website totals 6 MW. 3 MW out of such total are included in the Table 10 (list of RE power plants with PPAs)*

ANNEX 4: INTERNATIONAL EXPERIENCE WITH VRE INTEGRATION

	PHASE 1	
	VIETNAM	COLOMBIA
GENERATION PORTFOLIO	Coal: 36% **Hydro: 36%** Gas: 25% Oil and diesel: 1% **VRE: Virtually nothing; in the process of development**	**Hydro: 71%** Gas: 17% Fuel oil: 9% **VRE: 3% (19.5 MW wind, less than 1 percent)**
RE TARGET		6.5% generation from non-large hydro renewables for all those with access to the grid by 2020
CHALLENGES	• RE consideration excluded in the Grid Code. • Limited local expertise to manage VRE.	• Limited transmission capacity • Limited cross-border trade • Limited ancillary service market • Dated grid code • Inadequate methodology to calculate operating reserves with VRE • Limited remuneration options for VRE plants • Limited local technical capacities
SOLUTION (PLANNED OR BEING IMPLEMENTED)	• Facilitating the development and financing of solar projects.	• Extend transmission capacity to the north • Cross-border interconnection with Panama • Implement an intraday market • Update the grid code to include VRE technical requirements • Introduce locational marginal prices
	PHASE 2	
	THE PHILIPPINES	INDIA
GENERATION PORTFOLIO	Coal: 35% Oil and gas: 32% **Hydro: 17%** Geothermal: 9% **VRE: 7% (4% solar and 2% wind)**	Coal: 57% **VRE: 17% (6.7% solar and 9.9% wind)** **Hydro: 13.2%** Natural gas: 7% Nuclear: 2% Oil: 0.2%
RE TARGET	30% solar + 50% wind by 2030	175 GW of RE installed by 2022 (60 GW wind +100 GW solar)
CHALLENGES	• Need of additional generators to provide ancillary services • Requirement of energy storage to implement more VRE • Grid stability analysis to integrate new VRE plants	• Re-designing real time electricity markets
SOLUTION (PLANNED OR BEING IMPLEMENTED)	• Ancillary services market (energy storage system)	• Green energy corridor • Lowering minimum operating levels of coal plants (70 to 40%) • Electricity market redesign • Solar/wind + storage auction • Redesigning ancillary services market

About USAID's Urja Nepal Project:

USAID's Urja Nepal Project supports the efforts of the Government of Nepal in establishing effective policy, regulatory and operational changes to create a financially viable electricity sector, thereby enabling it to provide affordable, reliable, and secure electricity while encouraging private sector investment into Nepalese energy market. Urja Nepal is supported by the American people through the United States Agency for International Development (USAID) and is implemented by Deloitte Consulting LLP.

USAID's URJA NEPAL PROJECT

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