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Renewable energy for a low-carbon pathway in the Hindu Kush Himalaya:

Current status, potential, and challenges

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1. Introduction

Climate change is increasingly proving to be a major threat, both in the Hindu Kush Himalayan (HKH) region and globally. In order to tackle climate change, it is important to develop and harness renewable energy sources. Renewable energy technologies (RETs) have grown rapidly around the world due to falling prices, and have the ability to reduce greenhouse gas (GHG) emissions. Increasing the use of clean, safe, dependable, and cost-effective energy can also stimulate economic growth and innovation. Many countries around the world have set renewable energy (RE) targets. Regional member countries of the Hindu Kush Himalaya – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – have also set renewable energy targets to meet their climate goals and net zero pledges. [i] Given their geographical advantages, these countries have abundant hydropower, solar, and wind resources. The rapid economic and demographic growth of some countries in the HKH necessitates the development of clean energy sources.[1]

Currently, HKH countries heavily import fossil fuels to meet their growing energy demand. However, energy demand, fossil fuel supply, and its imports will be different by 2030 and in the years thereafter. Governments in the region will be more focused on reducing the emission of greenhouse gases. This will necessitate the development of clean energy technologies. The deployment of renewable energy is the best solution for these countries not just for the reduction of greenhouse gas emissions but also for more reliable and sustainable power supply.[2] As a result, countries in the HKH are attempting to reduce or eliminate their reliance on fossil fuels by harnessing alternative energy sources such as hydropower, solar, and biopower.

At the United Nations' 26th Conference of the Parties (COP 26) in Glasgow last year, a number of countries submitted ambitious climate targets in terms of adaptation, mitigation, and financial commitments. A number of countries submitted revised nationally determined contributions (NDCs) and, in many cases, made net zero pledges. At COP 26, ICIMOD, along with its regional member countries, held a number of events and campaigned under the slogan #HKH2Glasgow, which had three key messages (Figure 1). The campaign is supported by evidence, policy engagement, and strategic communication. Taking the 'Mountains of opportunity' element forward, ICIMOD is preparing a short- and medium-term investment framework to increase investment in the HKH region in the areas prioritised by the regional member countries. In this regard, an energy transition to cleaner and renewable sources has been identified as a way forward in climate change mitigation. These countries have included ambitious targets in their relevant national documents and are determined to meet them. However, in most of the HKH countries, finance and technical assistance will be key to meeting the targets set.

[i] 'Net zero' is when the amount of carbon dioxide emitted into the atmosphere by human activities – whether of a country or the world – equals the amount of carbon dioxide removed from the atmosphere by human interventions.

It is in the above context that this paper investigates the renewable energy targets and potential of regional member countries of the HKH. It is critical to monitor the goals, potential of, and challenges to the growth of renewable energy in each HKH country in the near future. This paper presents targets pertaining to renewable energy as put forward by the HKH countries, and the potential of the HKH region to contribute to the national climate targets related to renewable energy. In section 2, we provide an overview of the energy scenario, including the electricity consumption, production, and imports in different countries of the HKH. Net zero policies and other energy-related targets are discussed in section 3. Section 4 analyses the renewable energy potential in the region. Some recommendations have been suggested in the concluding section, which include greater financial support, customised policies, capacity-building, the generation of data, and the promotion of renewable energy technologies.

The information presented in this paper has been compiled and synthesised from various climate-related national documents such as the NDCs and national-level climate change policies, strategies, and action plans formulated by the countries of the HKH.

FIGURE 1 **ICIMOD'S THREE KEY MESSAGES FOR COP 26 AT GLASGOW**

Pulse of the planet

Recognise the HKH as the pulse of the planet – a region that is most vulnerable to the impacts of climate change

Mountains of oppurtunity

Invest in mountain-specific climate priorities to enhance the resilience of mountain communities

Power of 8

Harness the strength of the 8 HKH countries to enhance regional and international cooperation for climate action

2. Energy scenario in the HKH: An overview

Being home to nearly 42 per cent of the world's population (3,291 million), and given the rugged topography of the region, the countries of the HKH face significant challenges in providing energy and clean cooking services to their people. Approximately 97 per cent of the total population of the region has access to electricity, but only 68 per cent of its population has access to clean cooking sources. The remaining roughly one-third of the population relies heavily on solid fuels such as coal, dung, and fuelwood for cooking and heating, marginally less than the global average of 34 per cent (Figure 2).[3]

Energy is essential to human well-being and economic activity, and its access is an indicator of both economic and social progress. Per capita electricity consumption is regarded as an essential indicator of economic development. However, per capita electricity consumption is extremely low in many HKH countries and also compares unfavourably with the global average.

In Afghanistan, 98 per cent of the population has access to electricity. However, the country's annual per capita electricity consumption is very low, at merely 27 kilowatt-hours (kWh) per year. Only 30.2 per cent of the country's population has access to the national electric grid, and unevenly distributed – 88 per cent of urban households can access the grid, but merely 11 per cent of rural households can. Interrupted grid networks, the lack of investment, and political conflict all affect electricity supply in the country.

Bangladesh has made significant progress in electricity supply, increasing the share of its population with access to electricity from 47 per cent in 2010 to 92 per cent in 2020, and increasing per capita electricity consumption from 136 kWh/year in 2010 to 488 kWh/year in 2020. However, only one-fourth of its population has access to clean cooking sources.

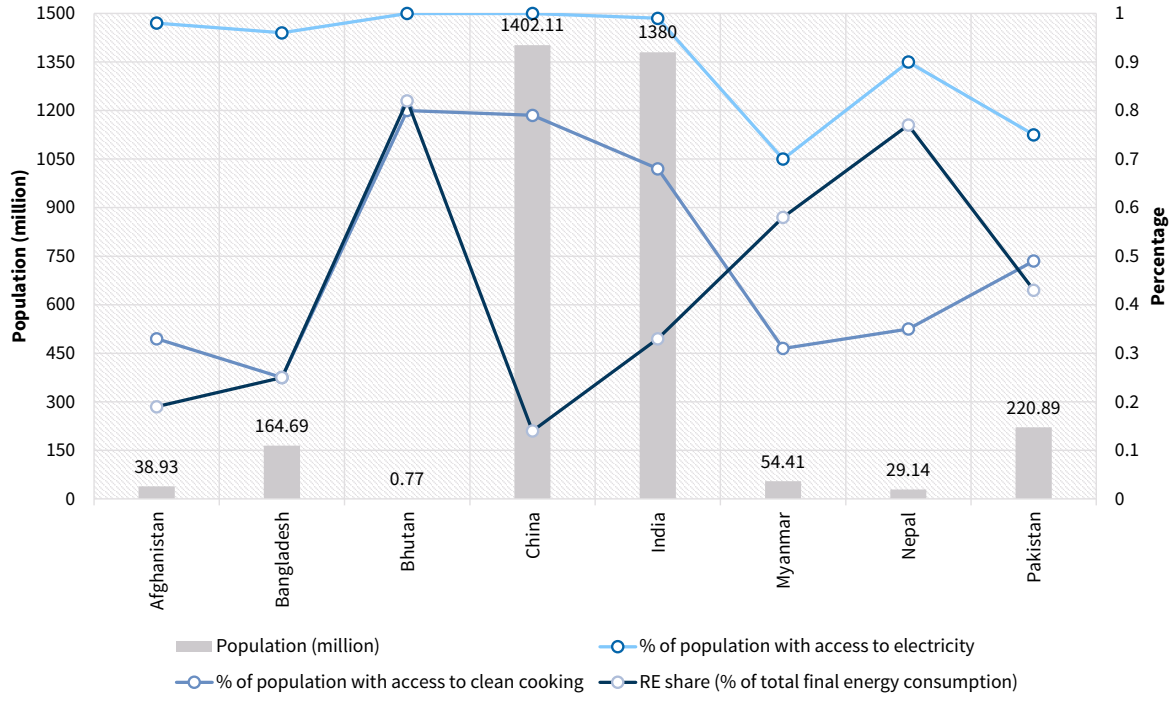
Among the countries of the HKH, Bhutan has a high per capita electricity consumption of 8,664 kWh/year, owing to its small population of less than one million and an abundance of hydropower. It has achieved a 100 per cent electrification rate and, at 80 per cent, a higher than average share among HKH countries of the total population with access to clean cooking sources.

Despite their large populations, China has achieved full electrification, and India has achieved a 99 per cent

electrification rate. In addition, 79 per cent of China's and 68 per cent of India's population have access to clean cooking sources. Inadequate energy supply stifles Nepal's economic and social growth. The country has one of the lowest per capita annual electricity consumption rates globally, at around 189 kWh. However, renewable energy accounts for 75 per cent of the total final consumption, the second highest among the HKH's countries, given their strong hydropower potential.

Pakistan has the lowest electrification rate among HKH's member countries, with 25 per cent of the total population, and nearly half of rural population still without access to electricity. Due to the unreliable electricity supply, per capita electricity consumption in Pakistan remained flat for nearly a decade after peaking in 2006.[4]

FIGURE 2 **THE SDG 7 SCENARIO IN HKH COUNTRIES IN 2020**



COUNTRY-WISE ELECTRICITY GENERATION AND RELIANCE ON IMPORTS

Electricity generation in the HKH countries depends heavily on fossil fuels in some countries and hydropower in others (Figure 3). Figure 3 provides the total installed electricity capacity by source in countries of the HKH.

Afghanistan's electricity infrastructure is divided into four networks: the Northeast Power System, the Southeast Power System, the Herat Zone System, and the Turkmenistan System. Electricity generation in Afghanistan is heavily reliant on fossil fuels and imports from neighbouring countries. The total electricity demand in the country in 2019 was 3,000 megawatts (MW). However, it could generate only 735 MW, and the balance was imported from neighbouring countries such as Tajikistan (433 MW), Uzbekistan (335 MW), Iran (164 MW), and Turkmenistan (80 MW).[5] There is a widening disparity between the demand and availability of electricity. The government and multilateral organisations have made significant efforts over the years to rebuild the country's electricity supply chain and promote self-sufficiency in electricity production. This has resulted in an increase in the proportion of households with access to electricity and an improvement in grid stability. Furthermore, the share of renewable energy in total energy supply was raised from less than 1 per cent in 2013 to 12 per cent in 2019.[6]

With expanding commercial and industrial sectors, Bangladesh faces challenges supplying adequate power. There is insufficient power generation capacity, and the existing national grid network cannot supply power to the entire country. As of October 2021, the country's

installed electricity capacity was 24.03 gigawatts (GW), of which 47 per cent was from natural gas power plants, 25 per cent from oil, 12 per cent from captive power plants, 7 per cent from coal, 5 per cent from diesel, and 3 per cent from renewables. Additionally, 1,160 MW is imported from neighbouring countries. The imports of liquified natural gas (LNG) and coal are expected to rise as domestic gas supplies decline. Bangladesh collaborates with China and India on coal power projects. However, energy demand is rapidly rising, and the supply is not keeping pace. The disparity between power demand and supply is significant, with the capacity shortfall projected at 2.5 GW.[7]

The electricity sector in Bhutan is dominated by hydropower plants, with a total installed capacity of 1,614 MW (as of December 2019). Approximately 98 per cent of the total hydroelectric capacity comes from medium, large, and mega hydropower plants. Druk Green Power Corporation Limited (DGPC) and the Bhutan Power Corporation (BPC) are the two major power utility companies in the country. DGPC owns and operates the country's large hydropower plants (more than 5 MW), whereas the BPC owns and operates small/micro/mini-hydro (less than 5 MW) and diesel power plants. BPC is also in charge of the country's transmission and distribution systems, as well as the retail sale of electricity to end users. About 70 per cent of the country's hydropower is exported to India, which accounted for 6,165 million units (MU) in 2019–2020.[8]

China is the largest producer of electricity in the world, with an installed capacity of 2,200,180 MW as of 2020. Thermal power accounted for nearly 57 per cent of its installed capacity. In terms of installed capacity of RE, hydropower totals 370,160 MW, wind power 281,530 MW, and solar capacity 253,430 MW. The use of energy from renewable sources such as solar and wind are increasing rapidly, from a growth of merely 2 per cent in 2011 to 9 per cent in 2021.[9]

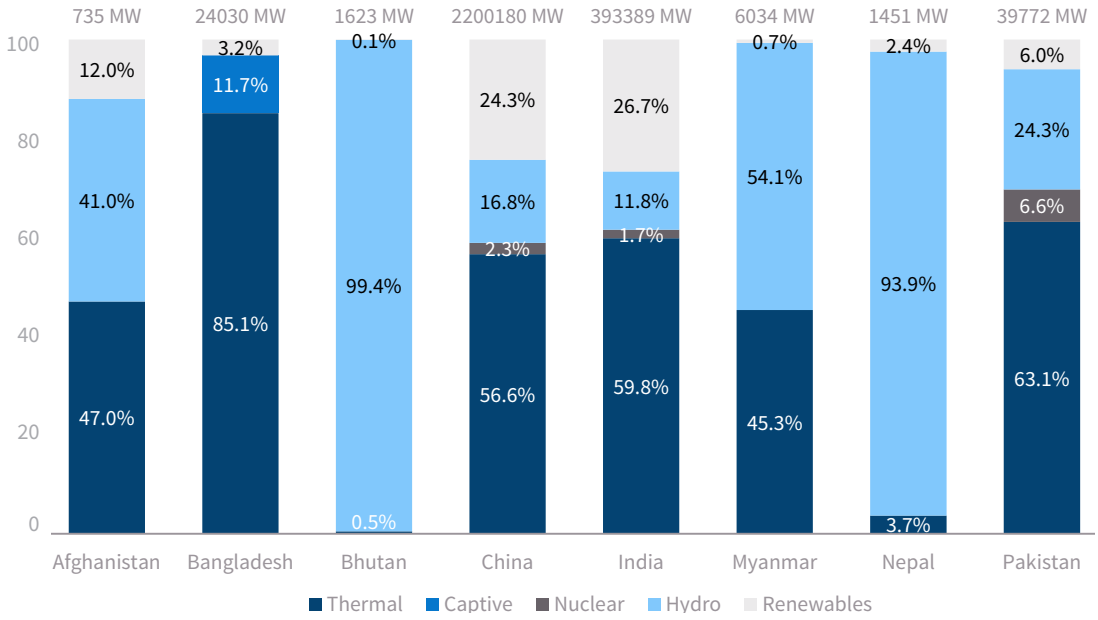
India's power sector is one of the most diverse globally, with conventional and non-conventional sources such as coal, lignite, natural gas, hydro, nuclear, wind, solar, and agricultural and domestic waste. With an installed capacity of 393,389 MW (as of December 2021), India is the world's third-largest electricity producer, with 40 per cent capacity from non-fossil fuel sources. Renewable energy sources (solar, biomass, wind, and hydropower) now account for 38.5 per cent (151.4 GW) of total installed capacity, up from 10 per cent (15.5 GW) in 2010–2011. The Government of India established rules regarding the Cross Border Trade of Electricity (CBTE) in 2016 to increase electricity trading with neighbouring countries. In 2019–2020, India exported 6,168 MU of electricity to Bangladesh, 7 MU to Myanmar, and 1,839 MU to Nepal, and imported 6,165 MU from Bhutan as part of the CBTE.[10]

Given its low electricity capacity and widespread poverty, Myanmar has one of the lowest rates of per capita energy consumption among all the HKH countries. The total installed capacity of the country is 6,034 MW, of which 2,496 MW comes from natural gas and 3,262 MW from hydropower.

The electricity sector in Nepal is dominated by hydropower. It accounts for nearly 94 per cent of the country's total installed capacity. The electricity demand in Nepal is increasing each year, and it has been importing more energy to meet demand. However, because a number of new hydropower plants have been built in recent years, electricity imports dropped by nearly 40 per cent in 2020 compared to 2018.[11]

The energy sector in Pakistan is heavily dependent on fossil fuels, both in terms of primary as well as secondary sources of energy. As of June 2021, thermal energy accounted for 63.1 per cent of Pakistan's total electricity capacity, with hydroelectricity accounting for 24.3 per cent, nuclear energy 6.6 per cent, and renewable energy 6 per cent. The prices of fossil fuels and electricity are rising at an alarming rate, contributing to acute power shortages throughout the country. Pakistan has experienced power shortages of 4,000–6000 MW in the recent decade. In 2019–2020, it imported 513.74 GWh of electricity from Iran, and around 498.37 GWh in 2021. Considering the growing energy demand and the rising costs of fossil fuel imports, the Government of Pakistan has begun to promote renewable energy technologies in Pakistan, and has been seeking collaboration with developed countries. This has resulted in a growing share in the renewables' installed capacity, of 6 per cent (2,386 MW) in 2021, up from 1 per cent in 2011–2012.[12]

FIGURE 3 SHARE OF FOSSIL FUELS AND NON-FOSSIL FUELS IN TOTAL INSTALLED ELECTRICITY CAPACITY IN HKH COUNTRIES



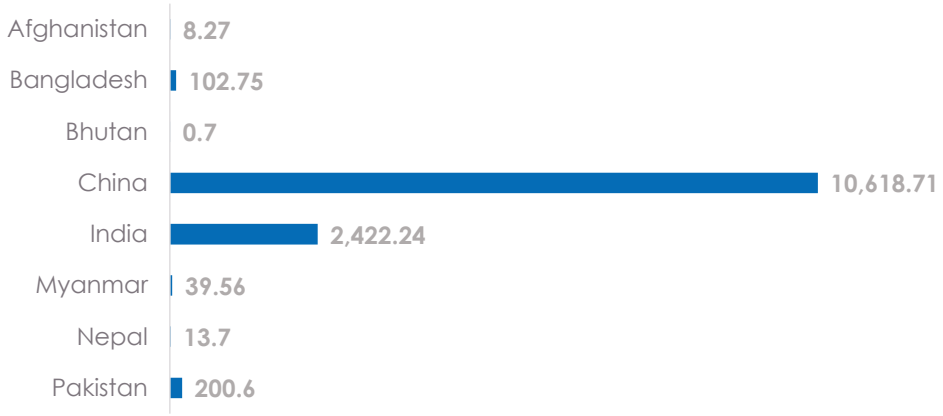
Sources: Annual reports of nodal electricity agencies in regional member countries

3. Net zero and energy-related targets

The energy sector is the largest contributor to greenhouse gas (GHG) emissions, amounting to 75.6 per cent worldwide in 2019.[13] Globally, as much as 68 per cent of GHG emissions is emitted by only ten countries.[14] In the run-up to COP 26 in Glasgow and during the conference, many countries committed to decreasing their carbon dioxide (CO2) and other greenhouse gas emissions, and presented pledges to reach net zero emissions. Currently, a total of 89 countries have put forward net zero targets.[15]

Renewable power deployment still needs to expand significantly to meet the Net Zero by 2050 Scenario share of more than 60 per cent of generation by 2030. Power generation from renewable sources must increase at an average rate of nearly 12 per cent a year during 2021–2030, almost twice as much as it did during 2011–2020.[16] To meet global targets, the world must double the rate of transition to renewable energy to have any chance of achieving net zero emissions by 2050, the International Energy Agency (IEA) has cautioned in a report.[17]

FIGURE 4 SHARE OF EMISSIONS FROM THE ENERGY SECTOR IN THE HKH (MTCO2e)



Source: Climatewatch, Historical GHG emissions. https://www.climatewatchdata.org/ghg-emissions

The HKH regional member countries include China and India, who are both among world's top emitters. The total GHG emissions from HKH countries are about 33 per cent of global emissions, which is quite high.[18] The energy sector is the largest contributor to GHGs in China and India, 83.8 per cent and 71.35 per cent respectively, and above 40 per cent for Bangladesh, Bhutan, and Pakistan. However, when considering the Himalayan regions in these countries, emissions are relatively low even here. In addition, the HKH does possess significant renewable energy potential that could contribute to mitigation via a transition to cleaner energy sources. Net zero targets from the HKH region include pledges made by Bhutan, China, India, and Nepal.

COUNTRY-WISE RENEWABLE ENERGY TARGETS

The target years for net zero pledges made by Bhutan, China, India, and Nepal are 2050, 2060, 2070, and 2045, respectively. While these pledges have been made, there is an urgent need for countries to put forward more ambitious strategies to reach these goals in the short term and in the longer term to seek to limit warming to 1.5° C, a key goal mentioned in the Paris Agreement. National-level targets for the energy sector in their respective NDCs submitted to the UNFCCC have been presented in Table 1. Most of these targets are aimed at a transition of the energy sector to cleaner and renewable energy sources and higher energy efficiency.

TABLE 1 **CLIMATE TARGETS OF THE ENERGY SECTOR IN HKH COUNTRIES**

Country	Climate targets
Afghanistan	To reach a renewable energy capacity of 5,000 MW by 2032
Bangladesh	Switch fully to supercritical coal power generation; reduce the energy intensity of its gross domestic product (GDP) by 20 per cent by 2030; reduce energy consumption in the industrial sector by 10 per cent; reduce overall energy consumption of the commercial sector by 25 per cent; enhance the use of efficient cook stoves by 2030
Bhutan	Offset 22.4 Mt of carbon dioxide equivalent (CO_2eq) per year by 2025 through the export of hydropower
China	Reduce the carbon intensity of the economy by over 65 per cent by 2030; non-fossil fuel share in primary energy consumption to be 25 per cent by 2030; forest volume to increase by 6 billion cubic metres (m^3) by 2030; to increase wind and solar power generating capacity by over 1,200 GW by 2030
India	Reduction in emissions intensity by 45 per cent by 2030; 50 per cent of cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030
Myanmar	Increase the share of solar and wind power to 54 per cent by 2030; decrease the share of coal use by 73.5 per cent by 2030; improve the energy efficiency of the residential sector by 8 per cent, the industrial sector by 7 per cent, the commercial sector by 4 per cent, and other sectors by 1 per cent; reduce deforestation by 50 per cent by 2030
Nepal	12,000 MW of hydroelectricity by 2030; 2,100 MW of solar energy by 2030; reduce dependence on fossil fuels by 50 per cent; develop 1,500 institutional solar power systems; develop 600,000 solar home systems; instal 475,000 improved cook stoves; increase the share of biogas up to 10 per cent for cooking in rural areas
Pakistan	Double the share of RE with a projected increase of 65 per cent by 2030; increase the on-grid generation of RE to 20 per cent by 2025 and 30 per cent by 2030; emissions reduction by 6.4 MT CO_2eq by 2023

Sources: NDCs of each country

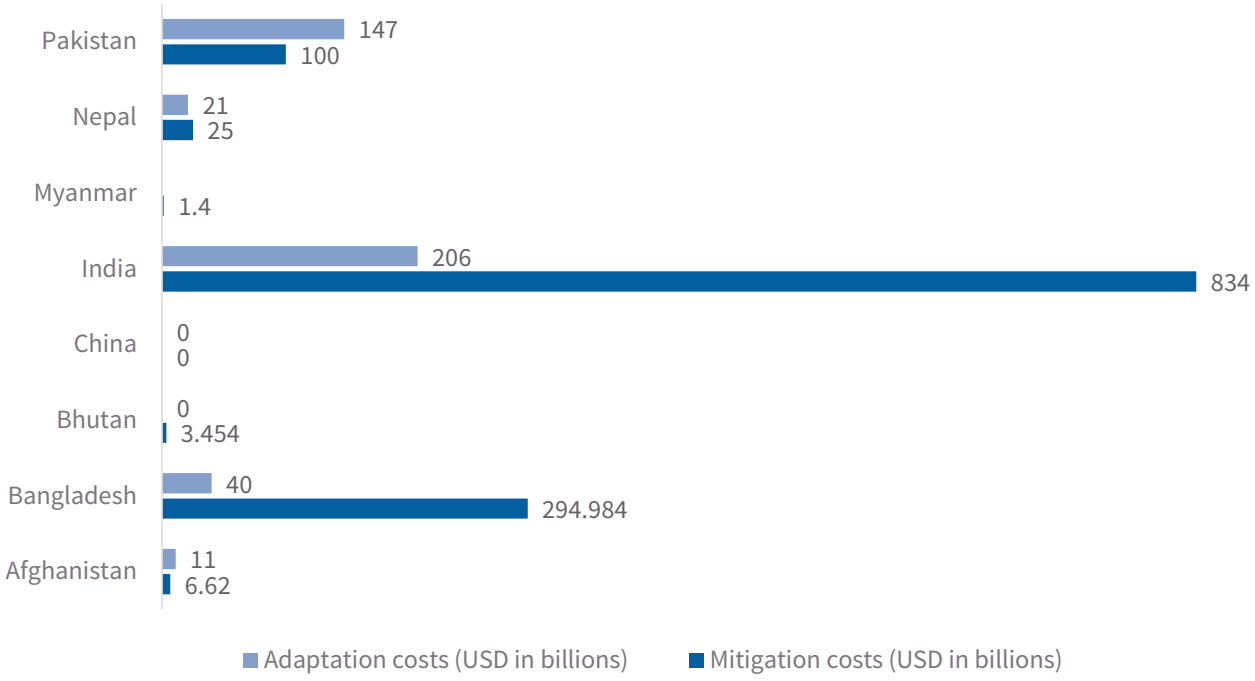
The focus of mitigation targets is mainly the energy sector, and the HKH countries have a wide array of programmes, plans, and initiatives as priorities in transitioning to renewable energy and enhancing energy efficiency. These have been summarised below:

- Augmenting and diversifying power generation capacity, with an emphasis on RE sources
- Reducing CO_2 emissions from the rail, road, air, and waterway transport systems and making strong commitments, by all the HKH countries, to switch to low carbon and more efficient transport systems
- Achieving greater energy efficiency in the industry subsector
- Ensuring the installation of improved cook stoves, specifically in the rural areas
- Protecting generation, transmission, and distribution facilities from climate-related disasters
- Increasing the share of RE in the energy mix through greater investments

INVESTMENT REQUIRED TO MEET NDC TARGETS

The availability of finance in time and at scale is vital for achieving global climate goals. Substantial financial resources are required by the HKH countries to implement climate actions and achieve the long-term targets mentioned in their NDCs (Figure 5). The implementation of NDCs for most HKH countries is are conditional and depends on the availability of financial support. The total cost for climate action (as mentioned by HKH countries) is around USD 1,690 billion till 2030. As for investments required for energy transition, only Bangladesh and Pakistan have given clear figures in their NDCs amounting to a total of approximately USD 200 billion until 2030. The required investment for China to meet its targets would reach around USD 640 billion in 2030[19]. The unavailability of, or delays in finance will have adverse consequences for these countries being able to meet their targets.

FIGURE 5 **LEVEL OF FINANCE REQUIRED TO MEET NDC TARGETS (USD BILLION)**



4. Renewable energy potential in the HKH

The HKH region is very rich in renewable energy resources including hydropower, solar, biomass, and wind. The estimated combined resource potential of the region is about 3,500 GW. The renewable energy potential of countries in the HKH region has been summarised in Table 2.

The most significant potential source of renewable energy in the HKH region today is hydropower, with a power generation capacity of over 600 GW, or 17 per cent of the total power generation capacity from renewable energy sources in the region. However, as of 2021, its utilisation was still very minimal. More than half of this (358 GW) exists in the provinces of China that lie in the HKH. The HKH regions in Afghanistan, Bhutan, Nepal, and Pakistan also have significant of hydropower potential to meet energy demand even if it were to increase at an annual rate of 10 per cent.[20] Regions in Afghanistan, China, India, and Pakistan also have a huge solar power potential. The wind power potential of Afghanistan and China is also considerable. Such availability of abundant renewable energy sources in the region will help enhance the energy security of the HKH countries.

TABLE 2 RENEWABLE ENERGY POTENTIAL IN COUNTRIES OF THE HKH, BY RESOURCE

Country	RE potential in the HKH (GW)					Total installed RE capacity of the country (GW)	RE target by 2030 (GW)	Current status as a share of the target (%)
	Hydro	Solar	Wind	Biomass	Total RE			
Afghanistan	22.08	80.19	5.8	NA	108.07	0.3	5	6
Bangladesh	0.14	NA	NA	NA	0.14	0.7	4.1	17
Bhutan	26.6	12	0.76	2.6	41.96	1.6	7.1	23
China	358.94	1,772.4	741.09	NA	2,872.43	895	1,200	75
India	122.77	223.99	0.73	0.49	347.98	141	500	28
Myanmar	11.27	12.68	NA	NA	23.94	3.3	14	24
Nepal	43	23.6	NA	NA	66.6	2	15	13
Pakistan	52.31	56	NA	NA	108.31	12.4	NA	NA

RE PROGRAMMES AND INITIATIVES IN THE HKH

There are numerous programmes and initiatives being initiated by each country to transition to renewable energy. While information at the national level is readily available, information regarding the HKH region is quite challenging to find in most cases. We present below some examples of initiatives in the renewable sector that the governments have prioritised.

Initiatives in Afghanistan's HKH region include solar photovoltaic (PV) and solar thermal applications. The largest one is a 1 MW solar PV off-grid system in Bamiyan province. Other important installations include a 250 KW solar PV off-grid system installed in Kabul province and a 100 kW solar PV off-grid system installed in Gardiz province. Many rooftops solar PV systems have been installed in remote regions through the National Solar Policy (NSP). Hydropower projects include the Shao Aros in Kabul province and the Shorabak hydropower dam in Badakhshan province. Afghanistan also has good wind resource potential, especially in the southeastern part of the country. Sixteen wind monitoring stations have been installed in different parts of the country. A few small wind turbine systems (of less than 50 kW) have also been installed in different locations.

Bangladesh's total installed capacity of renewable energy is 912.16 MW, of which around 74.3 per cent is from solar, and 25.2 per cent from hydropower.[21] In the case of its hilly regions, there is a 50 MW solar power project planned in Chittagong and for solar irrigation to replace

diesel water pumps. Additionally, solar home systems (SHSs) have also been deployed in the hills, including in the Chittagong Hill Tracts (CHT). Approximately 10,000 SHSs have already been deployed by the CHT Development Board and there were plans to provide 40,000 by 2021.[22] Such initiatives are crucial as nearly 90 per cent of the population relies on fuelwood and other biomass as their main sources of fuel for cooking. Such measures will contribute both to the target of universal energy access and also to a reduction in GHG emissions.

Much of Bhutan's energy demand is met by hydroelectricity. However, a large proportion of its population resides in rural areas and is still dependent on fuelwood for cooking.[23] The government has many policies and programmes at the national level to promote energy access and energy efficiency. Priority areas for RE in Bhutan include enabling solar 'prosumers' with a capacity of 50 MW; solar power installations totalling 700 MW; 3-MW power generation from biomass; waste to energy plants; the use of improved cook stoves; a renewable energy development fund; and energy efficiency and conservation measures.[24]

Major renewable energy initiatives in India include: a long-term Renewable Purchase Obligation (RPO) and Energy Storage Obligation trajectory till 2029–2030; a waiver of Inter-State Transmission System charges until 2025; an enhanced budget of the production linked incentive (PLI) scheme for solar manufacturing to INR 240 billion; open access for 100 kW renewable energy; the development of ultra-mega renewable energy parks; the launch of the National Hydrogen Mission; the PM KUSUM scheme for solar-powered agricultural pumps; a rooftop solar scheme for the residential sector; RE power bidding for round-the-clock (RTC) power, peak power, bundling RE with thermal power, etc.

Using government data, the potential and installed capacities of RE in the Indian Himalayan region (IHR) are presented in Table 3. The figures include the total from micro-hydro, solar, wind, and biomass and exclude large hydropower plants. It is clear from the table that there are huge gaps between installed and potential capacities, suggesting considerable opportunities for investing in RE development in the IHR.

TABLE 3 **RENEWABLE ENERGY POTENTIAL AND INSTALLED CAPACITY IN STATES OF THE IHR**

State	Total potential (MW)	Installed capacity (MW)
Arunachal Pradesh	10,723	142.34
Assam	14,182	–
Himachal Pradesh	37,444	1,031.82
Jammu & Kashmir	112,800	191.55
Manipur	10,745	17.69
Meghalaya	6,103	50.48
Mizoram	9,261	44.35
Nagaland	7,482	33.71
Sikkim	5,209	56.76
Uttarakhand	18,493	906.68
West Bengal	7,198	586.94
Tripura	2,132	30.88

Source: MNRE (n. d.)[25]

The commitments and targets for Nepal – which lies entirely in the HKH – in RE were presented in Table 1. The government's priority is to provide electricity access to the entire population whilst increasing its capacity through the deployment of RE. Recent actions by the government towards the clean energy transition via the increased use of electricity in Nepal include the establishment of the Electricity Regulatory Commission as the regulatory body for the electricity sector and upgrading the transmission and distribution infrastructure across the country. Charges for domestic consumers have been reduced, and electricity is free for domestic users consuming up to 20 units per month. In the case of industrial consumption, charges have been abolished and consumers will benefit from the decline in power tariffs in the range of 51%–56%. To promote electric vehicles, off-peak energy charges have been reduced by 60 per cent during the monsoon season, 51 charging stations have been set up by the Nepal Electricity Authority, excise duties have been entirely waived and custom duties reduced as well. Similar reductions have been made for electrical goods such as electric stoves, refrigerators, grinders, etc.[26]

The government of China has made a number of commitments at the national level. It has pledged that the share of non-fossil energy consumption will reach 20 per cent by 2025. In its updated NDC, the government has stated that: it aims to peak its CO2 emissions before 2030; emissions per unit of GDP will fall by 65 per cent against the 2005 baseline; it will increase the share of non-fossil fuels in primary energy consumption to 25 per cent; and increase total solar and wind power capacity to 1.2 million MW. It has said its installed hydropower capacity will be 80,000 MW by 2030. A renewable energy system dominated by hydropower will be established in southwestern China. During the 14th Plan period (2021–2025), RE will account for more than half the increase in primary energy consumption, and RE generation will reach 3.3 trillion kWh. Specific to regions in the HKH, it has also pledged to vigorously promote solar PV and wind power in Xinjiang, Qinghai, Gansu and Yunnan provinces and in the Tibet Autonomous Region (TAR). Specific targets and plans for the HKH region in China are listed in Table 4.

TABLE 4 **TARGETS AND PLANS FOR CHINA'S HKH REGION**

Province	Status, targets, and actions
Xinjiang	The installed capacity of renewable energy in the region has reached 82,400 MW Power transmission capacity reached 180 billion kWh Under the 14th Five-Year Plan, the government plans to vigorously promote the development of wind power and solar PV in the province
Qinghai	The installed capacity of renewable energy exceeded 47,000 MW, and the RE power consumption responsibility of the province has reached 65 per cent Under the 14th Five-Year Plan, the government plans to vigorously promote the development of wind power and solar PV in the province
Gansu	RE reaches about 60 per cent of the total electricity consumption in the province The proportion of non-fossil energy in total energy consumption reached 30 per cent
Sichuan	The total installed RE capacity of the province is 40,740 MW The RE target for the province is 128,780 MW by 2025
Yunnan	Currently, non-fossil energy accounts for more than 46 per cent of primary energy consumption in the province. Coal consumption will be controlled at about 34 per cent by 2025 The key actions include accelerating the construction of large hydropower projects on the main rivers; continuing to build two national clean energy bases on the Jinsha and Lancang rivers; developing both centralised and distributed RE sources such as wind power and PV power generation; and building a national multi-energy, complementary energy base

Source: Dong, L. (2022). Renewable energy for low-carbon pathway in the Hindu Kush Himalaya – Investment opportunities and policy perspectives

5. Challenges and recommendations

There is a huge, untapped renewable energy potential in the HKH region. Investing in a timely manner and harnessing these will be crucial to meet NDC and related national targets. It will have the added benefit of providing new, green employment opportunities in the mountains.

However, despite the best intentions of governments in the region, there are many obstacles in the expansion of the renewable energy market in the HKH. Upscaling and the widespread implementation of renewable energy solutions face several challenges. Some of these, and possible ways forward, are discussed here in the concluding section of this paper.

AVAILABILITY OF FINANCE

For all countries of the region barring China and India, finance is a vital component to meeting national-level mitigation and adaptation targets. As a result, it is vital that adequate finance is allocated at scale and in a timely manner. This is even more important considering that infrastructural costs are higher in mountain regions, given their geographical and topographic complexities. There is also a lack of sustainable financial mechanisms, regulations, and guidelines to mobilise investment in the energy sector. These, along with operational modalities regarding renewable energy development, need to be in line with long-term strategies, goals, implementation methods, and instruments.

GENERATE DATA AND KNOWLEDGE

Most countries of the HKH lack the knowledge necessary for comprehensive renewable energy interventions and to customise policies. There is a lack of analysis regarding both the quantitative and qualitative aspects of energy use. Hence, the generation of knowledge regarding local resource availability and the economic feasibility of energy technologies is recommended. It is challenging to find information on renewable energy at the HKH level, making it difficult to estimate the potential in the area with accuracy. The availability of such information would allow a better understanding of the contexts of the mountain states, which in turn would contribute to policy, programmes, and investment decisions. HKH mountain-specific energy data, including demand and supply patterns, is lacking. The energy data gap limits the formulation of evidence-based sustainable energy strategies, targets, and regulatory frameworks in the HKH mountain region. Up to date information would also be useful for investors and project developers.

THE NEED FOR CUSTOMISED POLICIES

HKH countries need dedicated policies customised to mountain conditions to promote clean and renewable energy for poverty alleviation and industrial development. Since the energy sector of countries of the HKH is growing, a clear policy framework and roadmap for renewable energy is recommended at the regional level. This will attract investments, help improve energy access, and support socio-economic development in the mountains. A policy framework must ensure the active engagement of various development partners, government agencies, and the private sector, and enable the sustainable development of the energy sector.

PROMOTE CLEAN ENERGY TECHNOLOGIES AND DISCOURAGE TRADITIONAL FUELS

HKH countries have made significant progress in providing access to clean cooking technologies. However, these technologies are often not affordable to rural households who continue to rely on fuelwood, other biomass, and kerosene for cooking. In this regard, countries in the HKH must introduce special financing programmes to make these technologies affordable. This will help promote renewable energy technologies and encourage rural households to use clean cooking technologies such as solar cookers and biogas. Technology promotion may require public campaigns to build awareness and induce behavioural changes among local communities in using renewable energy sources.

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