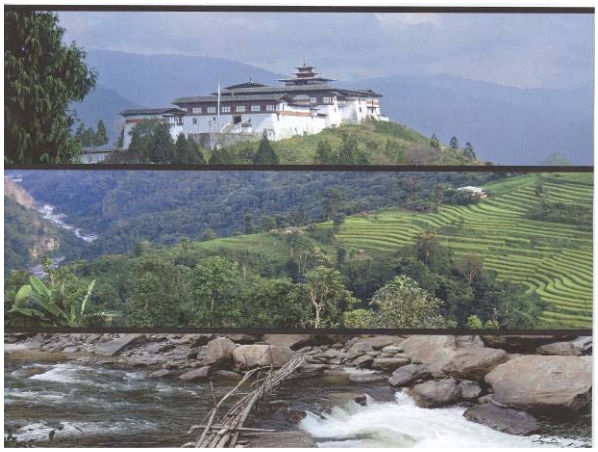
Baseline and Needs Assessment

Towards the Establishment of the Renewable Energy and Energy Efficiency Centre of the Hindu Kush Himalaya Region (REEECH)

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Only the most commonly cited acronyms are listed here. Those not frequently cited are further elaborated in the respective sections of this BNA.

ADA	Austrian Development Agency
ADB	Asian Development Bank
AKF	Aga Khan Foundation
BIMSTEC	Bengal Initiative for Multisectoral Technical and Economic Cooperation
BNA	Baseline and Needs Assessment
CBET	Cross-border Electricity Trade
DoE	Clean Energy Access Network
EACREEE	East African Centre for Renewable Energy and Energy Efficiency
EE	Energy Efficiency
GDP	Gross Domestic Product
GERES	Group for the Environment, Renewable Energy and Solidarity
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GN-SEC	Global Network of Regional Sustainable Energy Centres
GW	Gigawatt
REEECH	Renewable Energy and Energy Efficiency Centre of the Himalaya and
HKH	Hindu Kush Region
ICIMOD	International Centre for Integrated Mountain Development
IDCOL	Infrastructure Development Company Limited (Bangladesh)
IEA	International Energy Agency
INGO	International non-governmental organisation
INT	INTEGRATION energy and environment
LPG	Liquified Petroleum Gas
MHP	Micro Hydro Projects
MW	Megawatt
NGO	Non-governmental Organisation
RE	Renewable Energy
SE4ALL	Sustainable Energy for All
SAARC	South Asian Association for Regional Cooperation
SDG	Sustainable Development Goals
SAC	SAARC Energy Centre
UN	United Nations
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
USD	US Dollar
WB	World Bank

0 Executive summary

The **Himalaya and Hindukush** (HKH) mountain area covers an extensive territory separating the Indian subcontinent from the Tibetan Plateau, and is home to numerous different ethnicities, cultures, languages and social realities. The region, which traverses the national boundaries of Afghanistan Bangladesh, China, India, Myanmar and Pakistan, and includes countries such as Bhutan and Nepal which are wholly situated in the HKH mountain region, is estimated to be home to **200-270 million inhabitants**. More than 50% of the HKH mountain population (190 million people) resides in altitudes of over 1,000 metres above the mean sea level (AMSL), often in small rural communities or widely scattered homes. The region is characterised by remoteness, inaccessibility, relative poverty, proneness to natural disasters, harsh climate conditions and one subjected to climate change impacts.

Although seven of the eight *HKH countries* (which host *HKH mountains*) rank in the middle-field of the Human Development Index, most of them fall behind in terms of energy efficiency, access to clean, modern cooking energy and electricity. **Energy poverty is an even more fundamental challenge in the HKH mountains** themselves, characterised by a **strong dependence on biomass, supressed productive demands** and **poor energy efficiency**. Energy poverty hinders economic development and poses significant challenges to stemming environmental degradation, tackling climate change, and ensuring the conservation of unique mountain ecosystems. The degradation of natural resources impacts on the livelihoods of mountain communities who depend on their local environments, and also accelerates the adverse impacts of climate change for downstream economies (power generation, agriculture, floods). Accelerated glacial melting caused by clouds of short-lived climate pollutants, especially, black carbon, stemming from the industrialized South Asian Plans, Central China, as well as the Middle East, is also of particularly high concern.

There is a moment for collective action regionally, to achieve global and national commitments to universal energy access in the framework of the Sustainable Development Goals (SDG#7 – affordable, reliable and sustainable energy for all and SDG#13 – climate action) and the Paris Climate Agreement. In 2016, a comprehensive and consultative preparatory process to explore the impact potential of establishing the **Renewable Energy and Energy Efficiency Centre of the Hindu Kush Himalaya Region (REEECH)** was launched: The International Centre for Integrated Mountain Development (**ICIMOD**) a regional intergovernmental learning and knowledge sharing organization for sustainable mountain development joined forces with the United Nations Industrial Development Organization (**UNIDO**), which is promoting inclusive and sustainable industrial development with a focus on resource efficiency, cleaner production, as well as sustainable energy services for productive uses.

REEECH could become a vehicle for accelerating universal energy access in the HKH region and placing mountain energy issues on the forefront of the global, sustainable development and climate agenda: It is envisioned that REEECH will function as a regional hub under the umbrella of the Global Network of Regional Sustainable Energy Centres (GN-SEC) and in support of the global Sustainable Energy for All Network[1] (SE4ALL) initiative. Within the preparatory process for REEECH, a baseline and needs assessment (BNA) was commissioned, with financial assistance from the Austrian Development Agency (ADA), to understand the current energy context in the HKH region and to consider the necessity and potential added value, of the creation of REEECH.

[1] More information can be found at: http://www.se4allnetwork.org

The BNA, which was undertaken by the German consulting company, **INTEGRATION** environment & energy, involved desk and literature research, questionnaire-based interviews, group interviews, as we as key informant interviews. The results were concluded in the form of a draft report in November 2017, and subsequently, its findings were shared and discussed by regional stakeholders during a regional Validation Workshop held at the ICIMOD headquarter in Kathmandu, Nepal, from 01-02 December 2017.

The key findings of the BNA and their validation during the workshop in Nepal are summarized as follows.

Data limitations, challenges and barriers

Analysis of *national data* derived from the eight countries, reveals that since 1995, the total final energy consumption (TFEC) has more than doubled, largely due to population growth, urbanisation and industrialization in ICIMOD's member countries. While the consumption of commercial – often non-renewable – energy has increased tremendously in the industrialized and fertile agricultural plains, the **use of solid biomass remains a significant energy source in mountainous Nepa**l (80% of TFEC), Bhutan (57 %) as well as in Myanmar (70%), particularly for cooking and interior heating. Though comparable mountain-specific data does not exist for all countries in the region, it can be deduced, that solid biomass represents a dominant source of energy for cooking and thermal energy uses in the HKH mountain region. Improved energy efficiency and access to sustainable cooking and heating fuels are fundamental, as they disproportionately affect women and children and are often the most poorly addressed needs for sustainable mountain development.

An initial finding of the BNA highlights that there is insufficient data on essential energy needs for the HKH mountains. Challenges on HKH energy data include a large variation in their depth and quality (if available), a general lack of disaggregation for the HKH from national data statistics - in terms of access to electricity and its quality, as well as the entire absence of any comprehensive data on thermal energy efficiency despite the importance of space heating, building efficiency and cooking in the HKH. The lack of such HKH-specific data often makes mountain challenges invisible in national discourses and reinforces the marginalization of mountain populations. Sustainable energy policy for mountain areas will **require stronger data for evidence-based** action, supported by appropriate geo-spatial tools.

A key barrier for energy markets in the HKH is the absence of mountain-specific sustainable energy policies, targets, incentive schemes and regulatory frameworks. The lack of data and absence of adequate framework conditions are not conducive for market development and investments. Coupled with the **fragmented nature of markets**, which are often divided by economically impermeable national boundaries, this results in a lack of cross-border trade and isolated demand centres with limited market services and economic development.

Low household income and subsistence-based livelihood strategies pose challenges for the willingness and ability to pay for energy services, in turn impacting on the viability of energy systems. This is further compounded by a **lack of innovative capacities** on delivery approaches (e.g. payment modalities), and technological advancements and adaptations, for both renewable energy and energy efficiency. Such innovations are drivers for market change, as can be demonstrated in larger markets in Asia, however, they have yet to reach the HKH mountain areas. "Home-grown" technologies, under-developed business models (technically and economically), as well as a lack of mountain-specific designs (e.g. for the energy efficiency of buildings) are a persistent constraint in the region.

Supply-side interventions alone, are not enough to address energy poverty concerns. Knowledge and learning barriers are persistent problems and require equal attention. Behavioural change challenges are caused by a lack of **energy literacy** that hampers the adoption of energy efficiency and renewable energy solutions. Mainstreaming energy efficiency and renewable energy knowledge in the curricula for (future) energy practitioners, joint research to consider solutions relevant to the region as a whole and tracking renewable energy and energy efficiency related developments, complemented with knowledge sharing between and among policy makers, practitioners and the scientific community, are relevant to the region.

Technology preferences, cross-cutting and nexus issues

In terms of technologies, stakeholders unequivocally stress on the importance **of energy efficiency** in terms of thermal energy, focused on the energy efficiency of buildings, space heating, fuel-efficient cookstoves and efficient lighting. Water heating and cooling are key opportunity areas across the HKH area. When it comes to rural electrification, stakeholders stress their **preference for decentralized electrification** solutions (e.g. RE mini-grids and stand-alone solar systems), however, they see less need for support in grid extensions. Stakeholder wish to advance the **small hydropower sector**, which suffers from quality problems and to develop bio-energy systems, where feasible.

Additional energy-related considerations identified by stakeholders include the need for integrated and **advanced planning approaches** for rural electrification and energy, along with support towards the promotion of **energy entrepreneurship** to spur appropriate investments and market develop. Sustainable energy solutions to support productive uses need to be further analyzed and understood. In terms of nexus solutions, stakeholders highlighted the need to:

a. Support sustainable forestry for fuelwood use
b. Promote energy literacy (based on the benefits of renewable energy and energy efficiency adoption)
c. Enhance energy access to pastoral and migrating communities
d. Mainstream gender and empowerment aspects into energy policy development

Desired regional support (identified and confirmed by stakeholders)

Regional stakeholders articulate a clear message: the solutions to deliver on energy challenges in the HKH mountain region must focus on decentralized renewable energy solutions, on thermal energy and building efficiency considerations, while it is necessary that significant investments are also made on building up the necessary data, knowledge, technical skills and incentive schemes to effectively inform, address and manage renewable energy and energy efficiency related actions. To address these deficiencies, stakeholders from the HKH region confirmed their desire for the establishment of a regional renewable energy and energy efficiency centre, with a focus on:

- Knowledge, information and data management
- Strengthened policy, regulatory frameworks and standards
- Strengthened regional coordination and harmonization
- Support to the development and innovation and energy markets (entrepreneurship)
- Capacity development: awareness, trainings, operational and technical support

Value Addition Potential of REEECH

As confirmed by both workshop participants and identified through the BNA, **REEECH has the potential to add value at multiple levels** and cater to the needs of a broad set of stakeholders, including governmental institutions, the research and education community, civil society groups, NGOs, private sector actors, donors, and most importantly, of energy users themselves. The technical value potential of REEECH may be summarized, as follows:

1. Energy resource and resilience observation centre
2. Energy policy and market support schemes
3. Sustainable fuels
4. Energy efficiency in mountain buildings
5. Sustainable power systems

Given the uniqueness of mountain ecosystems, the socio-economic realities of mountain populations and widespread energy poverty in the HKH region, participants of the Validation Workshop stressed on the necessity of an integrated approach to energy management as being essential for natural resources management, livelihoods and resilience-building. They echoed that REEECH may have a unique role to play in providing more insight into nexus solutions to energy, linked not only to climate and environment-related aspects, but also to the water-food-energy nexus (for upstream and downstream linkages) and productive uses (e.g. for tourism).

Institutionally, REEECH has the potential to add value, as:

1. A specialized institution with a profile on “sustainable mountain energy” in the HKH, that seeks to complement existing actor initiatives, support coordination and reduce duplication
2. As an international (and regionally-based) knowledge and learning hub with a focus on:
    a. Best practices
    b. Replicability
    c. Technical knowledge
    d. Policy-influencing and awareness raising
3. As an innovation and business incubator
4. As a regional funding channel for sustainable energy-related investments

A clear need for the establishment of REEECH, with a unique focus on mountain energy and nexus issues, has been expressed by regional stakeholders. The outcomes of the BNA and Validation Workshop will help to inform and refine the feasibility study for the establishment of REEECH, which will consider the technical mandate of REEECH, its institutional design and financial implications.

The timing for the potential establishment of a regional renewable energy and energy efficiency centre to address the energy needs in the Himalaya and Hindu Kush (HKH) region, could not be more relevant, than it is today. There is currently a moment for collective action and a need for regional support to end energy poverty, particularly to achieve global and national commitments to universal energy access in the framework of the Sustainable Development Goals and the Paris Climate Agreement.

1 Background

Through the adoption of the Sustainable Development Goals (SDGs) in 2015, the international community has recognised and highlighted (under SDG 7) the importance and necessity of access to modern and clean energy in meeting global sustainable development. This is specifically relevant for economic development, the reduction of greenhouse gas emissions, mitigation of climate change impacts and the empowerment of minorities and marginalised groups. The importance of a regional centre, focusing on mountain-specific energy issues was explicitly highlighted in the outcomes of the High-Level Meeting on „Accelerating Sustainable Energy for All in Landlocked Developing Countries through Innovative Partnerships", held in Vienna, Austria, from 24 and 25 October 2016. The event was jointly organised by the Government of Austria, the Office of the High Representative for LDCs, LLDCs and SIDS (UN-OHRLLS) and the United Nations Industrial Development Organization (UNIDO), as a follow-up activity related to the Vienna Programme of Action (VPoA) for the LLDCs for the Decade 2014-2024.

The International Centre for Integrated Mountain Development (ICIMOD) is a regional intergovernmental learning and knowledge sharing centre serving eight regional member countries (RMCs) in the Himalaya and Hindu Kush region, which covers all of Bhutan and Nepal as well as parts of Afghanistan, Bangladesh, China, India, Myanmar and Pakistan. ICIMOD responds to the specific needs of low-income groups in mountainous areas with the goal of sustainable mountain development. The United Nations Industrial Development Organization (UNIDO) is promoting inclusive and sustainable industrial development in developing countries with a focus on resource efficiency and cleaner production, as well as sustainable energy services for productive uses.

To accelerate universal access to energy services in the HKH region, UNIDO and ICIMOD, with financial support from the Austrian Development Agency (ADA), commenced a comprehensive consultative preparatory process in 2016, to determine the added value, feasibility as well as the technical and institutional design of a potential Regional Renewable Energy and Energy Efficiency Centre in the HKH Region (REEECH). The process included broad stakeholder consultations, a baseline/needs assessment and related feasibility study, as well as a project document for guiding the first operational phase. A regional validation REEECH workshop, held between 1 to 2 December 2017 in Kathmandu, further informed and served to validate the outcomes of the preparatory process.

REEECH is developed as part of the Global Network of Regional Sustainable Energy Centers (GN-SEC)[2], coordinated by UNIDO in partnership with various sub-regional organisations in developing countries. The network is currently supported by more than ninety energy ministers and heads of state and aims at establishing a network of sub-regional hubs to accelerate the implementation of sustainable energy and climate commitments and reach economies of scales. GN-SEC addresses the existing capacity gaps of regional organizations by providing technical assistance for the creation of sub-regional sustainable energy markets and industries, as well as support to encourage innovation. The expanding network comprises a sub-network of centres for the African and the

[2] Existing regional centres of the GN-SEC include the Economic Community of West African States (ECOWAS), Centre for Renewable Energy and Energy Efficiency (ECREEE, 2010), the Regional Centre for Renewable Energy and Energy Efficiency in the Arab states (RCREEE, 2010), the East African Centre for Renewable Energy and Energy Efficiency (EACREEE, 2013), the Southern African Centre for Renewable Energy and Energy Efficiency (SACREEE, 2015), the Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE, 2015), and the Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE, 2016).

Arab region[3]; as well as a sub-network of centers for Small Island Developing States[4]. The network is currently expanding to Central America and Central Asia. With the joining of REEECH and ICIMOD, the network will integrate a strong expertise on climate resilience and sustainable energy mountain issues. Together the GN-SEC forms a strong advocacy group for promoting sustainable energy and climate issues of LLDCs, SIDS and LDCs on international level.

The REEECH assessments and consultations are closely aligned with the first Hindu Kush Himalayan Monitoring and Assessment Programme (HIMAP) assessment undertaken by ICIMOD, which has engaged over 300 researchers, practitioners, experts and policy makers, to comprehensively assess the current state of knowledge in the HKH, increase the understanding of various drivers of change and their impacts, address critical data gaps, and develop a set of action-oriented policy recommendations. The process is an important tool for placing mountain energy issues at the forefront of the global debate on the implementation of the SDGs, the Paris Climate Agreement and the Nationally Determined Contributions. The energy chapter of the HIMAP assessment, which coincided with this BNA, greatly enhanced the pool of stakeholders involved in the consultative preparatory process.

The process is also closely aligned with the development of the ICIMOD 2018-2022 Medium-Term Action Plan (MTAP-IV), in which access to modern energy through decentralised renewable energy solutions and appropriate energy efficiency measures, play an important role. In addition, past experiences gathered through the establishment of six existing regional Sustainable Energy Centres (SEC) affiliated with the Global Network of Regional Sustainable Energy Centres, with the support of UNIDO, were incorporated into the formative consulting assignment.

This BNA was developed with the support of INTEGRATION environment & energy (INT)[5] - a medium-sized and impact-driven private sector consulting company based in Germany with branch offices in most ICIMOD member countries.

[3] In cooperation with the East African Community, Southern African Development Community, Economic Community of West African States, and the Arab League.
[4] Including the Small Island Sustainable Energy and Climate Resilience Initiative (SID DOC), the Caribbean Community (CARICOM and the Pacific Community (SPC).
[5] Since its establishment in 1998, INT has worked in all ICIMOD member countries, with a focus on productive use, decentralized renewable energy (RE), and energy efficiency (EE) in mountain areas (contact: ohaas@integrattion.org).

2 Introduction

The HKH region traverses the national boundaries of Afghanistan, Myanmar, Pakistan, Bangladesh, India and China, and includes countries such as Nepal and Bhutan which are wholly situated in the mountainous region. It is estimated to be home to 200-260 million inhabitants. More than 50% of this population resides in altitudes of over 1,000 metres above the mean sea level (AMSL). The region can be characterised by remoteness, inaccessibility, relative poverty, proneness to natural disasters, harsh climate conditions and one subjected to climate change impacts, resulting in accelerated glacial melting. Energy poverty is a fundamental challenge in the HKH region.

Approximately 80% of the rural population residing in the region depend on solid fuels and biomass, to meet their thermal (water and heating) and cooking energy requirements (IEA and World Bank, 2015). This poses significant challenges for stemming environmental degradation, climate change, and ensuring the conservation of unique mountain ecosystems. Clean energy and improved energy efficiency play an important role in the mitigation of climate change and the reduction of (indoor) air pollution.

In order to address these challenges in the mountain context of the HKH region and to contribute towards the achievement of global and national-level commitments to universal energy access, environmental sustainability and poverty eradication by 2030 (particularly within the framework of the Sustainable Development Goals #7 and #13), through the potential establishment of a regional renewable energy (RE) and energy efficiency (EE) centre in the HKH region (REEECH), this Baseline and Needs Assessment (BNA) attempts to analyse the current energy situation in the HKH region, shed light on the gaps and needs in the sector and identify the potential scope and the niches that a future centre could address. In doing so, this BNA focuses on the following aspects of investigation:

a. Analysis of the baseline energy situation of the mountain areas of the HKH region dealing with existing energy access and security challenges; energy, water, food and climate nexus issues; RE&EE market situation and trends and existing regional and national sustainable energy policy frameworks for seizing potential benefits of RE&EE solutions and their co-benefits
b. Analysis of problems/barriers and drivers/opportunities in the RE&EE sector identifying and how regional cooperation could contribute to reduce barriers (comparative advantage) and strengthen existing drivers to reach economies of scales
c. Stakeholder and needs analysis, mapping out relevant RE&EE initiatives in the HKH region and identifying the priority needs of the most important RE&EE stakeholders in the region and their possible fields of cooperation and synergy

For ease of reading, this BNA is structured into six key sections. The first section (Chapter 3) outlines the methodology, timeline and approach employed in conducting the baseline and needs assessment. Chapter 4 provides a snapshot of the regional energy profile of the HKH region, focusing on energy access, energy sources, productive uses and cross-border characteristics. Building on the macro-level analysis, Chapter 5 provides a structured overview of the key national energy-related stakeholders in each of the countries comprising the HKH region, highlighting national policies, developments and trends with relevance to mountain regions (to the extent possible). Based on an extensive review of over 150 sources of literature, Chapter 6 illustrates the analytical background of mountain-related energy challenges in the HKH region, exploring the interlinked nature of mountain-specific development and sustainability challenges, such as energy poverty, livelihoods, climate change and nexus issues, while Chapter 7 analyses and presents the needs,

gaps, desires and preferences identified by stakeholders involved in the consultative process resulting in this BNA. Finally, based on the analysis of needs and gaps identified, Chapter 8 etches the possible synergies and engagement areas for REEECH vis-à-vis the activities of relevant actors engaged at national, regional and international levels. Chapter 9 then concludes with a statement on the need for REEECH and synthesis of REEECH's potential focus areas, to support the feasibility study towards the potential establishment of REEECH.

A note for the reader: the development of this BNA has been a cumulative process based on desk research, consultations, inputs from regional stakeholders and a validation workshop. Several adjustments have thus been made along the way. In order to signal the most critical verifications and affirmations arising out of the validation workshop in particular, you will find green boxes such as this one throughout the document, and particularly in Chapters 5 and 7, which underline and affirm the national and regional needs, as noted by key stakeholders in the HKH region.

3 Methodology

The results presented in this BNA are based on a broad, extended research work, combining several distinct research methods, ranging from in-depth interviews, semi-structured group discussions, literature review, and a questionnaire-based survey involving experts and practitioners from all ICIMOD member countries. For the reader's comprehension of the BNA, this chapter will provide details of the methodologies used for the research by presenting the work process of each respective method, categorizing and classifying the different sources, and evaluating the output and the general success of each methodology.

3.1 Kick-off meetings

The research process to assess the needs and potential added value of a regional centre (REEECH) kicked-off immediately following the commissioning of the assignment. Between 24-25 October 2016, representatives from all participating organisations (UNIDO, ADA and ICIMOD) met during a high-level seminar in Vienna. A second kick-off meeting was held at the ICIMOD headquarter in Kathmandu, Nepal, between the 5-10 November 2016, led by Integration Environment and Energy's Team Leader and Institutional Development Expert. During both occasions, the research team conducted interviews and group discussions feeding into a preparative action plan for the BNA.

The kick-off meeting in Kathmandu, Nepal, was combined with an institutional assessment of ICIMOD in which 15 in-depth interviews were held with key experts from all relevant sections. The first conclusions drawn from this institutional assessment is documented in the Inception Report (25 January 2017) and further addressed in the related Feasibility Study. The Inception Report outlined the adjusted methodology for the study, reflecting the early learnings from the research process, and the proposed list of stakeholders/experts to be involved in the questionnaire-based survey. It also comprised questions for the semi-structured group discussions, a table with proposed documents for the literature review, a list of institutions for the stakeholder landscape analysis, as well as a proposed questionnaire and draft table of contents for the BNA and FBS.

3.2 Desk research

Desk research comprised a core element of the BNA and formed the knowledge base of the research effort, enabling the team to contextualize all further data gained from surveys, focus groups discussions, and interviews. The intention of the desk research was to identify learning from past experiences, analyse the work of regional stakeholders and their projects, understand the existing knowledge concerning the regional energy situation, and identify niche areas and a work scope for a potential REEECH.

Initially, the literature consisted of the stocktaking of scientific articles and reviewed journals (A), studies (B), policy, regulatory documents and laws (C), as well as ICIMOD's own studies (D). The body of literature was enriched by the submission of documents by counterparts (predominantly ICIMOD and UNIDO) and enhanced with further literature searches. All consulted sources were carefully reviewed, categorized and assessed upon their relevance for the assignment, and labelled with keywords to facilitate future source-based work. The mentioned categories were defined as:

(1.) Access to:
    A) Electricity
    B) Clean cooking energy
(2.) Energy in buildings
(3.) Large scale renewable energy
(4.) Productive use

With a total of 125 sources, the literature review was extensive and thus it was necessary to derive and consider only the most relevant sources for further investigation. In order to make the valuable data taken from the aforementioned literature usable, information was consolidated and summarized in a Desk Review (internal document) and later fed into the respective sections of the BNA (in particular into Chapter 6 – analytical considerations concerning mountain energy and its associated challenges).

Moreover, the research was complemented by the findings of the first Hindu Kush Himalayan Monitoring and Assessment Programme (HIMAP) assessment, which engaged over 300 researchers, practitioners, experts and policy makers, to comprehensively assess the current state of knowledge in the HKH region, enhance the understanding of various drivers of change and their impacts, address critical data gaps, and develop a set of action-oriented policy recommendations.

While the Desk Review provided fruitful input to the BNA, data and information varied strongly between the different reviewed sources. They were in some cases found to be inaccurate, outdated, insufficiently reliable, or simply not explicit enough. The systematic review of literature and data sources of relevance clearly demonstrate the need for HKH-specific energy data collection, as well as the statistical and geo-data analysis of mountain environments and communities[6].

3.3 Questionnaires

Experts and key stakeholders working in the fields of renewable energy (RE) and energy efficiency (EE) in the HKH region were identified with the support of ICIMOD and UNIDO. They comprised representatives from governmental institutions, research and educational centres, civil society groups, as well as actors from the private and financial sectors, from all eight countries constituting the HKH region. INTEGRATION's national experts contacted the interviewees (mainly by telephone) and explained the survey goals to them, prior to inviting them to complete questionnaire-based interviews.

The questionnaire was separated into different topics, ranging from their understanding of needs, potential added value of REEECH, the perception of boundaries and limitations to the development of, and solutions to, RE and EE in their respective countries. Furthermore, the questionnaire aimed to map preferable strategies, approaches and potential intervention areas of. Based on a survey format provided by UNIDO, which was utilized in support of the creation of similar regional centres, INTEGRATION shortened and customised the template in consultation with ICIMOD and UNIDO. However, in order to cover all relevant aspects, the questionnaire was still consisted of a 20-page document, which required substantial effort to be filled in accurately.

[6] Filling this gap will help political agents address mountain specific issues, integrate local challenges into national agendas, and promote the use of renewable energy and energy efficiency measures in the mountain regions.

The field time for the questionnaire stage of the BNA was initially scheduled from the beginning of March until mid-April 2017. This, however, lasted until August 2017, since the questionnaire response time varied between respondents from different countries. Nevertheless, the questionnaires enabled the generation of a strong knowledge base for further analysis. Since the quantity and quality of responses varied across the HKH countries, INTEGRATION commenced further activities to close the essential knowledge gaps.

The following list provides additional information on the challenges concerning the questionnaires and outlines the mitigative actions taken as a result:

- **Afghanistan, Myanmar and Pakistan**: the quantity of information received, and the participation of key stakeholders was considered to be adequate, though some weaknesses in the quality of data received were observed. To remedy this, additional key informant interviews were commenced in all three countries to enrich the data and close knowledge gaps
- **Bangladesh, China and Nepal**: since the response rate to questionnaire-based interview requests was initially low, high-level workshops were conducted with regional stakeholders to collectively focus on the relevant aspects of the questionnaire. In addition to the workshop, participants from China and Nepal were requested to complete questionnaires. These results have been integrated into the interpretation of data in the remainder of this BNA
- **Bhutan and India**: while the number of responses obtained were low in comparison to other countries, their quality and integrity were considered to be sufficient. Due to the low level of responses, INTEGRATION conducted additional in-depth and key informant interviews among Indian stakeholders. For Bhutan, it quickly became apparent that only high-level representatives were able to provide inputs. As a result, additional background conversations were held to contextualize the findings and enrich them.

3.4 Group discussions / key informant interviews

As introduced above, several group interviews were conducted to complement the results of the questionnaires:

- **Bangladesh**: an in-depth group discussion was held at the Sustainable and Renewable Energy Development Authority (SREDA) on 5 June 2017 in Dhaka
- **China**: On 21 February 2017, a group of stakeholders participated in a semi-structured group discussion at the China Association of Building Energy Efficiency (CABEE / Beijing)
- **Nepal**: On 28 April 2017, a group of stakeholders participated in a semi-structured group discussion facilitated and held at ICIMOD's headquarters in Kathmandu.

Figure 1: Photos of the Group Discussions (left to right: Bangladesh, China and Nepal)

In addition to these group discussions, Integration conducted key informant interviews to contextualize the information obtained from the questionnaires and group discussions, to better understand the interrelations between relevant institutions, and to gather more information about private sector developments and energy markets in the mountainous HKH region. The data and information obtained from the interviews were compared against each other and merged in order to draw the most comprehensive picture of the energy landscape in the HKH countries.

The questionnaire-based interviews, key-informant interviews and group interviews involving more than 110 regional stakeholders, the majority of whom provided their input through the questionnaires, established an extensive knowledge pool to complement the desk research. These were further analysed and incorporated into a draft BNA and shared with participants ahead of the regional Validation Workshop held from 01-02 December in Kathmandu, Nepal. Feedback obtained on the first draft, together with the findings from the Validation Workshop, were further incorporated into this final version of the BNA.

4 Regional Energy Profile

The HKH region is home to approximately 270 million inhabitants and its geographical scope includes the whole of Nepal and Bhutan, approximately 60% of Afghanistan, 47% of Myanmar, 51% of Pakistan, and substantially lower population shares in the remaining HKH countries: Bangladesh, China and India. Table 1 below details the HKH regions' populations by country, and as a share of the total national populations of countries forming the HKH region.

Figure 2: Population Statistics from HKH Countries, 2013

Country	National Population	Population in the HKH region	HKH Region Population as Share of National Population (%)
Afghanistan	26,023,100	21,487,100	83
Bangladesh	148,640,921	1,663,648	1
Bhutan	754,637	754,637	100
China	1,360,720,000	31,083,364	2
India	1,250,212,824	79,604,744	6
Myanmar	50,725,241	11,523,280	23
Nepal	27,834,981	27,834,981	100
Pakistan	184,349,000	96,462,273	52
Total	3,049,260,705	270,414,026	9

Source: ICIMOD 2016

Figure 3 illustrates the geographic scope of the HKH region, as well as its downstream river basins. According to an analysis provided by ICIMOD, an estimated 30% of the HKH population resides below 500 metres above the mean sea level (AMSL), cumulatively 45% live below 1,000 AMSL, and 75% below 2,000 AMSL, implying that more than half of the region's population lives above 1,000 AMSL, in predominantly mountainous areas.

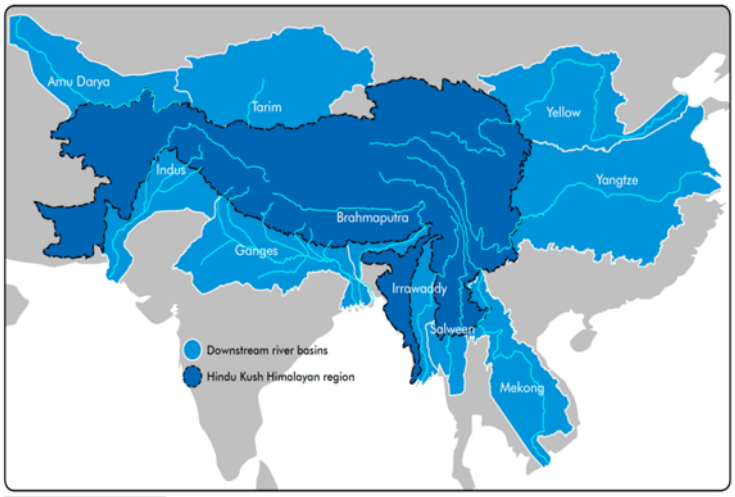


Figure 3: Map of the HKH Region and its Downstream River Basins (ICIMOD)

In order to ensure that REEECH has the potential of delivering support to target-group specific issues, it was agreed during the inception phase to narrow the focus of REEECH to RE and EE in areas experiencing mountain-specific problems such as remoteness, reduced accessibility and harsh climate conditions. Thus, the potential Centre would yield value by focusing on the HKH *mountain areas*, which implies that it covers only smaller parts of Bangladesh, China, India, Myanmar and Pakistan - where only a smaller fraction resides in mountainous or least hilly areas.

Analysing the energy situation of the HKH mountain population is important to uncover the potential development opportunities from a regional perspective. While there are some energy-related reports and articles covering areas within the HKH mountain region (UNDP, 2013), (Ramji et al.,

2012), (ADB, 2012), comprehensive HKH mountain-specific energy data barely exists in a systematic manner. Thus, it is important to note that the regional energy profile presented in the following sections (which is informed by available data – usually national), may not accurately reflect the energy situation in HKH mountain region (expect for Nepal and Bhutan, which fully belong to the HKH mountain area).

4.1 Primary energy sources and consumption

Rapid economic development in HKH countries in conjunction with population growth and urbanization has led to a duplication in total final energy consumption (TFEC) since 1995. China and India dominate the HKH countries in total energy consumption consuming around 75% and 20% respectively. Over 80% of the TFEC in HKH countries is met from commercial energy such as coal, oil, natural gas and electricity, while traditional biomass contributes only 16%.

While the use of biomass varies significantly across countries, it appears to be a dominant source of energy reflected in the TFEC, particularly in Nepal (80%), Myanmar (70%) and Bhutan (57%). Similarly, the consumption of commercial energy has increased in almost all countries signalling an energy transition from traditional fuels towards modern fuels in the HKH countries. Approximately 45% of the total TFEC in HKH countries is used in the industrial sector, 13% in transport, 25% in the residential sector, and the remaining 17% in commercial, agricultural and other sectors.

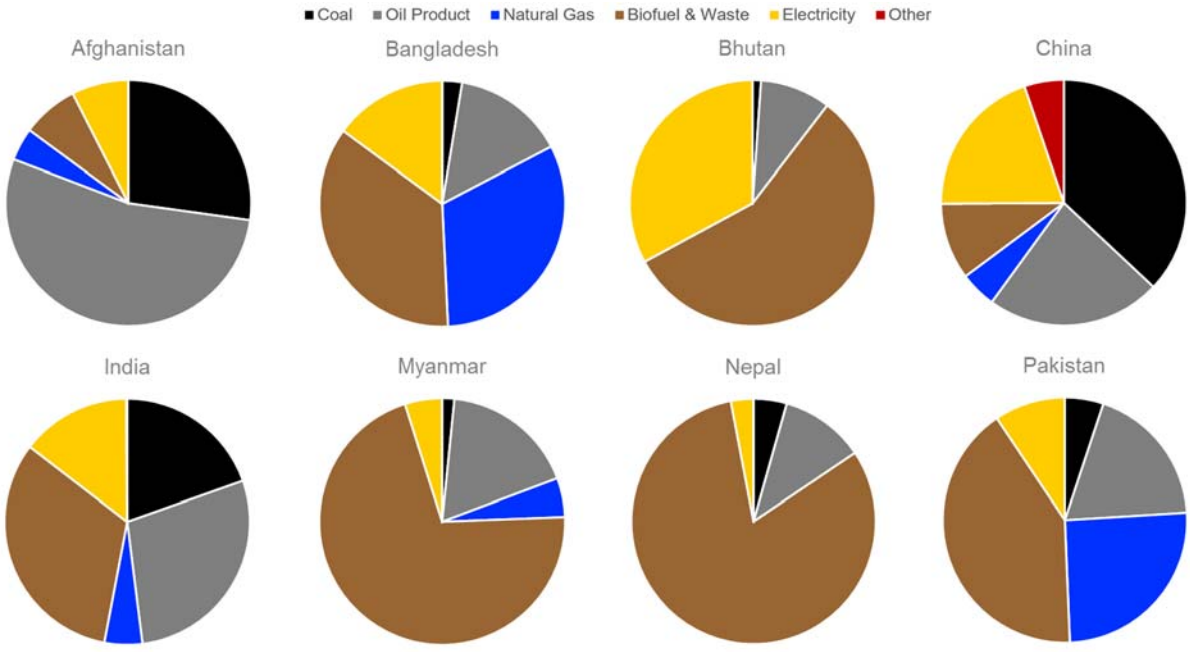


Figure 4: Share of Energy Sources in Total Final Energy Consumption per HKH Country

(Source: World Bank 2016)

The energy share of the residential sector in TEFC is amongst the highest in Nepal (83%) followed by Myanmar (70%) and Bhutan (58%). The industrial sectors of China and India consume 49% and 34%, respectively, and indicates an increasing trend, whereas energy consumption in the residential sector appears to be decreasing – though this does not imply a nominal decrease of energy use in the residential sector (IEA 2016; The World Bank 2016).

Many studies confirm that urbanization and industrialization increase energy demand, however this varies at different stages of development. With a rising share of urban population in the HKH countries, (see Figure 5) greater demand for modern and commercial forms of energy is likely to emerge in urbanising areas. Similarly, it can be expected that economic development in rural areas (where demand is currently supressed), is also likely to result in greater demand for modern energy.

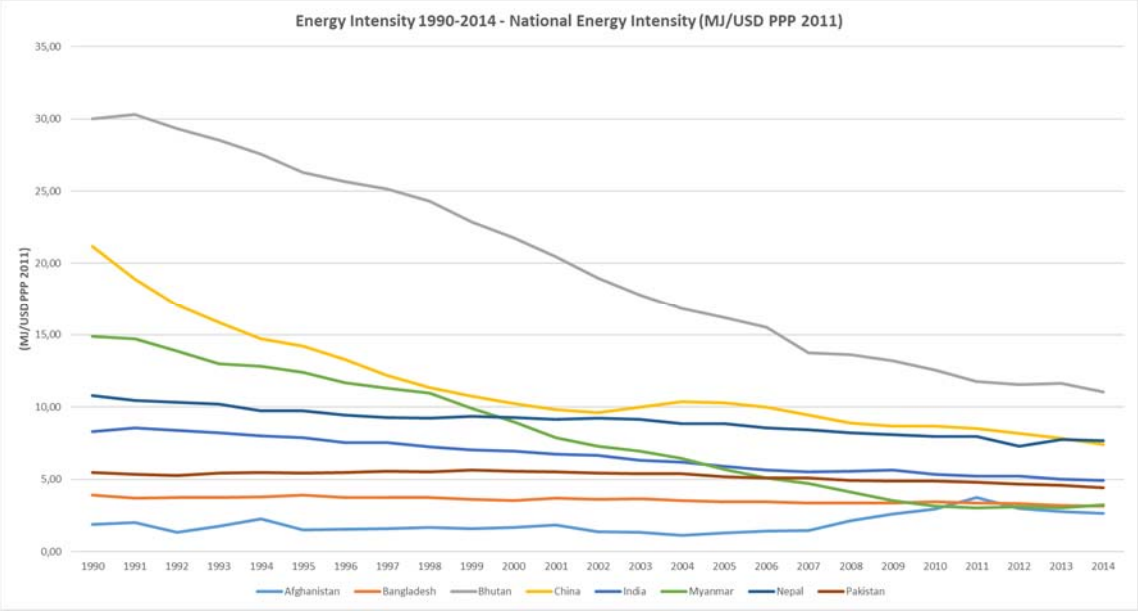
Figure 5: The Share of Urban Population (as % of Total Population) in the HKH Countries

HKH Countries	2007	2015	HKH Countries	2007	2015
Afghanistan	23.6	26.7	India	29.9	32.7
Bangladesh	28.2	34.3	Myanmar	29.9	34.1
Bhutan	32.5	38.6	Nepal	15.8	18.6
China	45.2	55.6	Pakistan	35.4	38.8

(Source: The World Bank, 2016)

The growth in total final energy consumption is observed despite a substantial reduction in energy intensity (MJ/USD). The energy intensity reduction per USD is strongest for Bhutan, China and Myanmar but less pronounced for India, Bangladesh, Pakistan and Nepal, while only Afghanistan shows a rising trend as can be seen from Figure 6.

Figure 6: Energy Intensity 1990-2014



Source: *adapted from the* Global Tracking Framework (2017)

The trends in energy efficiency vary significantly per sector, as can be seen in Figures 7-10. While significant gains in energy efficiency (MJ/USD) have been made in industries and services in China and India, stagnation or even lower energy intensities over time, is observed in other HKH countries. Energy efficiency is also stagnating or slowly increasing in the agricultural sector as well as in the residential sector, however data for Bhutan shows exceptionally high values that require further exploration and research.

Figure 7: Energy Intensity – Industrial Sector

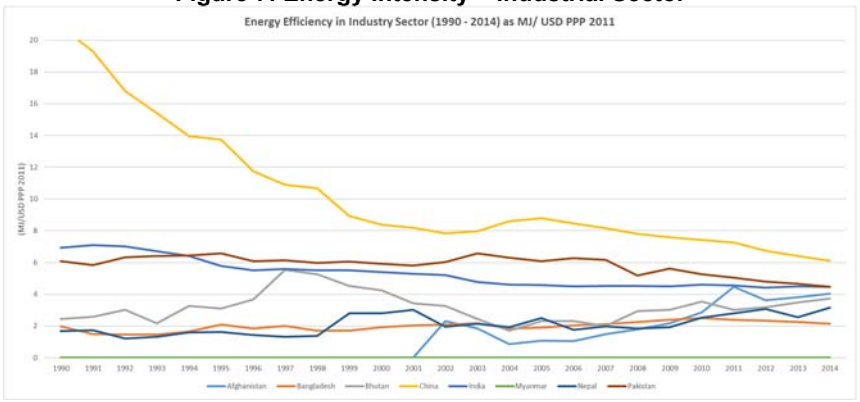


Figure 8: Energy Intensity – Service Sector

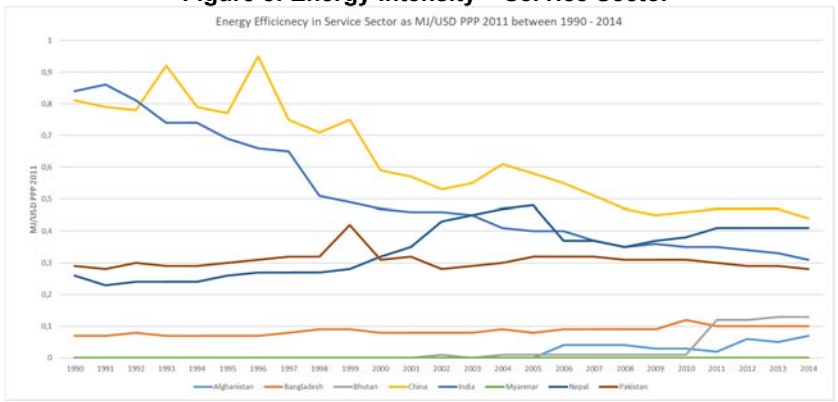


Figure 9: Energy Intensity – Agricultural Sector

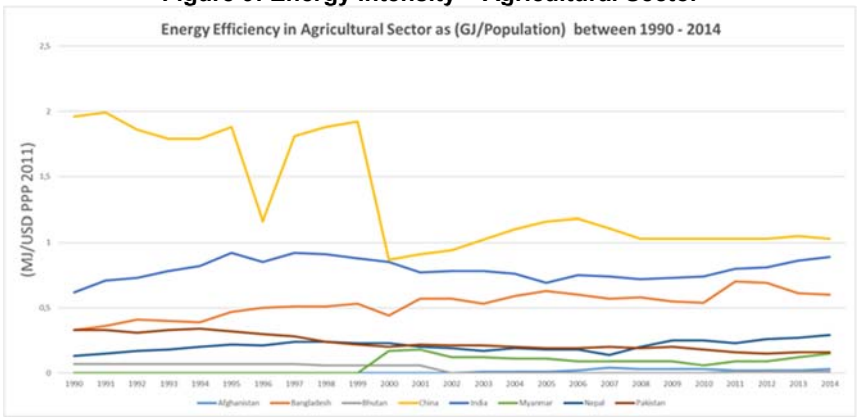
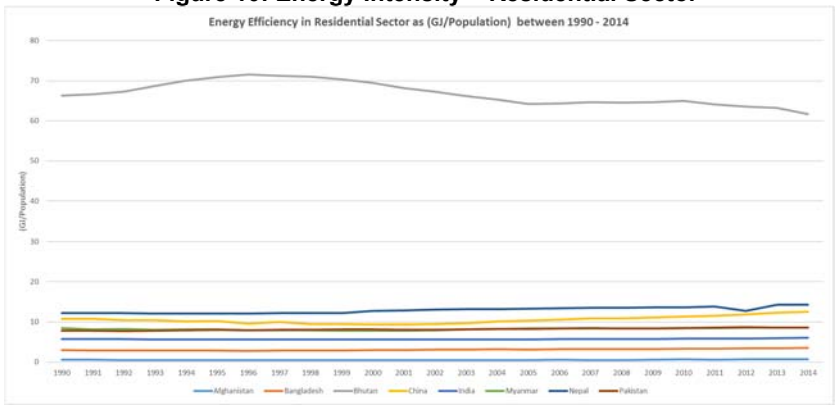


Figure 10: Energy Intensity – Residential Sector



Source: *adapted from* Global Tracking Framework (2017)

RE shares in electricity generation and consumption vary substantially among HKH countries. Bhutan, which relies strongly on hydropower, has achieved a share of almost 90%, while China is rapidly expanding its current and relatively low RE share in power generation (see Figure 11). The increasing use of fossil fuels in power generation creates industrial path dependencies. While new and fluctuating renewable energy sources such as solar energy and wind power are increasingly recognised as an adequate means of closing the demand and supply gap, their widespread use has so far, only been adopted in China and India.

Figure 11: Shares of Renewable Energy in the Total Energy Mix (Source: IEA, UN)

Countries	Year	Ren. energy [%]
Afghanistan	2008	25
	2011	15
Bangladesh	2002	39
	2013	27
Bhutan	2002	92
	2013	89
China	2002	13
	2013	11
India	2002	33
	2013	26
Myanmar	2002	76
	2013	70
Nepal	2002	90
	2013	84
Pakistan	2008	37
	2013	38

Hydropower constitutes the dominant energy source in renewable energy in the HKH mountain region but is less prominent in most countries in which the HKH mountain region only represents a smaller fraction of the country. The shrinking share of RE in the energy mix points to a great need to support the development of substantial hydropower capacities in mountainous areas in a sustainable manner as well as the cross-border exchange of electricity between countries with favourable hydrological and topographical conditions – such as Bhutan, Nepal and Myanmar – and countries with rapidly growing energy demand such as India and Bangladesh[7].

While the RE share of hydropower is already high in the mostly mountainous HKH countries, viable hydro resources are still far from being exhausted. The proven reserves in fossil fuels in the region are rather low, except for coal which would also be available in Myanmar and Afghanistan (no accurate data available).

4.1.1 Domestic access to modern energy services

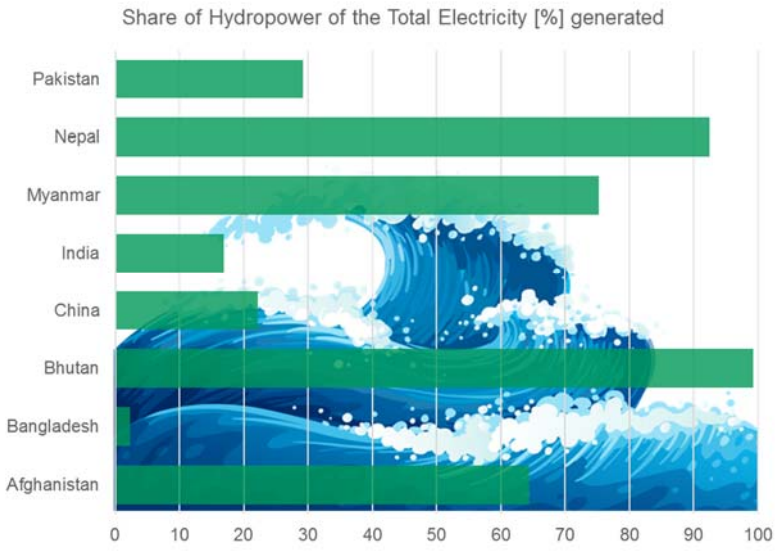


Figure 12: Share of Hydropower in Electricity Generation (The World Fact Book, 2016)

4.1.1.1 Access to power

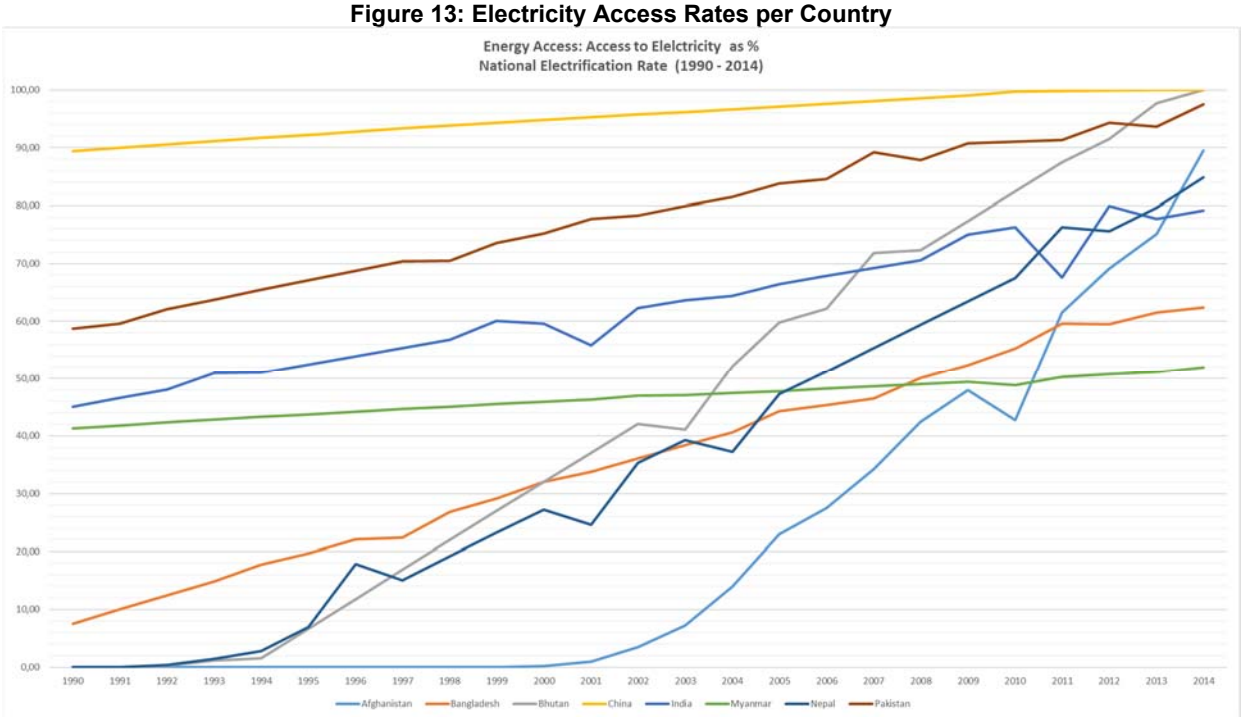
Speaking about electrification rates within the HKH region, differences between the eight partly or all-mountain countries could not be much greater: Myanmar, for example, still substantially lacks power generation and transmission infrastructure to large parts of its rural areas and almost entirely to its hilly and mountainous states and regions. However, it hosts a large sector for decentralized small hydropower systems in these regions as well as biogas-based electrification.

[7] It is worthwhile to highlight that those countries with low levels of economic development offer the best untapped power generation potential in the region e.g. Nepal, Myanmar and Bhutan.

Bhutan in contrast, has achieved full electrification (mainly grid based) and aims to increase its domestic power sales for productive uses to make the sector more viable, encourage electric cooking, and aims to increase power sales in the region (cross-border) to make use of its vast hydropower potential. Similarly, China is currently focused on the challenge of reducing the use of biomass within their rural population after having reached countrywide electrification.

The statistics presented below (see Figure 13) need to be approached with caution and in some cases, may be questionable. Electricity access rates may mask important constraints. For example, lighting and electricity needs are meagrely met in several countries - largely due to poor infrastructure and unreliable service provision[8]. Indeed, data on the spread of decentralized systems in use in the HKH mountain region is currently inconclusive, since these are often initiated by a wide variety of actors.

Figure 13: Electricity Access Rates per Country



Source: *adapted from* Global Tracking Framework (2017)

[8] Building on the observations of researchers and experts involved in the BNA, Afghanistan may not have effectively reached more than 90% of its population. Similarly, the access rates in Myanmar may be higher than the figures suggest, since decentralized power supply greatly developed in the informal sector during the time of civil conflict and political isolation. Countries that are classified as having 100% household access to electricity services vary in their electricity consumption by more than seven-fold. Thus, "full" electricity access does not necessarily mean access to a full array of modern energy services). (Pielke/Bazilian 2013).

In addition, it can be noted that the lack of region-specific energy data relevant to mountain areas masks the realities of energy poverty in the HKH. It is an apparent reality that electricity, where available, is often of poor quality and ranks in the lower tiers on the SE4ALL scale – often even in urban areas[9]. Lighting needs are often met with a combination of kerosene and electricity of poor quality. The lack of access to electricity – linked with issues of availability, accessibility, affordability, acceptability, and other dimensions – suppresses its demand for productive uses capable of supporting economic growth opportunities.

Areas of limited statehood: *Literature also reveals that access to electricity is often in particularly low in remoter areas, where there is a limited reach of governmental services or in areas of limited statehood due to conflicts or unresolved borders issues. In several countries and especially along many borderlines, quite some areas are severely affected by unrests or war-like conditions and are thus politically unstable, which means that the governments may only have limited access to the respective areas (Barnet, Zürcher 2009)*

Box 1: Energy Governance in Areas of Limited Statehood

Stakeholders from the region confirm a general trend towards decentralized solutions for those areas still lacking reliable and accessible electricity access, as well as their highest preference for RE mini-grids, followed by solar home systems - far ahead of their preferences for national grid and mobile solar solutions (e.g. lanterns). Stakeholders consider the main barriers for decentralized approaches in mountain areas as being attributable to a general lack of integrated planning based on accurate data on the locations and population size in un-electrified areas as well as data on the potential natural resources available there. Regional stakeholders and experts emphasize the need for advanced rural electrification planning in light of emerging decentralized technologies.

4.1.1.2 Thermal energy

While access to electricity is an issue of national concern, thermal energy for cooking and space heating has not received the same amount of public attention - often reduced to an intervention field for NGOs and civil society initiatives. Cooking energy, space heating and the thermal efficiency of cooking devices and buildings are inextricably linked with each other (here referred to as thermal household energy).

Following a report published by the IEA and the World Bank in 2015, Bhutan is the only country in the region that can offer half of its rural population access to clean, modern cooking energy[10] services[11]. In many other HKH countries, a strong majority of the rural population still depends entirely on biofuels, which is intensely used in mountain areas[12]. Such biofuel is commonly collected fuelwood but can also be any kind of scrub, animal dung or agricultural residuals.

Thermal energy for cooking represents a pressing energy need and one which is usually met through scare biomass resources in mountain areas. A common result of the predominant practice of collecting fuelwood is the overexploitation of biomass resources - beyond the natural carrying

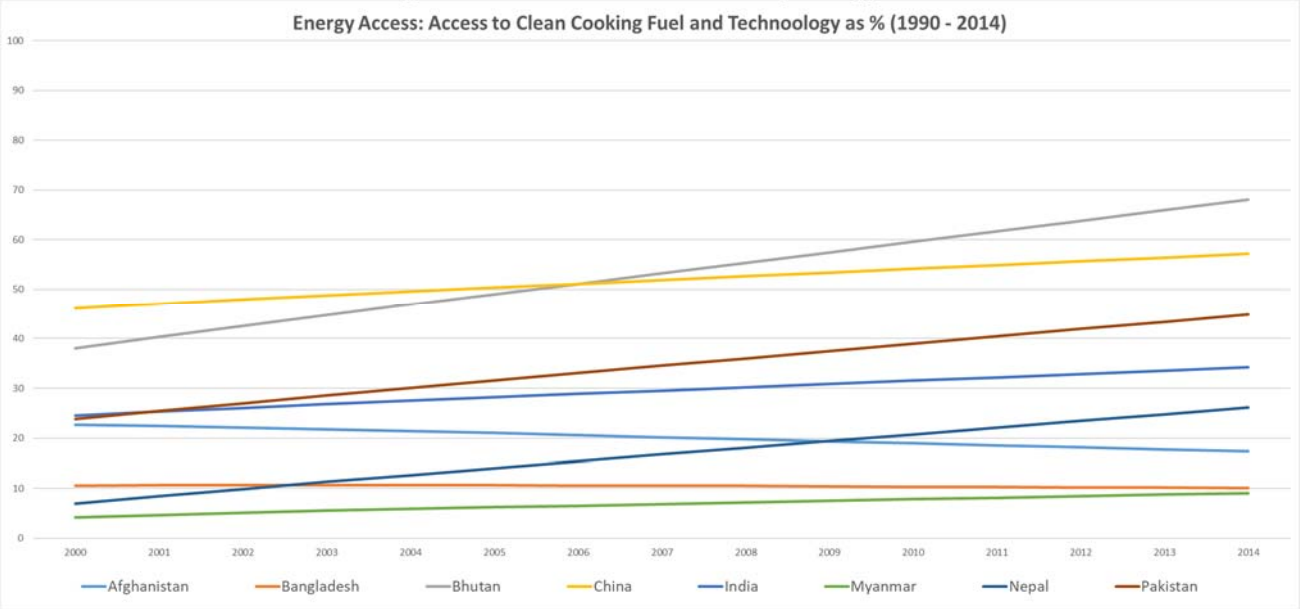
[9] It appears even paradoxical that the statistics, which are meant to guide policy makers at the national, regional, and global level, provide a statistical picture that marginalizes the issue and hinders the ability to take mountain-specific actions.

[10] Which used to be LPG but is increasingly substituted by electrical power.

[12] Even in the urban areas of countries such as Myanmar, Bangladesh, Nepal and Afghanistan, a considerable proportion of the population have no sustainable alternatives to the use of open fireplaces for cooking their meals.

capacities of local forests. It can be concluded that HKH countries have failed to shift from unsustainable biomass-based cooking to cleaner and sustainable solutions on a broader scale – as can be deduced from Figure 14.

Figure 14: Access to Clean Cooking Energy



Source: *adapted from* Global Tracking Framework (2017) *(GTF)*

Since the HKH mountain area has a relatively cool climate, the need for space and water heating is just as important as cooking and lighting. Space heating is inevitably connected to cooking energy, since open fireplaces and stoves are the main heat generators in most households in the HKH mountain region. Indeed, biomass as a cooking fuel often combines to serve the additional purpose of space heating in middle and high-altitude areas (Palit & Garud, 2010) (Santner & Jussel, 2003) (Bhatt & Sachan, 2004)[13].

Poorer households often use cookstoves as their main source of space heating. Caught between poverty and environmental degradation, mountain communities are finding it increasingly difficult to meet their energy needs for daily survival in a sustainable manner (Sharma et al., 2005) and the energy needs for reasonable ambient temperatures remains suppressed. Low income is one of the key determinants for the continued use of biomass for cooking (e.g. Hosier & Dowd, 1987). Not only are modern fuels more expensive but so are the costs of the appliances which utilize them (Bhattacharyya, 2006).

To contain the adverse effects of cooking with solid biomass and waste, the majority of pro-poor efforts have concentrated on the improvement and use of efficient cookstoves. However, despite efforts to promote them in the past decades, traditional cookstoves continue to dominate rural energy and there have been manifold challenges to scaling up the adoption rate of improved cookstoves. The specific challenges are deeply related to the local availability of energy sources and the living situation of the local population, e.g. their income situation (and the absence of income

[13] Despite emerging rural electrification, one of the reasons for the high demand for traditional fuels in Bhutan is due to its use for heating (Rahut, Behera & Ali, 2016). The reasons for the failure of the smokeless stoves initiative in Bhutan could be their inability to heat the room (Palit & Garud, 2010).

generating opportunities), regional cooking habits, seasonal availability of fuel or energy sources or due to the multi-purpose use of cooking fuels – such as for space heating.

In addition to fuel and stove types used, the efficiency of space heating greatly depends on the thermal energy features of houses and dwellings. It is an adverse trend of better-off households, that building designs from hotter parts of Asia (fitted with large single glazed windows, open hall-ways, poor alignment to the sun, metal roofs) and the materials they are constructed from (such as concrete, glass, steel or aluminium), are increasingly replicated in mountainous areas often influenced by migratory work patterns. The application of such building designs in areas prone to climatic variances has tremendously contributed to increased energy needs for heating in cooler periods, as well as for air conditioning (cooling) in warmer periods.

While institutional frameworks and policies around rural electrification have advanced in almost all HKH countries – although often not mountain-specific – there is a much stronger gap in their ability to meet thermal energy needs. Stakeholders rate access to clean cooking second highest (behind RE mini-grids) and place strong emphasis on bio-energy and sustainable forestry for fuelwood. It is only Bangladesh where the issue of access to cooking energy is less strongly pronounced – most likely due to the hilly terrain in which biomass vegetation may still withstand the pressure[14].

The energy efficiency of buildings and the need for solutions to space heating is a top priority for Pakistan and Bhutan, where it even ranks ahead of energy efficient cooking devices (although closely interlinked), but it is also a high-level priority for Afghanistan, China, India, and Nepal. Stakeholders emphasize the need for building guidelines and building and material codes. Some suggest that passive solar designs along with innovative technologies, e.g. compressed earth bricks, represent efficient remedies. Stakeholders also point to awareness creation, through education and capacity building needs.

4.1.2 Productive use of renewable energy

The productive use of renewable energy, both electric and non-electric (e.g. heat), can be defined as the use of renewable energy resources in pursuit of any kind of economic activity for the production or creation of added value which can be sold in order to earn a livelihood, enhance income or raise welfare. In a rural context, the productive use of renewable energy often takes place in sectors such as agriculture, rural industry, health and education. Process heat demand is often met by fuelwood and other biomass, petroleum products, coal or electricity, while motive power is often met by petroleum products and electricity (Rijal, 1999).

Since most HKH mountain communities generate their income as peasants[15], productive use in the sector of agriculture carries significant development potentials. Changing agricultural practices impose high demands for electricity and petroleum products for irrigation, processing and storage

[14] While similar vegetation types, e.g. in Myanmar, show strong signs of degradation.
[15] Key areas include water irrigation systems, pumps and other electrified farming machinery. The possibility to shift from traditional subsistence agriculture to cash-crops and commercial products such as horticulture, medicinal plants, herbs, and vegetables have been demonstrated in various mountain areas (Rasul, 2014b).

in the HKH[16]. Other types of cottage industry in the HKH include saw mills, potteries, blacksmiths, dairies, workshops and bakeries. Tourism is one of the emerging sectors for employment and income generation in the HKH and is expected to lead to an increase of the commercial share of energy consumption, as well as increased liquid fuel consumption and electricity demand[17]. The productive use of energy is limited in the region - electricity is largely used for lighting and operating household devices (televisions, radios and mobile phones), with no deliberate emphasis on productive use of energy. Bhutan, with its full electrification has made it a priority to promote the productive use of electricity for income generation, while transitioning to clean cooking and heating solutions.

Besides these broad potentials, several HKH countries (such as China and India) demonstrate economic opportunities which provide exceptional examples of how electricity access can be successfully integrated with rural development (Bhattacharyya and Ohiare, 2011). Other, more technology and business-specific opportunities include:

- In India, biomass gasification is a common technology in many industries such as sericulture, textiles, sand drying, aluminium extrusion, and dairy and milk processing. In recent years, newly developed technologies significantly lowered the quantities of consumed biomass, while at the same time raised the efficiency of the technology used (e.g. higher temperatures)
- In China, but also in some other areas of the HKH mountains, local communities specialized in the production of biomass briquettes

Though aware of the existing development potentials, governments in the HKH region are still struggling to plan energy programmes beyond supply side considerations. Thus, they do not sufficiently assume and promote future energy needs, which largely define the financial viability of energy systems, particularly of decentralized applications. Similarly, incentive programmes or subsidies are either non-existent or not sufficiently effective to serve the needs of local industries.

While the promotion of energy entrepreneurship and productive use is considered highly important among stakeholders, no overview of existing programmes and promotion schemes, shares of productively used electricity or energy could be identified in the scope of this BNA. Data on existing and potential (supressed) productive demands and know how to address the gap on broader scales are urgently required to design support programmes and energy supply systems as long-lived infrastructure and allow local industries to develop.

4.1.3 Cross-border energy trade and cooperation

Notable bilateral cross-border electricity trade (CBET) agreements are in place between the following countries: Afghanistan with Central Asia, Pakistan with Central Asia, India with Nepal, India with Bhutan, India with Bangladesh, India with Sri Lanka, and India with Pakistan. Several regional

[16] Energy consumption from the agriculture sector in Nepal accounts for 9.9% of total petroleum product consumption and 2.5% of total electricity consumption. The energy consumption of Nepal's agricultural sector fulfils different services: tillage (52%), irrigation (32%) and threshing (13%) (WECS, 2014).
[17] The sector is important for alpine mountain tourism, which is restricted to few areas in India, Nepal and Bhutan, but of relevance in these remote high-altitude areas.

organisations aim to enforce further bi- and multilateral cooperation, such as the South Asian Association for Regional Cooperation (SAARC) and the Bengal Initiative for Multisectoral Technical and Economic Cooperation (BIMSTEC).

One step towards further regional energy trade could be the harmonization of electricity grids[18], a topic recently pushed by India. So far, however, grid harmonization has mainly been an Indian project with some grid-connections to Nepal, Bhutan and Bangladesh, but a harmonized network could kick off further trade possibilities and could enable power trade across all of South Asia. Nepal and Bhutan could produce energy for Bangladesh, Sri Lanka or Myanmar using the Indian grid for electricity transfer, making clean, renewable energy available where it is greatly needed.

Many CBETs, such as the Greater Mekong Sub-Region (GMS), the Southern African Power Pool (SAPP), the West African Power Pool (WAPP) or the Nile Basin Initiative (NBI) started as bilateral trade relationships and eventually led to regional extension agreements. Transboundary electricity trade could, in particular, benefit the mountain countries for two reasons: exporting countries such as Bhutan, but in the mid-term also Myanmar and Nepal, could benefit more from the economic prosperity in the neighbouring countries. Secondly, cross-border energy trade has the potential to reduce the isolation and marginalisation of mountain areas by developing new infrastructure and border exchange points[19].

Regionally, CBETs have the potential to reduce dependency on coal and other conventional, non-renewable energy sources while underpinning economic development. While India is already investing in private energy projects in Bhutan, Nepal's and Myanmar's hydropower potential remains partially disregarded. While Indian and Chinese investors already attempt to exploit some of these countries' hydropower potentials and export the generated surplus electricity, deep scepticism towards these investors and geopolitical interests prevail and often, past experiences have witnessed the souring up of such relations[20].

Electricity and gas trade offer high potential, however, attempts to seize opportunities beyond bilateral or trilateral agreements have not yet taken place. Conversely, they have the potential of increasing tension between countries, which is why stakeholders recommend approaching them rather from the opportunity side instead of pushing for regional systems at times when the political circumstances do not allow for it. Such windows of opportunities may include local power trade between neighbouring provinces with immediate benefits for mountain populations. Examples include the electricity export from Thailand to the Shan State of Myanmar or from Tajikistan to Badakhshan in Afghanistan.

[18] Harmonization of the electricity grid requires harmonizing cross-border load dispatch and planning, ahead on electricity transmission.
[19] A third advantage might be seen in the development of fewer, environmentally less impactful sites. Since large hydro involves the creation of dams with great impact on nature and wildlife, it is deemed preferable to develop few of these in carefully selected locations.
[20] Myanmar's gas export deal with China is considered problematic and its elected government has suspended the Myitsone Dam, which would have exported great shares of energy to China. There is, likewise, a perception in Nepal that in the past, energy cooperation with India has not brought economic prosperity.

Summary – Regional Energy Profile

1. The HKH region is home to approximately 270 million inhabitants and more than half of the region's population lives above 1,000 AMSL, in predominantly mountainous areas. Comprehensive data on mountain-specific energy data barely exists in a systematic manner for the HKH region
2. While the use of biomass varies significantly across the HKH countries, it appears to be a dominant source of energy in many countries which have a larger share of mountainous areas: Nepal (80%), Myanmar (70%) and Bhutan (57%). Despite the lack of mountain-specific data for HKH countries, it can thus be assumed that biomass use is a predominant source of energy in mountainous regions. The energy share of the residential sector is relatively high in the more mountainous countries which constitute the HKH (as reflected in the TFEC): Nepal (83%), Myanmar (70%) and Bhutan (58%)
3. The HKH mountain population predominantly engages in agricultural activities and small cottage industries to secure their livelihoods. Changing agricultural practices impose high demands for electricity and petroleum products. Tourism is one of the emerging sectors for employment and income generation in the HKH mountain region and is expected to lead to an increase in the commercial share of energy consumption, liquid fuel consumption and electricity demand
4. While data on electricity coverage, institutional frameworks and policies for rural electrification appear favourable in the region, the data needs to be approached with caution. Electricity services may be unreliable, expensive, or of poor quality and thus its demand for productive uses to support economic growth opportunities may be supressed. A large gap in meeting thermal energy needs (for cooking and space heating) is also observed in the region
5. While hydropower is a dominant source of renewable energy in the HKH mountain region, it is still under-utilized – despite the vast potential for additional generation. Tapping into it presents a significant opportunity for impact to local development, mainly through small hydropower. Large hydropower brings opportunities for cross-border electricity trade, particularly between countries that have favourable hydrological and topographical conditions and those with rapidly growing energy demand. Their development has the potential to reduce the economic marginalisation and isolation of mountain areas, but requires approaches that ensure social and economic equity for the HKH mountain population, as well as reduced environmental and social impacts

5 HKH Stakeholders, Policies and Trends

This section provides a brief profile of each HKH country, with a particular focus on their trends in access to modern energy, energy supply, governance, as well as noteworthy developments and needs relevant to their HKH mountain areas. In addition, the section provides an overview of regional and international actors, as well as non-governmental actors, relevant for the HKH mountain region.

5.1 Domestic actors and trends

There are significant differences in energy access, policy developments and institutional structures among the countries constituting the HKH region. However, capturing the HKH mountain-specific patterns and trends accurately has been difficult, since mountain-specific data is often not disaggregated from national data, and since the policy and institutional landscape relevant for mountain regions is often fragmented or not visible. Indeed, the lack of HKH mountain-specific data and overview of actors, drivers, polices and results (such as achievements and failures of initiatives and efforts) highlights a great need for a mountain-specific institution focused on energy, capable of establishing a sound energy information base, as well as a facilitator of cross-border learning to enable needs-based and evidence-based energy decision-making applicable to mountain areas.

5.1.1 Afghanistan

The Republic of Afghanistan in southwestern Asia has a rugged terrain inhabited by a variety of ethnic groups. It is a land-locked country, 1,450 km in length and 725 km in width, sharing borders with six other countries: Tajikistan, Turkmenistan, Uzbekistan in the north; China and Pakistan in the east and south; and Iran in the west. About three-quarters of Afghanistan consists of mountains and uplands with some peaks in the Hindu Kush reaching 7,600 m.a.s.l. The Khyber Pass winds northwest through the Sefid Koh Range near Peshawar in Pakistan to Kabul in Afghanistan. On the Tajik frontier is the Amu Darya River, while the country's longest river is the Helmand in the south. Climatic conditions, while extremely variable, are generally dry and much of the country is desert and scrubland.

Access: Afghanistan hosts approximately 30 million people and approximately 60% of its land areas belongs to the HKH mountain area. Afghanistan has always been on the lower end of electrification in comparison to the other HKH countries, however, latest statistics indicate tremendous success rates in electrification with a postulated rate of 90% for the entire country. These figures are believed to overstate the reality on the ground[21] and might be attributable to the lack of accurate data or to methodological challenges in remote areas. Nevertheless, the rates of electricity access have improved over recent years; while access to clean cooking has deteriorated and ranks second lowest in the HKH region (17% in 2014, World Bank).

Energy supply and demand: Afghanistan has a significant electricity deficit in terms of power generation, resulting in an enormous gap between electricity demand and supply. Domestic power

[21] The customer base of DABS, the national utility, indicates approximately 1.3 million connections. Assuming there are 7.5 household members (high assumption) per connection, the total number of supplied Afghanis is little below 10 million people. Comparing these figures with the assumed population of approximately 33 million people, it appears inconsistent that almost 20 million people would be supplied by means other than the national grid.

generation represents only 23% of total electricity consumption - largely generated from old hydropower stations (90%). The supply gap has been largely met through increasing power imports from Uzbekistan (35%), Tajikistan (30.5%), Iran (21%), and Turkmenistan (13.5%) building on the implementation of the North-East Power System; (NEPS) consisting of a grid linking 17 load centres (including Kabul, Mazari-Shariff and Jalalabad), which has tremendously improved the supply situation (Ghalib, 2017). Further intended regional power projects are in the making, including the Turkmenistan-Afghanistan-Pakistan-India natural gas pipeline (TAPI) and the CASA-1000 (electricity trading arrangement between Kyrgyz Republic, Tajikistan, Afghanistan, and Pakistan).

Energy governance: The Ministry of Energy and Water (MEW), which is responsible for the development of the power sector, including rural electrification and the promotion of energy efficiency, recently founded the dynamic Renewable Energy Department (RED). Rural Electrification is additionally supported by the Ministry of Rural Rehabilitation and Development (MRRD), which focuses on community-based off-grid systems, mainly MHPs and SHS. The state-owned electricity utility, Da Afghanistan Breshna Sherkat (DABS), is a vertically integrated service provider operating power plants, and the national transmission and distribution network, and customer services. Standards for energy-related goods are issues by the Afghan National Standard Authority (ANSA).

The Inter-Ministerial Commission for Energy (ICE) as well as its attached sub-groups coordinate energy-related planning. It is chaired by the Minister of Economy and includes all the major energy sector stakeholders in Afghanistan, ranging from government ministries to development partners.

RE-related goals were anchored in the National Renewable Energy Policy, which is already approved, while there are only draft versions of an EE policy and no specific standards exist for the latter. Afghanistan has a Master Plan for Power as well as a five-year plan on energy. However, stakeholders observe a gap between targets and actual implementation, which has not been reported for any other HKH country[22].

Recently, the Electricity Service Law has been approved by the Government of Afghanistan and there is an attempt to push for more privatisation and market regulation in the renewable energy sector. It is in this context that tax and custom reductions for RE products as well as draft Power Purchase Agreements (PPA) are being discussed. It is intended to set up a regulatory body within the MEW.

Achievements and needs: The development of centralised utility-scale sustainable power generation systems in Afghanistan is severely hampered due to many years of instability, violent conflicts and war. Nevertheless, promising numbers and examples exist in the decentralised power sector, which is of relevance for the HKH mountain region in Afghanistan:

- Under the National Solidarity Programme (NSP) and other IDA-funded projects, the MRRD implemented up to 8,000 community-based micro hydropower systems (World Bank 2016), though many are reported to suffer from operational problems[23].

[22] While policy making is progressing, it is insufficiently translated into operational regulations and effective programme structures, which might be reasoned in lacking capacities dysfunctional institutions.

[23] Many of these systems suffers from operational problems in their early years of operation. This is due to severe underinvestment, lacking plans, limited site-supervision, sub-standard components, poor operation models and capacities (GIZ, 2008; 2010).

- The Energy Supply Programme for Afghanistan (ESRA) – implemented by GIZ with the support of INTERATION e&e – established eight quality mini-hydro power plants (up to 0.5 MW) and one PV-based mini-grid (250 kWp), supplying cumulative approximately 100,000 rural inhabitants' sustainability in the off-grid areas in the provinces of Badakhshan and Takhar (Ashden 2012).
- Under the Bamyan Renewable Energy Project, one of the world's largest off-grid 1.05 MWp Solar PV system was implemented. It was funded by New Zealand's Ministry of Foreign Affairs and Trade. The project brings energy to 2,500 homes, businesses, and government buildings, while concerns about the ability to pay for services exist.

Afghanistan's stakeholders are interested in increasing the domestic manufacturing of RE and EE technology and in overcoming technical barriers. They place special emphasis on the development of hydropower systems in remote areas as well as on solar. Afghanistan's stakeholders see potential in promoting institutional solar systems and are interested in supporting activities on solar water heaters, which are ideal for the sun-rich but cold environment there[24].

5.1.2 Bangladesh

The People's Republic of Bangladesh is home to approximately 160 million people and consists of broad deltas formed by the Ganges and Brahmaputra rivers as they flow into the Bay of Bengal. The country is exceptionally flat with about 75% of its area situated at less than 10 m.a.s.l. The Chittagong Hill Tracts, low hills of Sylhet and the highlands in Rangpur are the highest points of elevation in Bangladesh. Only a tenth of its national territory, located in Chittagong Hill Tracts[25] along the India and Myanmar border, is part of the HKH mountain range, home to approximately 1.7 million people.

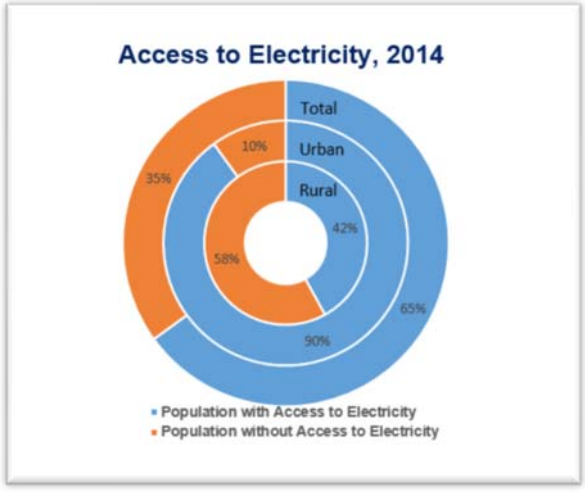


Figure 15: Access to Electricity in Bangladesh

Access: Although one of the government's highest priorities is providing electricity and other commercial energy to the population at the household level, especially in the rural areas, there is scarcity of access to affordable clean energy. Approximately 76% of the population had access to electricity as of June 2016, with a total of 21.8 million connections (Power Cell, 2016). According to the World Bank and ADB sources, the electrification rate was 90% in urban areas and 42% in rural areas in 2014 (Figure 15). The quality of electricity supply in the latter is still poor. Access to clean cooking energy is stagnating at 10% (World Bank, 2016).

[24] Despite the predominantly arid lands and chronically overused natural resources, stakeholders still confirm interest in bio-energy, which may be applicable in certain fertile areas such as the Kunduz river valley.
[25] The Chittagong Hill Tracts (CHT) is a 13,295-sq. km remote region of hills and lakes consisting of Bandarban, Rangamati and Khagrachari districts located in the south-east of Bangladesh. As per Population Census 2011, the total population of CHT is 1,598 million, which represents only little more than one per cent of the country's population. Thirteen different tribes with different languages and cultures live in CHT.

Energy supply and demand: Out of the 12,365 MW generation capacity in Bangladesh, most of the electricity is produced through gas-powered thermal generation (61.69%) (BDPB, 2016). Peak demand is met by independent power producers (IPPs) using diesel, furnace oil and gas-based generators. Electricity is also being imported from India since September 2013.

While Bangladesh is a water rich country with massive rivers traversing its national territory, the country's hydropower potential is very limited[26]. The 230 MW hydroelectricity facility of Kaptai, located in the Chittagong Hill Tracts areas, is the only grid-connected source of renewable energy power. The first utility-scale solar projects are just under way. Investments in decentralised RE were previously made in largely captive power systems for industries (e.g. biogas to power, and roof-top solar), however, such investments are beginning to slightly decrease due to the improved quality of the central system. Private sector investments are being made in decentralised solar mini-grids and solar irrigation pumps, with the government having set out ambitious goals regarding the latter.

It is expected that both decentralised and utility-scale solar power will eventually kick-in again more strongly when private-public agreements become more standardised, and once feed-in and net-metering systems are enacted and tested. Nevertheless, the national energy mix is highly dependent on natural gas and other conventional, non-renewable energy sources. To increase the RE share, regional cross-border trade of electricity is a promising alternative to profit from vast renewable energy potentials in neighbouring countries and it creates a substantial off-take market, e.g. for Bhutan.

Energy governance: The country's mid-term goal is to offer a reliable electricity system for all by 2021, in which sufficient supply capacities are a key priority. The New Energy Policy (NEP) from 2006, together with the Bangladesh Poverty Reduction Strategy Paper – which refers to biomass and indoor air pollution – govern the energy sector activities within a diversified institutional landscape. The Ministry of Power, Energy, and Mineral Resources (MPEMR) oversees electrification activities, including the efforts towards improved cookstoves (Power Division, 2013). Within the MPEMR Power Division, the Power Cell oversees the power sector reform.

The Bangladesh Energy Regulatory Commission (BERC) is responsible for consumer protection, the approval of tariffs and pricing, issuance and distribution of generation licenses. The recently established Sustainable and Renewable Energy Development Agency (SREDA) acts as a focal point for renewable energy and energy efficiency. The power market is unbundled with the Bangladesh Power Development Board (BPDB) operating most publicly owned generators and acting as a single power buyer from public and private generators, before selling to distributors.

The Power Grid Company of Bangladesh (PGCB) is a wholly owned subsidiary of the BPDB. It operates the national transmission grid, schedules grid operations and wheels energy to distributors. The Rural Electrification Board (REB) oversees operations of the 80 consumer-owned rural electric cooperatives (PBSs) all over the country except in the Chittagong Hill Tracts (CHT). Within the HKH region, the Infrastructure Development Co. Ltd. of Bangladesh (IDCOL), a government-owned company and global leader in the development of decentralised electricity markets, stands out exceptionally, for decentralised renewable energy promotion.

[26] The SAARC estimates the hydropower potential for Bangladesh to be no more than 1 GW, representing 0.3% of the total hydropower potential of South Asia (Singh, et al. (2013): 15).

Achievements and needs: Bangladesh is a global leader in the promotion of private sector-based rural electrification. IDCOL and its facilitating Partner Organisations have implemented the world's largest SHS programme[27] as well as a scaled household biogas and improved cookstoves programme. Until May 2017, approximately 4.1 million SHSs have been installed under the programme in remote areas, where electrification through grid expansion is challenging and costly, ensuring basic electricity access to 18 million people (12% of the country's total population), though only 105,605 Solar Home Systems have been installed in the CHT region. The number of household-level biogas plants in the same area is also low - only 200 out of the total 46,200 planned as part of the programme. Based on state-of-the-art financial models, Bangladesh is promoting private sector-based RE mini-grids and solar irrigation pumps with grants and loans.

Another key actor is the Integrated Development Foundation (IDF), which is a non-governmental organisation, fostering SHS with the help of the provision of long-term credits for rural families. IDF established a 100-kw solar plant in Shandwip (Chittagong district) and other micro-grids. IDF is also active in promoting water mills, solar pumps and solar dryers. Nevertheless, IDCOL's role in developing the domestic RE sector is instrumental in generating broad employment opportunities. In 2013, the International Renewable Energy Agency (IRENA) ranked Bangladesh as having the sixth-largest renewable energy-related workforce in the world - with 114,000 jobs.

Bangladesh's stakeholders rate the economic and financial barriers as "high" for increasing the share of RE and advanced EE, especially in the CHT area, which is a relatively remote border region with a strong influx of refugees from Myanmar and suffers from inaccessibility due to its topography[28]. The stakeholders give high priority to RE mini-grids[29]. For the hilly areas, stakeholders are highly interested in exploring small hydropower. Bio-energy is another priority area in which Bangladesh has achieved remarkable success in household and other small-sized systems. However, the country faces challenges in implementing larger biogas digesters and generators.

5.1.3 Bhutan

The Royal Kingdom of Bhutan is located between India and China's Xinjiang Autonomous Region and its territory falls completely under the HKH mountain region. Northern Bhutan consists of a virtually uninhabited area known as the Great Himalayan Region, which contains the country's highest peak, Kula Kangri at 7,554 m.a.s.l. In central Bhutan lies the Middle Himalaya with temperate valleys inhabited by much of the population. Along the Indian frontier is the Duars – a narrow, tropical plain crossed by deep gorges and partially cleared for rice cultivation.

Bhutan has plentiful supplies of fresh water with four main rivers flowing south from the Himalayas – the Manas, Raidak, Sankosh, and Torsa. Nearly half of Bhutan is covered by forests which, with its surface waters and small mineral reserves, constitute the country's natural resource base. The

[27] IDCOL has 56 Partner Organisations such as Grameen Shakti, RSF, IDF, TMSS, UBOMUS and others, offering micro-finance-based dissemination schemes. However, IDCOL is not explicitly active in the mountainous areas of Bangladesh.
[28] Even though the quality of electricity supply through the national grid has improved in urban areas, the situation in CHT area may not change soon because of difficulty in expansion of distribution lines in the hilly rural areas.
[29] Bangladesh's institutions have defined clear priorities for grid extension, which leaves a relatively large market for RE mini-grids through private sector approaches.

small economy is based on agriculture, which accounts for about a third of GDP and 80% of employment, along with hydroelectricity exports to India and forestry, although in recent years, ecotourism has also grown in importance.

Access: Bhutan has long recognised and addressed the importance of electrification to cover basic needs and promote economic development, which has been extremely effective and strong[30]. Bhutan set itself the ambitious target to reach countrywide electricity coverage and though the figures on Bhutan's electrification rate vary slightly among different statistics, it is believed that this goal has been largely met as of today. In this context, Bhutan's stakeholders appear to have made their energy choices in favour of large hydropower, centralised and grid-based electricity, which is accompanied by decentralised systems, mainly PV, in areas where centralised systems have not been feasible.

With universal electrification achieved and power generation surplus capacities beyond current demand, Bhutan is currently promoting a shift towards electrical devices for cooking (Palit & Garud, 2011). With more than two-thirds of the country's population reported to benefit from clean cooking energy, the country is ahead of all other HKH countries. Besides electricity-based cooking, the Department of Renewable Energy (DRE) introduced 14,500 cookstoves and 3,102 family-sized biogas plants through a pilot project supported by UNDP until 2016. UNDP also supports the "Sustainable Rural Biomass Energy Project", which focuses on the dissemination of efficient cookstoves.

Energy supply and demand: The all-mountain and all HKH country, Bhutan, has managed to become a net energy exporter by tapping some of its national hydropower energy potential, while still having to import conventional energy sources like coal, gas, and fuel.

Energy governance: The Constitution of Bhutan mandates that at least 60% of the country remains forested at all times (currently 72.5%). Bhutan is one of the few countries in the world with net greenhouse gas sequestration capacity largely due to its vast forest cover and widespread use of hydropower and biomass energy. Bhutan has committed to an ambitious agenda of developing over 10,000 megawatts (MW) of hydropower capacity by 2020 with assistance from the Government of India. In 2011, the Government of Bhutan issued a Draft Renewable Energy Policy to promote alternative renewable energy sources other than large hydropower. The policy aims to diversify the country's energy mix through the use of wind, solar, biomass, as well as small and micro hydropower technologies.

In Bhutan, the energy sector is mainly administered through two ministries, the Ministry of Agriculture (MOA) and the Ministry of Economic Affairs (MOEA). The former is mainly associated with the administration of biomass, while the latter is responsible for policy formulation, planning, coordination, and implementation of conventional energy generation, consumption and exports, and fossil fuel imports. Under the MOEA the Department of Energy (DOE) functions as the Government's policy and planning agency, while the Renewable Energy Division (RED) under the DOE oversees renewable energy development. As the national electricity provider, the Bhutan Power Cooperation is responsible for the rural electrification of the country. The Department of Small Scale and Cottage Industry fosters some productive use initiatives, which have become increasingly important to increase the ability to pay for more cost covering tariffs in rural areas.

[30] Between 2017 and 2019, the GDP of Bhutan is expected to grow by an average of 11.1 % per annum, according to forecasts from the World Bank's Global Economic Prospects, published in January 2017.

Achievements and needs:

Bhutan's stakeholders report that national targets for EE as well as support schemes for RE and EE business start-ups are under development by the Department of Renewable Energy. They also report about the current development of a feed-in and net-metering framework for RE as well as for the availability of loans for RE and EE entrepreneurship.

Bhutan's stakeholders are interested in solar water heaters but put most emphasis on advancing information and data systems. They prioritise awareness creation about RE/EE solutions for their mountain population and see the need to promote the domestic manufacturing of RE/EE and increase its local content in terms of production of RE/EE equipment. These developments may allow for fruitful regional cooperation in view of private sector engagement.

5.1.4 China

The People's Republic of China is the world's third largest country in terms of land area and the largest in terms of population. It shares borders with the following HKH countries: Afghanistan, Bhutan, India, Myanmar, Nepal and Pakistan. The mountainous areas of China account for large portions of its terrain, while the HKH mountain area covers approximately 17%[31]. The mountainous areas feature rich ecological biodiversity, natural resources and cultural heritages.

The strong economic development experienced in China has led to increased rates of urbanisation, even in mountainous areas such as Xinjiang and Tibet. China is, thus, increasingly building on an understanding that the development of mountain areas in a "business as usual" scenario would result in irreversible environmental damage. As a result, it views energy efficiency interventions as the key to sustainable living.

Access: Official sources from China state that full electrification was achieved in 2015, though there is hardly any data available on the specific situation in high altitude areas and for the nomadic or semi-nomadic populations[32]. Today's rate of access to clean energy for cooking is rated at 57%. In 2013, the World Bank pointed out that the cooking energy consumption in the countryside will continue to rely mainly on solid fuels until 2030, if no adequate steps to support stepping up the energy ladder are taken. Coal or firewood dominate traditional cooking in mountain areas. Focusing on air quality and sustainability gains, clean and more efficient cooking fuels and technology is promoted in plateau mountainous cities[33].

Energy supply and demand: China's energy demand and supply situation is characterised by superlatives. Being the world's leading country in power generation from renewable energy, China

[31] Five provinces hosting more than 80% mountainous areas in China.

[32] Between 2001 and 2005, the Township Electrification Programme in China operated by the National Development and Reform Commission, intended to bring renewable electricity to 1.3 million people in 1,000 townships in the Chinese provinces of Gansu, Hunan, Inner Mongolia, Shaanxi, Sichuan, Yunnan, Xinjiang, Qinghai and Tibet. The follow-up programme, the China Village Electrification Programme, aimed to provide renewable electricity to 3.5 million households in 10,000 villages, by 2010. Several reports dating back to 2011 and 2012 stated that the Central Government strongly invested in the sector to bring electricity to the last 500,000 people in the high mountain areas, who were counted to have no access to electricity back in 2011.

[33] Stakeholders reported that clean cookstoves are developing rapidly in China. They explained that the Yunnan Aerospace Industry has developed more than 100 kinds of clean cookstoves, which can reduce energy consumption by 50-60%. There are pilot cities in Gansu, Anhui and other provinces.

is likewise the world's largest emitter of greenhouse gases and consumer of fossil fuels[34]. To improve air quality and meet its climate goals, China is placing increasing effort into becoming more energy efficient. From 2010 to 2015 China reduced energy consumption per unit of GDP by 18%, and CO_2 emissions per unit of GDP by 20%. Today, there are signs of China's energy consumption peaking in 2017, which makes it more realistic to meet global climate targets (Stanway, Doyle 2017). Distributed power generation from renewable energy remains below expectations in China[35].

Energy governance: The energy policy of China, developed by the Central Government, anchors its energy policy intentions in its five-year plans[36]. The recent Thirteenth Five-year Plan (2016-2020) places strong emphasis on biogas, solar and wind power as well as on energy saving and emissions reductions. It sets out support schemes for RE/EE innovations and related business start-ups. The previous Twelfth Five-Year Plan, also placed great emphasis on green energy and induced incentive systems such as the Golden Sun Programme, which provides financial subsidies, technology support, and market incentives to facilitate the development of the solar power industry.

China's Action Plan for the Prevention and Control of Air Pollution, issued in September 2013, is another landmark in China's greening energy approach. China has enacted many policies to standardise renewable energy products, to prevent environmental damage, and to regulate the price of green energy. These policies include, but are not limited to, Renewable Energy Law (2005), the Safety Regulations of Hydropower Dams, and the National Standard of Solar Water Heaters. The Renewable Energy Law explicitly states in its first chapter that the development and the usage of renewable energy is a prioritised area in energy development. In this context, China offers tax reductions on EE measures and RE products.

Institutionally, the Ministry of Energy was dissolved in 1993 after five years of existence due to overlaps in mandates with other governmental entities. Since then, China has been developing its energy sector without a dedicated government agency managing the country's energy portfolio37. In 2010, the National Energy Commission was established, with the mandate to coordinate the overall energy policies of the country. The purpose of this rather new commission is to draft a new energy development strategy, evaluate energy security and coordinate international cooperation on climate change, carbon reduction and energy efficiency.

While standards for energy efficiency design in public and residential buildings already exist, the Government ramped up its work on EE in buildings in mountain areas by founding the China Association of Building Energy Efficiency (CABEE[38]) – Mountain Cities' Building Energy Efficiency and Green Building Union. The newly founded association may be become the main actor on EE in the Himalaya region and focus on buildings and urban planning by developing standards and

[34] Including a large share of coal power, which accounts for approximately 19% of global consumption.
[35] It appears noteworthy that during achieving full electrification, most decentralised renewable off-grid systems, such as MHPs, were shut down when the national grid arrived, despite rules aiming to protect such systems and investments.
[36] These plans include targets on building energy efficiency, green buildings, and energy-saving and emission-reduction, biomass-based energy, solar energy, air heat energy, and shallow geothermal energy to satisfy the needs of cooking energy.
[37] Related issues are supervised by multiple organisations such as the National Development and Reform Commission (NDRC), Ministry of Commerce, State electricity Regulatory Commission (SERC), and so on.
[38] CABEE is a national association approved by the State Council and the Ministry of Civil Affairs of China, administered by the Ministry of Housing and Urban-Rural Development of China (MOHURD). Its fields of activities include green finance, standards and polies, capacity building, and the promotion of viable market solutions and best technique solutions in the building sector.

polices, promoting green retro-fitting, disseminating new technologies and solution, and setting up international cooperation platform[39]. Energy efficiency in rural areas will be another focus of CABEE.

Achievements and needs: The Silk Road Economic Belt, also known as the Belt and Road Initiative (BRI) focuses on connectivity and cooperation between Eurasian countries, primarily the People's Republic of China (PRC), the land-based Silk Road Economic Belt (SREB), as well as the Maritime Silk Road (MSR). The strategy underlines China's push to take a larger role in global affairs. Besides trade and manufacturing goals, the new silk road should foster, among other goals, global investment in renewable energy from which the HKH region may benefit through HCREEE as three out of six land-based corridors interconnect HKH countries[40].

Chinese stakeholders offer intensive experience in EE. China is the only HKH country that has taken up the issue of EE in mountain buildings sufficiently. Stakeholders are interested in more distributed RE power systems as well as in advancing bio-energy. Intensified use and know-how on solar water heaters ranks high for stakeholders too. Overall, they still see a lack of awareness of decision-makers on feasible RE and EE solutions. According to stakeholders, financial obstacles, local manufacturing challenges, technology issues, market and trade obstacles, and gender issues do not require more attention since there has been strong progress.

5.1.5 India

The Republic of India is the second most populous nation in the world and the world's largest democracy. India is a union of 28 states and seven centrally administered territories. It consists of the entire Indian Peninsula and portions of the Asian mainland including parts of the HKH. This huge country, borders Afghanistan, Bangladesh, Bhutan, China, Myanmar, Nepal and Pakistan; and thus, all HKH countries. The Himalaya in the north feeds the river-plain region and consists of flat lowlands crossed by three great river systems – the Indus, Ganges and Brahmaputra. This area is the most fertile and densely populated part of India.

Access: At the village electrification level, more than 99% (DDUGJY, 2017) of villages (590,278 out of 597,464 villages) in India have been connected to the main grid as of 31 December 2016. However, the arrival of the national grid does not equate to effective and efficient household electrification. Following current World Bank statistics, around 21% of the rural Indian population lacks access to electricity. Other sources mention up to 33% of the rural population as indicated in Figure 16. Even where household connections are installed, the lack of access to reliable power supply encourages people to use temporary diesel-based or solar solutions.

[39] Its leadership (president) will be rotating from each province; the first one is the Chongqing Association of Building Energy Efficiency that boasts great achievements in EE for mountainous areas.
[40] China-Central Asia-West Asia Corridor, China-Pakistan Corridor, and the China-Bangladesh-India Corridor.

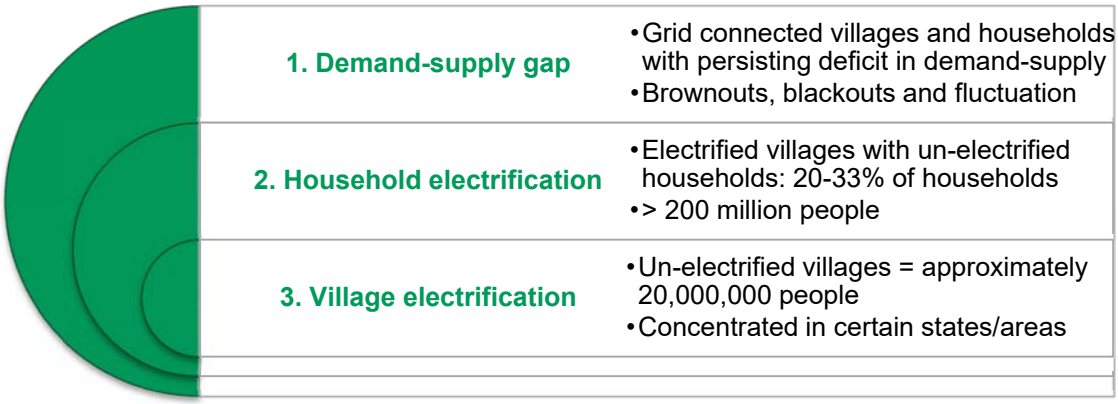


Figure 16: Electrification Gap in India

While progress in electrification has been made in India, access to clean cooking energy has been stagnating in recent years. Subsidies for LPG have been found to disproportionally benefit middle and high-income households, as well as the urban population. Indian mountain states have also been involved in the launch of induction cookstoves. However, studies conclude that they have largely replaced LPG in middle-income households, with little impact on the fuelwood consumption of poorer rural households.

Energy supply and demand: The tremendous backlog in generation capacity additions, inefficient transmission and distribution (T&D) infrastructure, and electricity tariffs that remain below generation cost and the levelized cost of electricity (LCOE) hamper the effective electrification of rural areas. Though India has great renewable energy potential, electricity is still predominantly generated through traditional, non-renewable resources, of which coal plays a major role.

Energy governance: The Minister of Power announced in 2016, that the national ***24/7 Power for All*** campaign would achieve electrification of all Indian villages by 2019 (Power for All, 2017). The main electrification initiative is the grid-based Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY, 2015) which includes 921 projects to electrify more than 1.2 million non-electrified villages and improve electricity reliability to nearly 6 million partially electrified villages in the mountainous provinces of Sikkim, Jammu and Kashmir, Himachal Pradesh, and Uttarakhand[41].

The Rural Electrification Corporation is attached to the Ministry of Power and functions as the nodal agency for the implementation of DDUGJY. It is complemented by a financial support scheme for the electrification of remote, non-electrified villages in areas where grid-extension is either not feasible nor cost effective. The latter support is provided by the Ministry of New and Renewable energy (MNRE). Below these ministries, federal institutes such as the National Institute of Solar Energy (NISE), the National Institute for Wind Energy (NIWE), the Sadar Swaran Singh National Institute of Bio-Energy (SSS-NIBE), and the Solar Energy Corporation of India (SECI) are attached and process the more operative levels below policy making.

Financial support for the implementation of utility-scale RE and EE programmes is made available through IREDA, which is a non-banking financial institution, set up by the Government of India in

[41] It followed the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) programme, which was launched in 2005 as the first rural electrification flagship initiative.

1987 with the mission of promoting self-sustaining investment in RE, EE, and environmental technologies for sustainable development. This leading financial institution in RE and EE is increasingly entering the decentralised energy market (rooftop solar, as well as RE mini-grids).

In the federal system of India, nodal agencies and line ministries at the federal level cooperate closely with state level institutions such as the Jammu and Kashmir Energy Development Agency (JAKEDA), the Ladakh Renewable Energy Development Agency (LREDA), and the Kargil Rural Electrification Development Agency (KREDA). At the federal level, the MoP together with the MNRE assume responsibility for energy supply, RE, and rural electrification as nodal agencies.

The Clean Energy Access Network is an all India representative organisation, launched in 2014 with a clear mandate to support, unify and grow the decentralised clean energy sector in India. It aims to bring together diverse stakeholders across India and is working to improve energy access for the rural and urban poor and to create an inspiring model for others to learn from.

India generally, but its HKH region in particular, benefits from a broad spectrum of larger and smaller non-governmental organisations, such as:

- The Ladakh Ecological Development Group (LEDeG) focuses on the distribution and promotion of solar cookers, MHP and PV mini-grids[42]
- The R&D-oriented, Himalayan Environmental Studies and Conservation Organisation (HESCO), has developed and installed advanced watermills, bringing basic electrification to 2,000 villages in the HKH
- The India-based Pan Himalayan Grassroots Development Foundation, has been involved in the installation of household-level biogas units in Uttarakhand and Himachal Pradesh
- The NGO Avani, promotes charcoal as a cleaner cooking fuel and operates a Bio-Energy Programme, in which electricity is generated using pine needles

Achievements and needs:

Indian stakeholders place emphasis on small and large hydropower as well as decentralised power systems (RE mini-grids and SHS). Some mountainous areas of India are already at an advanced stage of electricity access. In Himachal Pradesh (98%), in Uttarakhand (87%), and in Jammu and Kashmir (79%) of households have power connections. These states offer promising potential for small and large hydropower and its grid integration, which is another topic of importance (including other variable RE sources).

Larger un-electrified “pockets” can, however, be found in the states of Arunachal Pradesh and Assam in the HKH mountain region. Work on decentralised RE there requires adjustment to the frameworks and business models developed for India’s plains, to be impactful in challenging mountain environments. Stakeholders also expressed a need for up-to-date data and spatial modelling/planning for off-grid applications.

5.1.6 Myanmar

The Union of Myanmar’s topography is challenging. Three parallel chains of mountain ranges, the Western Yoma or Rakhine Yoma, the Bago Yoma, and the Shan Plateau, originating at the eastern

[42] With support from India Canada Environment Facility (ICEF), Ministry of New and Renewable Energy (MNRE), Ladakh Autonomous Hill Development Council (LAHDC) and people of Durbuk block.

end of the Himalayas, run from north to south across the country. Myanmar shares its borders with 3 HKH countries: China's Yunnan province to the east, Bangladesh to the west, and India to the northwest. Around half of the national territory of Myanmar lies within the HKH mountain area, home to a quarter of the country's population. Myanmar's lowlands, river banks and delta areas, which are extremely fertile and economically critical, are more densely populated than other regions[43].

Myanmar's political situation is as challenging as its topography. The country is organised into seven regions and seven states, many corresponding to the traditional homelands of the larger of Myanmar's 130+ distinct ethnic groups. Myanmar also has several longstanding ethnic insurgencies. Following the recent transition towards more democracy, Myanmar aspires towards social inclusion, which requires restoring the prosperity of the "Golden Country". Social inclusion and development is particularly important for Myanmar's long neglected rural dwellers.

Access: Access to clean cooking energy is virtually non-existent in Myanmar's rural areas with a national mean access rate of only 9%. Official statistics suggest that at least 70% (while others quote 84%) of the rural population remains without access to electricity, representing one of the lowest rates of electrification in Southeast Asia and perhaps, even globally. Only 30% of Myanmar's rural population is believed to benefit from electricity. Myanmar practitioners in village electrification developed a strong Community of Practice in the field of micro hydropower and biogasification over the last decades, which may not be adequately reflected in national statistics. Several thousand micro and mini-hydropower systems have been installed, particularly in Shan state; while bio-gasifiers are more popular in rice growing areas in the Irrawaddy delta region.

Energy supply and demand: Myanmar is expanding access to electricity at a strong pace and is confronted with rapidly growing electricity demand in its existing network. At present, approximately 5,300 MW of capacity is attached to the national electricity network with an effective peak capacity of 3,010 MW. The demand in the network is expected to double within the next decade and to double again in the following decade. Hydropower is the dominant source of electricity in Myanmar, representing a total share of approximately 61% of the total energy mix in power generation. Natural gas accounts for a further 35% of the energy mix for power generation. Coal and diesel play a minor role, each with 2%.

The development of large hydropower systems has been suspended following the peaceful power transition in view of their potential environmental impact as well as cross-border investments and the obligations involved therein. Myanmar is also rich in natural gas but bound in long-term export contracts, which represent one-third of the country's exports overall. This has contributed to the fact that 65% of the primary energy supply consists of biomass energy, used almost exclusively (97%) in the residential sector – with devastating impacts in terms of deforestation.

Energy governance: The Union of Myanmar is currently placing high priority on electrification, especially in rural areas. It is committed to achieving 100% electrification by 2030 by participating in the SE4ALL initiative. The constitution of Myanmar as well as the Electricity Law (2014) divides the responsibility of licensing power supply systems between the Union Level, where the Ministry of Energy and Electricity (MoEE) oversees generators above 30 MW. The Ministry of Industry defines standards and conducts inspections regarding their adherence to safety features. The Department of Research (DRI) is assigned with technical questions regarding RE systems.

[43] The country has three major river systems – the Irrawaddy (Ayeyarwady), the Sittang, and the Salween (also known as the Thanlwin in Myanmar), of which the Irrawaddy is the longest at about 2,170 km.

The Electricity Supply Enterprise (ESE), the Yangon Electricity Supply Corporation and the Mandalay Electricity Supply Corporation (MESC), operate the transmission and distribution network procuring power from state-owned facilities and IPPs as well as through Build Own Transfer Joint (BOT) Venture contracts[44]. States and Regions can issue licenses for systems below 30 MW if they are not connected to the national grid.

The Government has also developed the ambitious National Electrification Plan (NEP)[45]. Blended with International Development Assistance (IDA) funding for electrification, NEP comprises two components. The on-grid component is implemented by MoEE and the off-grid component by the Department for Rural Development at the Ministry of Agriculture, Livestock, and Irrigation (MoALI):

- **Component 1**: Grid extension (IDA USD 300 million), implemented by the NEP-Project Management Office (PMO) of the MoEE/DEPP.
- **Component 2**: Off-grid electrification (IDA USD 80 million), implemented by the NEP-PMO at the MoALI/DRD.

In addition to NEP, the predecessor Government also issued the National Energy Policy (2014) as well as the current version of the Electricity Law. Both were developed in view of utility-scale projects for centralised grid electrification and, thus, set challenging barriers for small-scale power systems, which often remain informal. The National Energy Policy of 2014 as developed by the National Energy Management Committee (NEMC) encompassed all energy sector branches, however, following transition, many inter-ministerial committees including the NEMC were dissolved and the above-mentioned policy, laws and plans are currently under revision.

The Renewable Energy Association of Myanmar (REAM) represents the interest of decentralised power producers. It supports the Small Hydro Power Association of Myanmar (SHPAM) as well as, the recently created, Bio-Gas Association.

Achievements and needs:

RE mini-grids, which have a strong track record in the country and enjoy highest priority in Myanmar and are followed by grid-based electrification and solar home systems high (almost equal), The surprisingly high level of acceptance of SHS might be reasoned in the large dissemination programme under the National Electrification Plan (NEP), which is supported by the World Bank and other IDA actors[46]. Myanmar's stakeholders are particularly interested in support of small and medium-sized hydropower solutions.

5.1.7 Nepal

Nepal is a landlocked, all mountainous country situated between India and Tibet, and fully located within the HKH mountain region. It hosts eight of the ten highest mountains in the world in its mountain belt, while most of its arable land and half its population are concentrated in the southern

[44] Foreign investors are required to set up joint ventures with domestic companies. Licences for large scale power systems are subject to renewal and will finally be transferred to the government.
[45] The NEP earned criticism for ignoring Myanmar's local renewable energy resources (hydro power and bio-energy) by suggesting a 99% coverage of the national grid - based on large hydro and other utility scale projects as the cheapest means for rural electrification along with SHS. Mini-grids are viewed as a temporary solution until grid arrival.
[46] Benefiting from experiences made elsewhere in the region, it ensures better quality and reasonable capacities (60 W minimum), which are generally appreciated, although critics in the delivery mechanism exist (80% grant-based).

region known as the Terai, an extension of India's Ganges Plain. The majority of Nepal's fast-growing population depends on farming and other agricultural activities. Nepal faces serious socio-economic problems and the country remains one of the poorest in Asia. Political stability appears to have increased after completing the political transition from an absolute monarchy to a multi-party democracy.

Overcoming a decade of internal conflict, the "Gorkha earthquake" which struck with a maximum Mercalli Intensity of IX (violent) killed nearly 9,000 people in April 2016. This resulted in a strong set-back for Nepal's economic recovery and infrastructure development, following adoption of the new constitution in 2015. Today, Nepal is undergoing a decentralisation process, which may support improved governance to mobilise public revenue and private investments for infrastructure, which is urgently required.

Access: The World Bank statistics publish an electrification rate of 85% for 2014 because of an incremental increase in access to electricity in the decade before (27% in 2000). This, however, might not fully reflect the actual situation in mountainous areas as the quality of supply and data processing appear to be challenging[47]. Nepal's extreme mountain geography in the north makes it hard to reach remote communities with centralised infrastructure, as well as to carry out economic activities beyond subsistence agriculture.

Nepal virtually lacks fossil fuel resources. Approximately 85% of the country's primary energy consumption is derived from fuelwood, agricultural waste and animal dung. Cooking energy needs are grossly met by such sources. As a result of the continued pressure on biomass fuel stocks, deforestation represents a major problem and the Government of Nepal intends to meet 10% of such demands through biogas.

Energy supply and demand: More than 90% of the total electricity generated in Nepal is derived from hydropower plants. While Nepal has enormous hydroelectric generation potential – it is believed that up to 40 GW could be economically feasible for development – very little has been exploited to date. The level of effective consumption of modern energy is supressed at relatively low levels compared to other developing countries in the region. Demand, however, is growing rapidly[48], which is to some extent met through increasing cross-border electricity trade with India.

The national grid reportedly serves only a fraction of those counted to have access to electricity and their average electricity supply is often less than eight hours per day, with load shedding accounting for up to 16 hours during winter. Beside the national grid, thousands of small installations (diesel gensets, solar home systems, small island mini grids, etc.) are being used in Nepal and many citizens in remote areas are accustomed to meeting their energy needs with biomass, human labour, and small quantities of kerosene.

Energy governance: Nepal's Energy Policy, adopted in 2006, places emphasis on decentralised rural energy (electricity and thermal energy) for poverty reduction and environmental conservation by ensuring access to clean, reliable and appropriate energy. In 2016, the Renewable Energy Policy was adopted with the goal to encourage poor households to use renewables by providing

[47] The quality of electricity available in the national grid but also from decentralised power systems often qualified only for Tier 2 or 3 of the SE4ALL scale, meaning that electricity is only available for a few hours per day, which limits its productive uses. Secondly, the remaining data gaps in statistics may not be up-to-date nor precise due to the way in which they are counted and maintained.
[48] Electricity consumption of the national utility is said to increase at a rate of approximately 9% per annum.

subsidies for their deployment. Eligible applications include mini/micro hydropower, improved water mills, solar energy (home systems, mini-grids, grid connected), biogas, biomass energy, wind energy and wind-solar hybrids.

In 2003, the renowned Micro-Hydro Village Programme and the Rural Energy Development Programme were established. Both programmes intended to increase electricity access to rural areas in the remote villages of Nepal, using renewable energy sources. Subsequently, two institutions took over responsibility in the field of rural electrification:

- The Nepal Electricity Authority (NEA) is a vertically integrated power utility under the Ministry of Energy. It acts as the sole purchaser of electricity from all IPPs and as the agent for all power purchase agreements for energy exchanges with India. It also operates the transmission system and provides end user services
- The Alternative Energy Promotion Centre (AEPC), founded in 1996, is a semi-autonomous institution formally attached to Ministry of Population and Environment (MoEST). It is responsible for the deployment of renewable energies and acts as an intermediary institution between the operational level, project developer and decision-making levels. It is responsible for the delivery of subsidies and financial assistance for off-grid rural electrification and is active in the promotion of improved cookstoves

Beside the MoE and MoEST, the Ministry of Industry is tasked with overseeing energy efficiency audits and efforts in the industrial sector; while the Ministry of Forest and Soil Conservation (MoFSC) is relevant in view of bio-energy, sustainably forestry and conversation.

Achievements and needs: Several authors have written in a critical manner about the efficiency of Nepal's state agencies. However, these agencies have also demonstrated best practices in certain sectors and fields of activities, such as the development of the decentralised MHP sector as well as community based on-grid electrification (see below). AEPC is currently undergoing a decentralisation process aligned to the new constitution, while NEA approaches its technical inefficiencies through the Nepal Energy Efficiency Programme (NEEP - supported by GIZ).

Best practice: **Community Rural Electrification Programme in Nepal***:* The Community Rural Electrification Programme (CREP), a grid-based rural electrification programme significantly contributed to rural electrification in Nepal. The community involvement was aimed to bring in operational efficiency in the distribution sector. Consumer associations, typically in the form of village cooperatives, took up the responsibility of managing, maintaining and expanding the rural distribution of electricity, and investing approximately 20% in terms of cash and in-kind support to the distribution network. Reportedly, more than 230 cooperatives have entered into agreement with NEA for electricity distribution (*Palit & Chaurey, 2011)*

Box 2: The Community Rural Electrification Programme, Nepal

Nepal's stakeholders express balanced needs across most intervention areas, though they place special emphasis on the issue of grid-connected RE and the exploration of geo-thermal power resources. Stakeholders expressed little need for solar home systems or institutional solar systems – they perceive economic and financial barriers as the main reason for the endemic issue of energy poverty in mountain areas.

5.1.8 Pakistan

The Islamic Republic of Pakistan borders with several HKH countries: Afghanistan to the north and northwest, China to the northeast, and India to the east and southeast. The 2,900 km Indus River is Pakistan's dominant geophysical feature – it rises from glacial melt in Tibet, flows through India's Jammu & Kashmir state and enters Punjab about 800 km from its source. It then flows northwest towards Gilgit, where it turns and flows in a south-westerly direction to the Arabian Sea[49].

Pakistan's terrain is extremely varied. In the far northwest near the Chinese border is K2, the world's second highest peak. Khyber Pakhtunkhwa is one of the four administrative provinces of Pakistan, located in the north-western region of the country, where it shares its international border with Afghanistan. Khyber Pakhtunkhwa was known as the North-West Frontier Province (NWFP) until 2010. It hosts a variety of ethnic groups and was infamously known for its poor security situation, which has improved substantially in recent years.

Punjab hosts the Islamabad Capital Territory and much of the country's fertile farmland on the upper plains of the Indus Valley. West and south of the Indus Valley, the country rises to the Balochistan Highlands and the famed Khyber Pass, through the Safed Koh mountains towards Afghanistan – a major regional transit point for centuries, and one with rugged tribal areas marked by insurgencies throughout the last two decades.

Access: Pakistan ranks second among the HKH countries in terms of energy access, with only a tenth of the rural population reported to have no access to electricity, though numbers might vary severely depending on the literature sources reviewed. The plain areas of Pakistan may be considered as electrified, while the KPK (Khyber Pakhtunkhwa province) still suffers from both a lack of access to electricity as well as poor quality power supply among a majority of decentralised MHPs.

Energy supply and demand: Historically, but even more after the depletion of its domestic gas resources, Pakistan has been highly dependent on conventional energy sources, especially coal, to cover their energy demands. Artificially low retail tariffs in conjunction with fast population and economic growth has strained Pakistan's electricity supply network as well as public spending, resulting in frequent brownouts and blackouts, even in major cities such as Karachi, contributing to what is labelled as "rotating debt".

Hydropower plays a vital role in the country's energy mix. Three GW installations, around 30 mid-size and numerous small hydropower plants generate a combined total of approximately 59 GW per year. A vast number of micro hydropower systems have been installed in mountainous regions over the past decades, however, research suggests that most MHPs only reach 50 to 60% of their intended capacity and provide inadequate supply quality, which discourages the use of electricity for productive uses.

Energy governance: Until very recently, the energy sector of Pakistan operated under the overall supervision of the Ministry of Water and Power. However, in August 2017, the Ministry was divided into the Ministry of Energy that includes two constituent divisions (the Power Division and Petroleum Division) and the Ministry of Water Resources.

[49] Starting in the 1930s, the Indus and its major tributaries including the Chenab, Jhelum, Ravi, and Sutlej rivers were extensively developed and modified with numerous barrages, diversions, and canals for irrigation and hydroelectric power production. Water rights issues associated with the Indus and its tributaries have long been a source of political friction with India. The status of the Jammu and Kashmir region is yet another matter of dispute.

In the electricity sub-sector, the National Electric Power Regulatory Authority (NEPRA) is responsible for regulating the electricity supply in Pakistan. Furthermore, the Pakistan Electric Power Company is responsible for overseeing the affairs of all the Distribution Companies (DISCOs), Generation Companies (GENCOs), and the National Transmission Dispatch Company (NTDC). NTDC acts as the central power purchasing agency for the procurement of power from the GENCOs, hydropower plants and IPPs, on behalf of the DISCOs.

The most important public institutions relevant to the HKH mountain region are the Pakhtunkhwa Energy Development Organisation (PEDO) in KPK province, the GB Power Development Board in Gilgit-Baltistan, and the Hydroelectric Board of the Azad State of Jammu and Kashmir. The Private Power and Infrastructure Board facilitates and provides oversight to private sector initiatives, mostly in the form of IPPs.

Another key public-sector institution is the Alternative Energy Development Board (AEDB) which is the federal representative agency responsible for the promotion for renewable energies in the country. The AEDB focuses on developing renewable energy systems and services in remote areas via engagement of the private sector. A key initiative under its umbrella is the Renewable Energy Policy for Pakistan.

The main non-governmental organisations active in the energy sector in the HKH region of Pakistan is the Sarhad Rural Support Programme (SRSP), National Rural Support Programme (NRSP), and the Aga Khan Rural Support Programme (AKRSP). All three organisations have been operational for a long time in the region and are in many ways, linked to all major RE and EE initiatives in the HKH region of Pakistan[50].

In terms of on-going or upcoming RE initiatives, the Government of KPK has a vision to develop 1000 Mini-Micro HPPs. Under this initiative, PEDO is already implementing 356 projects in various districts of KPK, whereas the remining 672 projects are to be developed in the upcoming “Access to Clean Energy Programme” supported by the Asian Development Bank. Furthermore, under the project “Development and Usage of Hydropower and Renewable Energies in Khyber Pakhtunkhwa”, INTEGRATION Environment and Energy is supporting KfW in the realisation of 96 PV pico/mini-grids and eight micro hydropower plants.

With regards to EE, the National Energy Efficiency and Conservation Authority is the main governmental institution responsible for EE activities across the board. One of its major achievements is the recently passed National Energy Efficiency and Conservation Act, 2016, which calls for the establishment of institutions and mechanisms for enhancing EE activities in various sectors across the country[51].

Finally, the current and future energy scenario in Pakistan is expected to be highly linked to the China-Pakistan Economic Corridor (CPEC), which is planned to pass through the HKH region of the country. While some RE initiatives have been announced, the CPEC is still a very opaque programme with little or no initiatives announced to target off-grid regions in the relevant areas.

[50] Considerable challenges with regard to quality aspects in implementation were found in their vast MHP projects (AKRSP 2012a; 2012b).

[51] In terms of projects, the Renewable Energy and Energy Efficiency (REEE) programme by GIZ is one the few initiatives aiming to target EE issues in SMEs and other areas such as cooking, etc. While there are other ongoing international and national programmes on EE, there is a general lack of focus of such activities on the remote areas in the HKH region, which therefore presents huge potential for further development.

Achievements and needs: The reputation of RE mini-grids may have suffered from decades of implementation of micro hydropower stations in which insufficient learning in terms of implementation quality was achieved. Only in recent years, key actors, such as the Pakistan Poverty Alleviation Fund (PPAF), have adopted new quality criteria for both, micro hydropower and the emerging solar mini-grids.

Pakistani stakeholders prioritize interconnected RE mini-grids in remote regions as an important field of activity to reduce exclusion to electricity access and to make existing systems more sustainable. Strong preference is given to the development of mini-hydro power for the HKH region. Stakeholders also rank grid-based electrification as a priority above solar home systems, followed by RE mini-grids, which is an untypical pattern in the region.

6 Mountain Energy and its Associated Challenges

The analysis of policies and trends within different HKH countries reveals, that the energy concerns of the HKH mountain region are often decoupled from national and regional developments, do not keep pace with national-level energy development, or even fall short due to fragmented and challenging markets in politically and economically distant areas. It therefore comes as no surprise, that the HKH mountain area falls behind average energy access rates in Asian countries, since regional differences and even differences within countries, can be very pronounced.

Energy poverty is often linked with multi-dimensional development issues, such as poor socio-economic development, relative/absolute poverty, and to some extent, the political and economic isolation or marginalisation of minority groups and/or more remote, distant regions. Indeed, these are akin to many of the issues the Sustainable Development Goals set out to address. While many of these multifaceted development challenges are structural, static and persistent for decades, there are signs of potential progress in relation to energy and energy poverty, as a result of the dynamism and diversity of actors involved in the energy sector and the advent of more decentralized technological solutions.

The following chapter explores the nature of energy poverty in mountain areas of the HKH region and elaborates its embeddedness in climate change issues as well as its nexus challenges. It is based on an analytical desk review of approximately 150 sources of literature and aims to assemble the key streams of thought that represent the current debate on energy poverty and energy access in the HKH mountain region[52]. It, thus, narrows down the perspective from regional energy profiles (Chapter 5) and country-specific circumstances (Chapter 6).

6.1 Energy poverty

Worldwide, around one billion people are excluded from access to reliable electricity, and more than three billion lack access to clean cooking facilities and suffer from severe energy poverty[53] – they mostly reside in the rural areas of Africa and Asia. In energy-poor regions, communities and households are usually disconnected from affordable and reliable electricity networks or systems, to meet their basic energy needs. Even fewer people have access to clean, modern cooking energy, relying instead on firewood, coal, charcoal or animal waste, to cook their meals and heat their homes. While the international community now acknowledges the severity of the energy challenge, as reflected in 2030 Agenda for Sustainable Development, where it states under the SDG 7 that until 2030 all people shall have "*access to affordable, reliable and modern energy services*"[54], the specific hardship of energy poverty in highlands and mountainous regions with harsh climate conditions has not received sufficient attention, neither politically nor in global public policies.

[52] We have included references only where we understand that specific perspectives may not represent the body and canon of knowledge or where direct quotes from published sources were made.
[53] "inability to keep home adequately warm
[54] United Nations Department of Public Information (2016).

6.1.1 Environment and population

The HKH mountain area covers an extensive territory separating the Indian subcontinent from the Tibetan Plateau. The HKH mountains form a unique ecosystem due to their vast ecological diversity, distinct landscapes, natural conditions and climate zones, and is home to numerous different ethnicities, cultures, languages and social realities. Approximately 400 million people in HKH countries still lack basic access to electricity and rely on traditional biomass fuels for cooking. The population density drastically decreases in the high mountain areas, where people are confronted with challenges and natural limitations such as lacking infrastructure, inaccessibility, and a comparably low electrification rate. Around 190 million people reside in the HKH mountain and hill terrain, though only 53% of the region's population lives above 1,000 m.a.s.l (including cities like Kabul and Kathmandu) and 23% above 2,000 m.a.s.l.

A great portion of the high mountain population live in small rural communities or widely scattered households and suffer from severe poverty and marginalisation. Even though seven of the eight HKH mountain countries rank in the middle-field of the Human Development Index, they fall far behind in terms of electricity access and are even worse off in terms of access to clean, modern cooking energy. The HKH, housing 9% of the population of the HKH countries, has low access to electricity; while energy needs for cooking, space heating and water heating are largely met by biomass. Over 80% of rural households in all HKH countries are deprived of modern energy for cooking (IEA and World Bank 2015). Since centralised energy infrastructure is often not a viable option, decentralised and mobile energy solutions are required in mountain areas, particular in the rangelands which occupy over 60% of HKH's geographical area (Sharma, 2009).

6.1.2 Energy resources and utilization

Despite the abundant primary energy supply options available in mountain areas, a lack of access to modern energy prevails. The HKH comprises 20% forests, 15% shrub lands, and 39% grasslands (Schild, 2008) and is known as the 'water tower' of Asia, whose hydroelectricity generation potential is estimated to be more than 500 GW (Vaidya, 2012). Hydroelectricity can meet a large part of the present and future electricity demand in the HKH countries. Where hydroelectricity is tapped, it often deprives mountain communities from access to it, and it also externalizes its social and environmental costs on the same marginalised communities.

A realistic assessment capturing the underlying demand and supply patterns and trends has not been carried out in the HKH mountain areas since Rijal (1999), covering China, India, Pakistan and Nepal. There is still little knowledge about actual energy needs, existing supply and suppressed demands, since energy-related data specific to the HKH mountain area is scarce and unavailable, implying that national level data serves as a potential entry point. Energy demands in the HKH mountain area are, however, shaped by myriad factors, mainly related to specific biophysical and socio-economic contexts. The mountain-specific characteristics of inaccessibility, fragility and marginality, combined with the 'isolated enclave' (Papola, 2002) nature of mountain economies and communities, leads to different manifestations of energy demand patterns and trends in which basic energy needs are still poorly met by modern energy services and productive demand remains supressed.

An important characteristic of the household energy use in the HKH mountain area, as opposed to the HKH countries as a whole, is the heavy dependence on traditional biomass fuels (wood, agricultural residues and animal dung). For example, around 90% of the cooking energy needs in

the rural areas of India are met through traditional sources of energy (Misra et al. 2005). In Bhutan and Nepal, countries wholly under the HKH mountain region, more than 85% of the total domestic energy needs are met through traditional fuels. All studies underscore that the extraction of fuelwood exceeds its sustainable supply.

6.1.3 Fundamental causes of energy poverty

'Energy poverty' is widespread in the HKH mountains - in rural and remote areas, as well as in peri-urban and urban areas. This is due to the high energy intensity of the region and the need for appropriate technology and materials for the energy efficient use of supply resources. That energy poverty remains a persistent problem in most higher altitude areas is a consequence of lacking national infrastructure and policy attention. This reinforces itself because of prevailing socio-economic hardship and poverty. Often, non-cash based economic systems limit the ability to pay on the demand side.

In the context of this BNA, the following broader definition of 'energy poverty' has been utilized:

"As a dimension of multifaceted concept of poverty, energy poverty in its broadest term has been defined as the absence of sufficient choice in accessing adequate, affordable, reliable, high quality, safe and environmentally benign energy services to support economic and human development" (Reddy 2000).

Further operationalization and common understanding of the concept of 'energy poverty' will be required to allow for tracking progress towards reducing it. In the context of the HKH region, it is recommended to develop a holistic approach which takes access to energy services to satisfy basic energy needs (e.g. lighting, cooking) as well as energy efficiency aspects (e.g. to maintain warm homes) into account.

Box 3: Working Definition of Energy Poverty

Providing affordable and reliable energy to a widely scattered population in mountainous regions is a complex challenge, considering that the often-impoverished mountain population lives under extreme climatic conditions in remote and difficult to access landscapes, far away from national infrastructure (electricity grid, gas-pipelines and ports). Sparsely populated areas are often only accessible by roads in poor conditions, which leads to a high opportunity cost for the private sector, who as a result, rends to prioritise investments in more industrialised and densely populated areas.

While dedicated policy support is greatly required, remote mountainous areas often receive insufficient attention, and are often marginalised in national policy making, regulations and infrastructure development, which predominantly focus on economic centres, fertile plains and densely populated areas. Remote mountain people are not necessarily discriminated due to their affinity to smaller ethnic groups, but increasingly, because they are insufficiently visible and represented in national discourses and data efforts, which again reinforces their marginalisation.

6.1.4 Infrastructure and policy solutions

Rural mountain communities are unable to be served at least cost through traditional infrastructure approaches, such as the extension of national grids. This calls for alternative approaches. While the mountainous HKH region is rich in resources for renewable energy and favourable for decentralised solutions using energy resources sustainably, national politics and traditional approaches

to centralised infrastructure development often neglect such opportunities[55]. Each national government follows different strategies, has different capacities for rural development, and is confronted with its own regional challenges (see Chapter 6). Thus, adopted solutions for the HKH region need to be mountain-specific, with appropriate financial incentives and support schemes. Though some schemes do already exist in the majority of HKH countries, many authors criticise that these are often misused, create systems with little accountability, or do not meet the actual needs of their intended target group[56].

Sharing experiences on a regional basis can thus be the key to improving both national political agenda and incentive models to promote the people's ability to invest in renewable energy technology and energy efficiency schemes. However, affordability considerations and suitable financing mechanisms for the adoption of technologies and smart subsidies on fuels (while avoiding displacement of fuels in other sectors) still lack professionalization and sustainability among HKH countries[57].

6.2 Climate change and environmental externalities

Access to modern energy is crucial for water, food and livelihood security; and to reduce the vulnerability of mountain communities to the impacts of climate change. Traditional, non-renewable or non-sustainable energy sources can only play a limited role in addressing energy poverty and increasing energy security in mountainous regions - the vulnerable ecosystem of the HKH mountain range is already under massive stress due to the impacts of local deforestation and is increasingly exposed to extreme weather events caused by climate change.

Though climate change is a pressing issue for all world regions, its impact on the HKH region is of special concern. While the global warming of surface temperature, in general, was measured to be around 0.75 °C within the last 100 years, the Himalaya region experienced an average warming of 0.6 °C per decade. In a scenario study, Beldring (2011) estimated that the region's temperature will rise by at least 1.4 °C until 2050 and between 2.5 °C to 4.9°C until 2100. He summarises the effects as follows:

> *"Increasing concentrations of greenhouse gases in the atmosphere changes the radiation balance of the earth-atmosphere system, resulting in increasing ground temperatures and changes in cloud cover, precipitation, air humidity, radiation, wind and other meteorological elements. These changes will lead to changes in the land phase of the hydrological cycle with impacts on glacier mass balance, snow storage, soil moisture in the unsaturated zone, groundwater storage, evapotranspiration and runoff (ibd.:5)*

[55] Likewise, liquid fuels with high energy content may not be affordable to rural dwellers with local livelihood strategies based on subsistence agriculture and little monetary income. Besides these concerns about the environmental sustainability of energy sources such as fuel, gas or coal, traditional energy resources are also hardly accessible to the local population due to high prices and long distances to the nearest supply centres.

[56] When establishing mountain-specific incentive models, users' perspectives and experiences matter, requiring specifically tailored solutions supporting them where it is most needed.

[57] Many HKH countries also provide subsidies on electricity. However, they deprive the mountainous population in two ways: First, by not giving them access and, second, by artificially increasing energy demand which is largely met by large hydro with negative impacts on the mountain ecosystems.

6.2.1 Energy and adaptive responses to climate change

Mountainous regions in general and its glaciers are fragile ecosystems. A substantial rise in temperature results in major glacial melting, irreversible glacier loss, rising water streamflow, and flooding in the next decades before water flows will be reduced for the foreseeable timeframe. For the next two to three decades, Beldring predicts changing rainfall cycles, an increased flood hazard, and massive glacial melting; and beyond this timeframe, decreased river flows as glaciers recede, with devastating water scarcity[58].

The prevailing dependence on fuelwood has a direct effect on the fragile mountain ecosystem. Through deforestation, the mountain population places high pressure on the dwindling forest resources, aggravating land degradation, especially in the higher mountain areas where plant growth and recovery are slow. The HKH mountains form a diverse and highly complex, though vulnerable, ecosystem, with unique flora and fauna, extreme climatic conditions, and massive glacier formations. Climate change is now placing additional stress on this complex ecosystem, and already exhibiting early impacts in high-altitude, mountain areas.

The need for secure, reliable and sufficient access to modern energy, together with advanced building materials and technologies ranks high amongst the adaptation needs to reduce impacts in increasingly hot periods in summer, with heavy rainfalls, while providing advanced shelter against harsh winter conditions. Increasing the resilience of rural communities against climate change also reduces the cumulative impacts of climate change and deforestation to the entire population located in the region of Central, East, South-East and South Asia – who are inter-dependent in terms of their water and energy security sources (see the following Section).

6.2.2 Climate change mitigation aspects

Glacial melting is further accelerated regionally by clouds of short-lived climate pollutants (SLCP), especially black carbons, largely stemming from the industrialised South Asian Plains and central China, but even from as far as the Middle East. Black carbon is a product of incomplete combustion, usually produced when biofuels and fossil fuels are burnt inefficiently. SLCPs are transported as an aerosol into the HKH mountain region, where it rains off, leaving a carbon coat (darker shade) on the snow and glacier surfaces. This leads to an increase in heat absorption from the sun and ultimately results in an accelerated glacial melting process.

The HKH glaciers have an enormous potential for water storage, making the HKH mountains the birthplace of numerable greater and smaller Asian river systems, such as the Brahmaputra, the Ganges, the Indus, the Yangtze, the Mekong and the Huang He, which serve as the primary source of freshwater for more than 1.3 billion people in neighbouring downhill countries. Sustaining the Himalayan freshwater ecosystem services is thus critical for the food, water and energy security of the HKH's downstream river basins (Rasul, 2014).

At the same time, the impacts of climate change on hydropower and biomass resources may bring greater uncertainty to the region (Shrestha et. al 2015). In this context, the role of hydropower resources for the future of Asia stands out. Changing hydrological regimes, in which potentially more water flows are available over the next decades, before discharge is continually reduced,

[58] Other natural disasters like avalanches, landslides, storms, and increased seismic activity only add up to the situation.

already reduces investment certainty and the attractiveness to invest in medium and large hydropower today[59]. For policy makers and industries, to set the course today, it is critical to predict hydrological changes and overcome political obstacles through transboundary systems.

Though only a minor share of greenhouse gases and SLCPs are emitted by the mountainous HKH region, it is the local mountain population that is in need of finding adaptive responses (see above) to ensure their well-being while reducing the impact of climate change on water resources and systems, which are of cardinal importance for the region as a whole. Regionwide mitigation strategies to reduce the increasing impacts from back carbon are urgently required on the other side. The HKH community is required to act as a strong pressure group for raising awareness regionally and globally, for strategies to reduce the exposure to black carbon[60] in mountain regions as well as for finance and technical assistance in adaptation.

6.3 Nexus challenges

Through the declaration of the SDGs, the UN brought energy poverty and its correlation with other severe development issues onto the public centre stage and made it a top priority for international development work for the next 15 years. The seventh SDG on energy "is crucial for achieving almost all of the SDGs, from its role in the eradication of poverty through advancements in health, education, water supply and industrialisation, to combating climate change" (UN, 2016).

Energy poverty is not a stand-alone issue but must be seen in a broader context. Strong nexuses with further development issues such as food security, water scarcity, a lack of access to health and education services, as well as environmental degradation can already be observed in mountain areas – these need to be further monitored to inform appropriate policy development measures. The following sections explore some of the most import energy-nexus challenges, as related to the HKH region.

6.3.1 Income poverty and energy access

In 2013, the World Bank published an unambiguous diagram, proving a clear nexus between access to energy and economic development. Without exception, it showed that the higher a country's per capita electricity consumption, the higher its GDP per capita (Singh et al. 2013). This relation also works the other way around – there is a clear correlation in which higher GDP leads to advanced access to modern energy. It can thus be assumed that by facilitating access to electricity for mountain communities in the HKH region, poverty may be reduced to a certain extent, while the long-term economic impact will also depend upon market opportunities that emerge.

The socio-economic impact of (renewable) energy investments depends on the ability to make productive use of it to access to local markets, as well as on local capacities and infrastructure. The positive impacts of access to modern energy will materialise slower where subsistence agriculture or nomadism prevails, or if households only have limited access to and opportunities, to

[59] Hydropower, as a non-fluctuating renewable energy source with low levelized cost of electricity (LCOE), is instrumental to mitigate greenhouse emissions in Asia and must be promoted in the next decade to avoid further path dependencies on fossil fuels.
[60] Which requires cleaner production processes, reduction of slash and burn practices in agriculture in the HKH foothills and plains, as well as increased use of renewable energies for power generation.

participate in markets. As energy systems are costly in their use, their sustainable operation depends on sufficient revenues to meet expenses for fuels, capital maintenance, as well as for reinvestment at the end of their lifetime.

Wherever cross subsidisation is not applicable or desired, local energy systems depend on both adequate supply side technologies and economic demand side factors, largely influenced by income. The productive use of energy plays a vital role in sustaining local energy systems and increases the economic viability of energy systems, while contributing to local economic development. New income opportunities ideally lead to an increased ability to afford modern energy and an opportunity to climb up the energy ladder.

Energy systems must be affordable and thus right-sized. It comes naturally that the productive use of electricity, which may range from farmland irrigation systems, to electric crop mills or the establishment of a tourist attraction, support local economic development and are therefore deeply interconnected with the level of access to energy – particularly in remote areas where the reach of governmental services is often low. Thus, mountain energy systems may be more demand than supply driven and may favour decentralized approaches.

Migration is another aspect connected to the energy and income poverty nexus. Though usually not explicitly singled out as a reason for migration, notable migration movements from mostly rural, energy poor and economically underdeveloped regions to urban on-grid areas can be observed. Modern energy is indispensable for economic development and social participation - lacking access to it must be understood as a core reason for people to migrate from the remote countryside to grid-connected communities and metropolitan areas.

6.3.2 Community-based models

In the absence of public investments, mountain communities have often retreated to their own technical capacities to maintain systems. They often utilize implementation and operation approaches that reduce costs technically (local adaptation), ensure systems are needs-specific (lower supply grades) and capitalise on the existing strong social cohesion though community-based models. It is community engagement which often makes energy provision in mountainous regions of the HKH area different from most other regions. Through such approaches, remarkable levels of self-electrification through micro-hydropower facilities as well as forest and land management, could be achieved – these are globally outstanding lighthouses.

In such contexts, electricity or fuel needs to be understood as a Common Pool Resource (Ostrom, 2011) in which users also act as providers and develop rules to sustain their resources. Nevertheless, such models often suffer from quality issues and are less capable of being upscaled or broadened, since the goal of community-based systems is to supply a certain spatial area, which contrasts with private sector actors who wish to extend coverage to increase profits.

Community-based systems are generally a success story in the HKH region, however, they require support once systems become larger, as well as technically and economically more complex. Such support needs to be provided by strong and dedicated institutions that are cost-effective and adequately designed. Support is required to ensure that systems are above a critical quality threshold, and sustainable operation and maintenance models are in place, which ensure access to technical services and ensure the sustainability of systems.

While community-based approaches should be taken seriously from a governmental point of view, as they result in developmental co-benefits, such as improved local governance and social coherence, support to their professionalisation is essential. Reductions to their operational costs may be achieved through approaches blended with more private sector participation

6.3.3 Gender dimension of energy poverty

Caught between poverty and environmental degradation, mountain communities in most of the HKH find it increasingly difficult to meet their daily energy requirements in a sustainable manner (Sharma, 2009). Mountain people, especially women and girls, by virtue of their traditional gender roles, suffer the most from time poverty when spending great portions of their available time per day gathering resources such as wood or water to satisfy their basic needs. Often this is to such an extent that they simply have no time to enlist their participation in any livelihood enhancing income-generating opportunities.

In many developing countries, time poverty is a gender-related issue. Women happen to be more affected by time poverty, especially when household related tasks and the gathering of basic resources like firewood and water fall into the women's scope of duty by tradition. Finding solutions that alleviate time poverty therefore also lowers the workload and time pressure on women, allowing them to invest their time in education, economic activities or even leisure time, thus promoting the independence and self-determination of women. Heavy reliance on traditional solid fuel used in traditional ways entrenches poverty and erodes indoor air quality which again affects women and children more intensively.

With reliable access to electricity and to modern, clean cooking energy, time poverty could be substantially reduced. The is also huge potential to create livelihoods for women by integrating them at all levels of the renewable energy supply/value chain. Yet the potential of women as entrepreneurs in sustainable energy is under-utilized in most HKH countries due to the existing gender differentiated risks and barriers (e.g. gender gaps in access to affordable finance, access to finance, information, technologies and markets), these need to be addressed by creating an enabling environment for linking women entrepreneurs to a wide range of stakeholders and resources, as well as empowering them through political advocacy and/or awareness campaigns.

Summary – Mountain Energy and its Associated Challenges

1. Energy access rates in the HKH mountain region fall far behind average energy access rates among Asian countries. The energy needs for cooking, space heating and water heating are estimated to make up more than 85% of the total domestic energy. The high dependence on biomass, resulting in poor indoor air quality, respiratory illnesses, deforestation and land degradation, combined with the impacts of climate change (e.g. temperature rises), pose a massive stress on human health – in particular for women – and fragile mountain ecosystems
2. Mountain areas suffer disproportionally from the impacts of climate change. Advanced building materials along with advanced heating and cooking technologies and access to electricity are crucial adaption strategies. They increase the resilience against the impacts of climate change, while ensuring food and livelihood security of the mountain region, as well as water security for interdependent downstream economies. The mountain glaciers feed major Asian river systems, and up to 1 billion downstream users
3. The energy and related nexus concerns of the HKH mountain region are often decoupled and unaddressed by national and regional developments. Energy poverty is widespread in the mountain region – impacting on all aspects of wellbeing and despite the exploitation of large hydro potentials that feed industrialized and urbanized areas in downstream economies
4. The HKH mountain population predominantly resides in widely remote communities. As a result, centralised energy infrastructure is often not a viable option. Providing energy centrally to a widely scattered population comes with high investment costs. Decentralized and autonomously managed (e.g. community-managed) solutions may thus be an appropriate approach in mountain settings. More support to ensure the sustainability of local community-based infrastructure, as well as incentives to attract the private sector for blended approaches or public private partnerships, is required
5. Facilitating access to affordable modern energy for mountain communities and supporting communities to make productive use of its benefits (new income opportunities), is crucial for sustainable economic development of the region, overcoming poverty, and thus the ability to pay for energy services, which can ensure the overall economic viability of energy systems. There is growing evidence of the potential to create new income opportunities (e.g. for women) at all levels of the renewable energy value chain

7 Needs and Gap Analysis

As outlined in Chapter 5, each HKH country faces specific challenges and limitations with their respective energy governance systems. However, despite their structural differences and experiences, the majority of HKH countries share similar mountain realities and barriers regarding energy poverty. The nexus-related issues associated with energy poverty are also shared across most of the HKH mountain region, as highlighted in Chapter 6.

Building on the earlier desk-based analysis, this Chapter focuses on the verification and country-wise differentiation of the desk-based findings among regional stakeholders interviewed as part of the baseline analysis effort. It aims to identify the convergences of areas of particular concern, their potential technical solutions, and the value-added and desired functions of the potential REEECH, as informed and expressed by the views and technical expertise of regional stakeholders engaged in the BNA.

It is essential to highlight that the sample drawn is selective and biased by the choice of experts, the willingness to fill the questionnaire which varied by stakeholder type and country. As such, the analysis presented below needs to be understood as opinions of stakeholders rather than being representative for all stakeholders or any other group (statistically speaking "population")[61]. The results of the gap analysis were, however, presented at the Validation Workshop to a larger group of stakeholders and its findings confirmed.

7.1 Perceived barriers

Several challenges can be identified region-wide, while others appear to dominate in individual HKH countries, or a group of countries. The homogeneity of energy challenges encountered in the HKH mountain areas, as well as the heterogeneity of institutional responses, allow for strong value addition through cross-fertilization, adoption of best practices and advanced cooperation between the various countries constituting the region, as outlined in the preceding section.

7.1.1 Policy barriers

Energy governance in the HKH region is highly complex and dependent on natural resources, institutional capacities, market structures and their state of development, as well as on socio-economic factors. For those countries, in which "mountain areas" host only a smaller portion of the total population, the energy sector governance tends to neglect the specific mountain challenges. As can be seen from the analysis of access to energy services (Chapter 5.1.1.) and the specific mountain challenges and considerations (Chapter 6), tremendous challenges must be overcome to achieve SDG 7 and the vision of the SE4ALL initiative. This is strongly confirmed by stakeholders across the HKH region:

Stakeholders strongly emphasise the lack or absence of sustainable energy policies, targets, legal and regulatory frameworks for mountain areas (scoring a mean average [ø] of above 8 out of 10[62]) or their lacking harmonization with other key policies (ø >7.5), as a key barrier to achieve the

[61] The authors of the study gauged the pros and cons of the quantified presentation of the selective sample and rather qualitative method. It was finally decided that the indications and insights provided by its visualization outweigh the risk that the numbers presented are taken or communicated as statistically sound.

SE4ALL goals. See Figure 17, which provides country-specific values). Additionally, more than 75% of all questioned stakeholders confirmed that challenges with regard to regulatory aspects in mountain areas exist. This applies for centralized as well as decentralized systems and concerns all forms of RE and EE equally, as well as building standards.

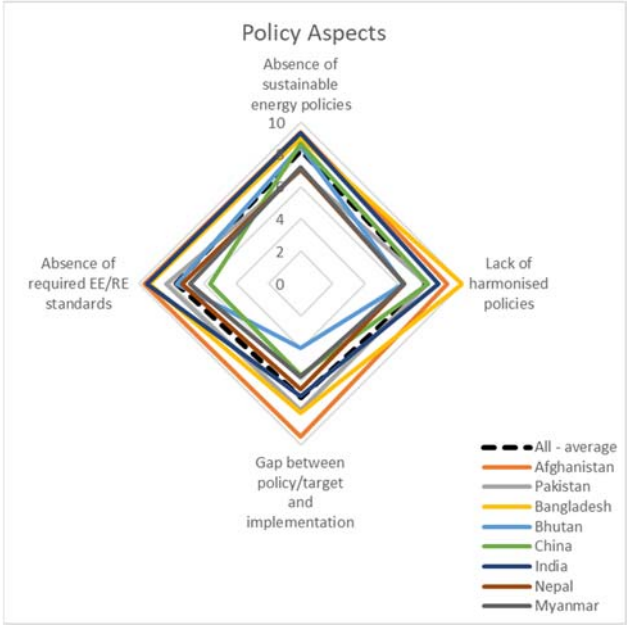


Figure 17: Stakeholder Perception of Policy Challenges

Technical standards, e.g. for energy efficient equipment or the lack and inadequacy thereof, are surprisingly still rated high as barriers in the HKH region (ø>7.5), only Chinese stakeholders viewed this technical area as no priority for themselves. In all other countries, HKH-specific standards are considered to be a challenge, and an area in which REEECH may support the development of cross-regional standards as well as regional certification. Adopting international standards or transferring standards from comparable regions in the HKH, for building and construction materials, is considered to be crucial.

The majority of stakeholders believe in the potential and positive influence of REEECH in shaping a more conducive and enabling environment for the mountain areas. In their view, overcoming the persistent challenges in the HKH mountain region requires regional institutional support to identify policy responses to pressing issues and to nourish successful initiatives, businesses, civil society organizations and public bodies. Strong support for REEECH comes from Afghanistan, Bangladesh, Bhutan, China, India and Myanmar and while overall four out of five respondents agree that regional cross-border cooperation can help to address policy and regulatory issues, the remaining stakeholders were undecided in that regard. Stakeholders placed emphasis on the following value-addition role of REEECH:

1. **High-level agenda setting** including regional mountain energy strategies and energy plans, and improved coordination and facilitation of cross-border projects. For some the development of clear, realistic and mountain-specific targets on RE and EE are important[63] too; while others called for the development of a “self-sufficiency agenda”
2. **Support at the operational level** in terms of joint learning from shared experiences on mountain-specific policies, awareness creation on the socio-economic benefits of RE and EE in mountain areas, as well as lobbying for mountain-specific requirements in policies, regulations, and standards/technical requirements
3. **Direct technical support** in reviewing regulatory frameworks and RE/EE promotion mechanisms with a mountain “lens”, based on mountain-specific regional best practices. Support for the development of specific action plans along with an “easy RE and EE promotion mechanism”, as well as mountain-specific standards, were also mentioned by stakeholders

[63] The gap between policy targets and actual implementation is strongest for Afghanistan, while it is low for Bhutan, which appears to meet realities on the ground.

7.1.2 Economic and financial barriers

Asides from mountain-specific energy policies, regional stakeholders and experts rate economic and financial barriers as a major obstacle to address energy challenges in mountain settings. While economic (e.g. vitality concerns) and financial (e.g. lack of adequate financing) concerns are rated high in most countries (see Figure 18), the strongest mean average is found in the **lack of innovation capacities for mountain-specific energy concerns** (ø>7.5). Other topics are less pronounced and/or are more diversified by country, but still rated high by most stakeholders.

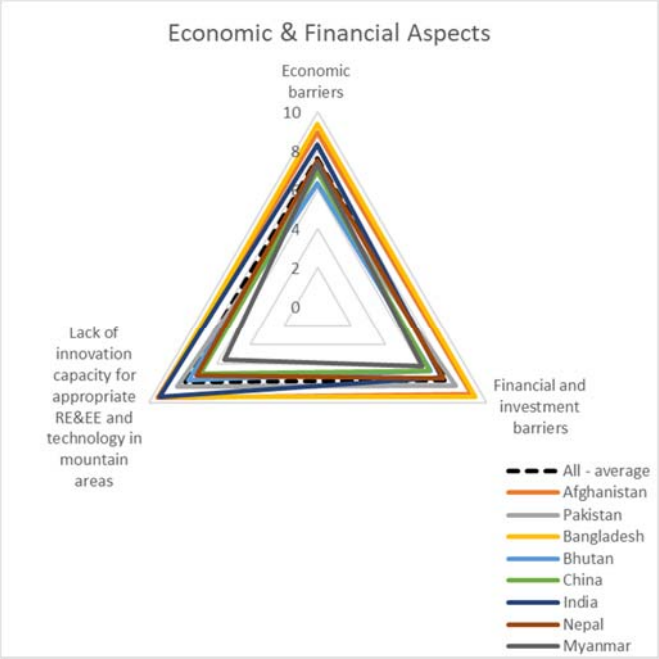


Figure 18: Perceived Economic and Financial Challenges

The lack of innovative capacities is strongest for cooking, space heating, the EE of buildings, as well as for productive uses. Stakeholders perceive that REEECH could play an important role in supporting energy business incubation and know-how transfer on smart promotion mechanisms and new delivery approaches for RE and EE technology. The issue is, thus, also linked to knowledge and awareness barriers (see section below).

Except for Nepal and Myanmar, which both host a strong local RE (manufacturing) sector for decentralized RE systems, all other countries underscore a strong need for more innovative capacities. Economic barriers are rated highest in Afghanistan and Pakistan as well as above average in Nepal, while financial investment barriers are rated high for Bangladesh, Pakistan, and Afghanistan.

7.1.3 Knowledge and awareness barriers

Overall, the analysis points to a lack of awareness on feasible RE and EE solutions by potential users - ranked high in Afghanistan, Bangladesh, Bhutan, and China; while considered to be a low priority matter for Pakistan and Myanmar, but a medium one for Nepal. Information and knowledge

gaps at institutional levels are rated high for India, Afghanistan and Pakistan, as well as for Bhutan and Nepal, while the topic is of lesser concern for China and Myanmar.[64]

The lack of technical know-how with regards to RE and EE implementation by institutional actors in mountain areas is perceived highest in Afghanistan, Pakistan and India.

To support innovative capacities for sustainable energy concerns (see economic and financial barriers) as well as to foster know-how and implementation capacities of institutional actors with regards to mountain areas, strong support to adopt regional approaches has been expressed. Four out of five respondents consider that regional cooperation mechanisms can help to uplift innovative capacities for mountain areas, as outlined below:

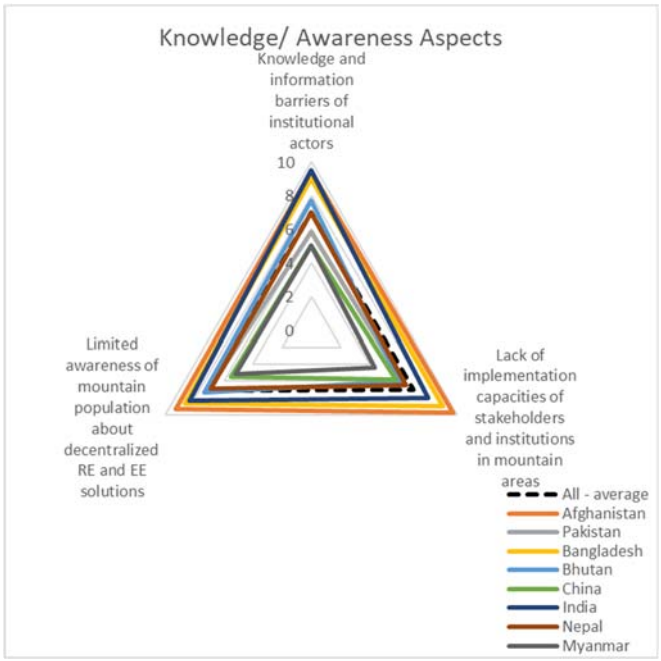


Figure 19: Knowledge and Information Barriers

I. **Joining forces in research and development activities:**
   - Pooled funding for regional research initiatives
   - Supporting collaboration of R&D centres of university and private sector for technology development for mountainous regions
   - Regional scholarship and exchange programmes, fellowships
   - Facilitating private sector engagement in R&D and business incubation

II. **Mainstreaming of RE and EE topics into curricula**:
   - Research and study tours for students
   - Inclusion of RE and EE topics into vocational and academic curricula
   - Offering specialized summer courses on energy in mountain areas
   - Exposure programmes at the regional level for young professionals, the youth

7.1.4 Market barriers

The perception of market barriers varies intensively between HKH countries as shown in Figure 20. Market barriers are perceived high in all categories in Afghanistan, while most stakeholders view issues with regards to the awareness of feasible RE/EE solutions in mountain areas, where only Myanmar's stakeholder see less challenges.

[64] Data and information aspects play a strong role when it comes to the question where the potential REEECH could effectively help and are even stronger emphasised for the desired regional support expressed by stakeholders.

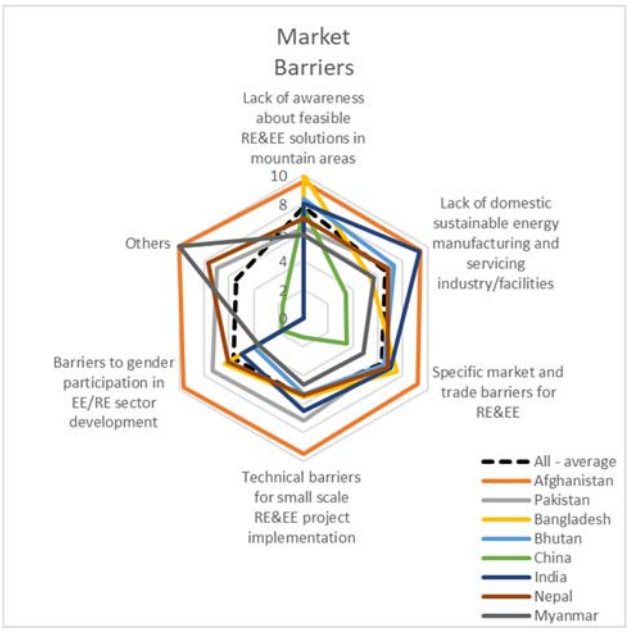


Figure 20: Perceived Market Barriers

Indian stakeholders point towards constraints in the domestic manufacturing industries for mountain areas. Nepal and Myanmar highlight "other reasons", which may be attributable to general governance challenges. India and Pakistan also see technical barriers as a constraint. China does not perceive strong market barriers to be an issue, with the exemption of the aforementioned issue of lacking awareness for RE/EE solutions.

The different reasons for the prevailing market barriers, as indicated by stakeholders, may be attributable to lacking support mechanisms and framework, information gaps and innovative capacities, as earlier highlighted. This may also be coupled by the issue that existing promotion schemes for RE/EE systems often fail to create markets capable of attracting strong private sector actors or are limited to small areas which fragment business opportunities, or due to other uncertainties.

7.2 Technical solutions

Interviewed stakeholders appear to have clear choices when it comes to rural electrification and renewable energy technologies, while they express more variety when it comes to energy efficiency solutions, as well as key cross-cutting aspects.

- **Rural Electrification:** Regarding the prevailing rural electrification challenges, preference is given to decentralized systems which appear to receive little recognition in energy governance. This refers primarily to RE mini-grids but also to other stand-alone RE systems, such as SHS or institutional solar (see Figure 21).

  Country-specific aspects also appear to vary with regards to the achievements made (e.g. Chinese stakeholders give little priority to grid-electrification, while the topic is relevant for India and Pakistan). Mobile solar solutions are named as important in Afghanistan, Bangladesh, India, Myanmar and Pakistan; while they appear not to be required in Bhutan and China.

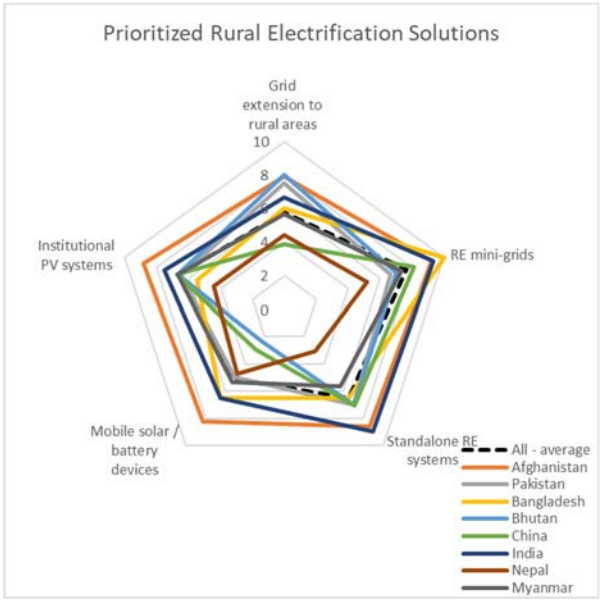


Figure 21: Prioritized Rural Electrification Solutions

RE-technology: Priorities are rather clear with regards to RE technologies, where strong emphasis on water heating and cooling stands out (see Figure 22). This is followed by bio-energy and hydropower as preferred options to tackle energy poverty or create revenues from renewable energy sources. Geothermal energy is only important for a few countries (Bangladesh, China, and Nepal). RE grid integration is of high relevance for India, which is currently experimenting with larger PV on-grid systems.

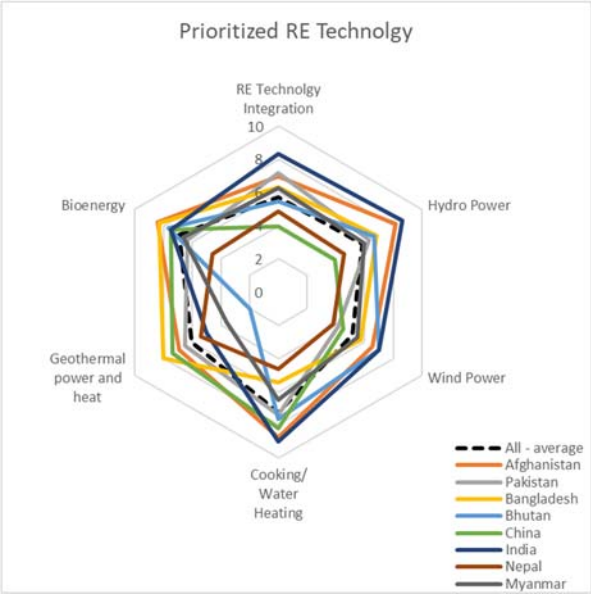


Figure 22: Prioritized RE Technologies

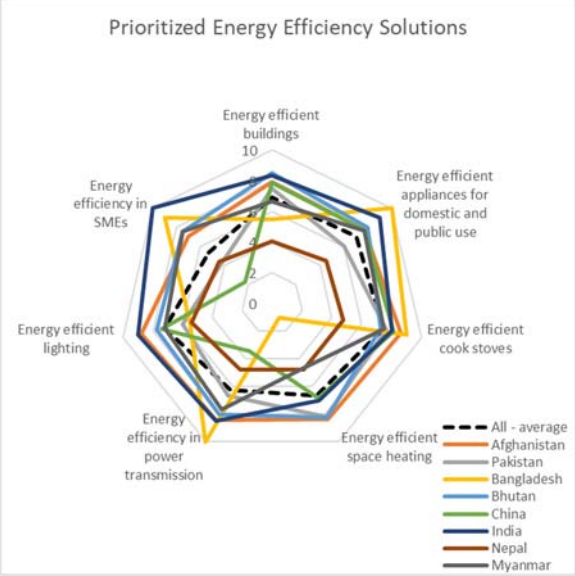


Figure 23: Prioritized EE Solutions

Energy efficiency: The picture is far more diverse when it comes to energy efficiency. Overall, energy-efficient cookstoves are rated highest followed by energy efficient lighting and buildings. There are, however, strong differences between the various countries with regards to other aspects such as space heating, which is of high relevance for Bhutan and Afghanistan; while it enjoys less attention by Bangladesh's stakeholder, which does obviously not reduce its relevance for all high-altitude countries (see Figure 23).

- **Cross-cutting issues:** There is a strong consensus among HKH stakeholders that advanced approaches towards rural electrification planning are required, together with the promotion of sustainable energy entrepreneurship and productive uses. Some countries, e.g. India and China, place high priority on the benefit-sharing of large hydropower facilities, while it is not clear whether the topic was well understood by all, as it is a relatively recent concept. Certain countries, which are quite advanced in decentralized electrification, specifically point to the need for advanced RE operation models, e.g. in Bangladesh (see Figure 24).

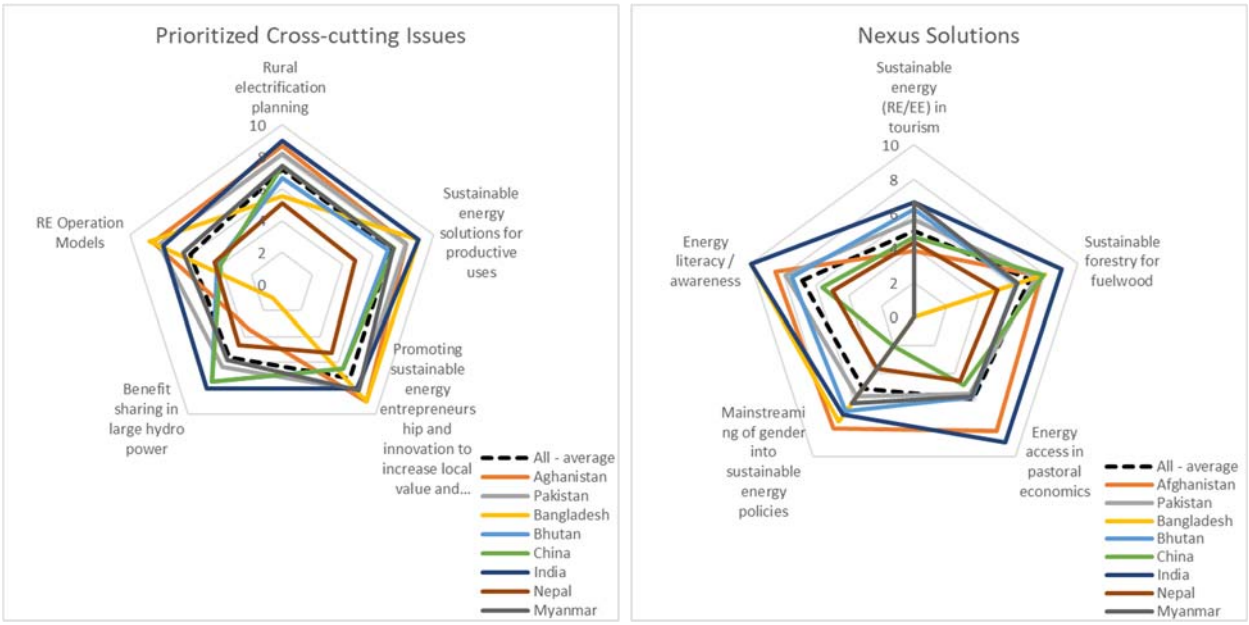


Figure 24: Prioritized Cross-cutting Issues and Nexus Solutions

Nexus Solutions: Stakeholder addressed a strong need to address the aspect of sustainable forestry for fuelwood use, which is ranked high across all stakeholders and fits well with the voiced needs for advanced cooking devices, as well as the energy efficiency of buildings and thermal heat (water and heating). Similarly, with the exception of Myanmar, stakeholders place a strong emphasis on energy literacy, which is coherent with the need for awareness creation on user level, which was earlier expressed as a persistent challenge. Providing access to sustainable energy for pastoral communities is also ranked high in India and Afghanistan. Sustainable energy in tourism is an important nexus solution consideration, especially for Myanmar, Bhutan and India.

7.3 Desired regional support

An overwhelming majority of interviewed stakeholders (90%) consider the creation of REEECH to add value. Methodologically, stakeholders perceive added value in REEECH's role in technical support, knowledge and data management, support to policy formulation, private sector promotion, targeted research and networking (ranked order). In this section, the perspectives shared between most countries are presented while country-specific deviations are highlighted.

7.3.1 Shared perspectives

Stakeholders share a general understanding that REEECH should function as a vibrant knowledge hub and information provider that facilitates the sharing of best practices, exchange of regional experiences, and intensifies technology transfer – regionally and internationally. In addition,

through support in communication[65] and, where required, through piloting of technologies or approaches, market viability can be demonstrated. The following functions and respective sub-topics earned the highest support from regional stakeholders and are again presented in a ranked order:

I. Strengthening knowledge, information and data management, and awareness raising

- Establishing a HKH data system on (sustainable) energy and supporting national data collection activities (ø>8) found the highest level of support overall and is accompanied by the wish of Afghanistan, India and Bangladesh, to develop comprehensive databases and maps for RE/EE activities (ø>7)
- Stakeholders wish to engage in regional awareness workshops, conferences, exhibitions and campaigns, organised under the mountain-specific umbrella of REEECH (ø7.5)

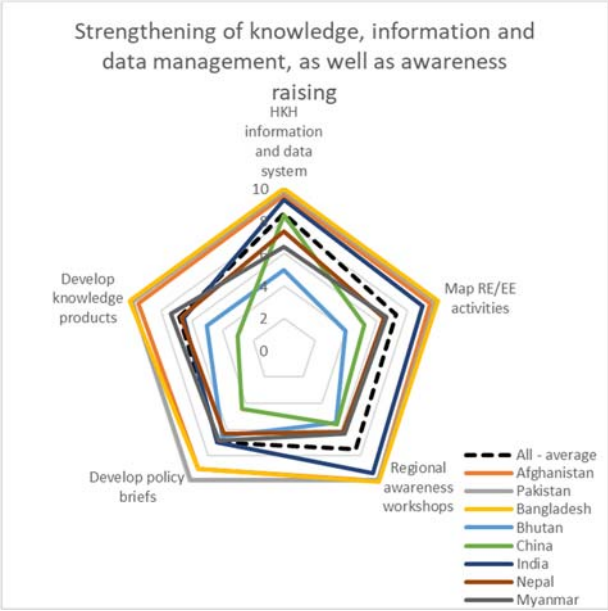


Figure 25: Desired Support – Knowledge, Information Management and Awareness Raising

II. Strengthening policy, regulatory frameworks and standards

- Policy and regulatory barriers were ranked highest and regional and mountain-specific support was thus requested by regional stakeholders. It is thus coherent that stakeholders desire that REEECH should support the creation of mountain-specific financial mechanisms and incentive schemes (ø>8) as well as facilitate the adoption of policy, legal and regulatory frameworks for RE&EE in mountain areas (ø>7.5)
- Support to standards in EE (e.g. building codes) and RE equipment (both ø around 7.5) are ranked high too, while needs vary more intensively across the different HKH countries

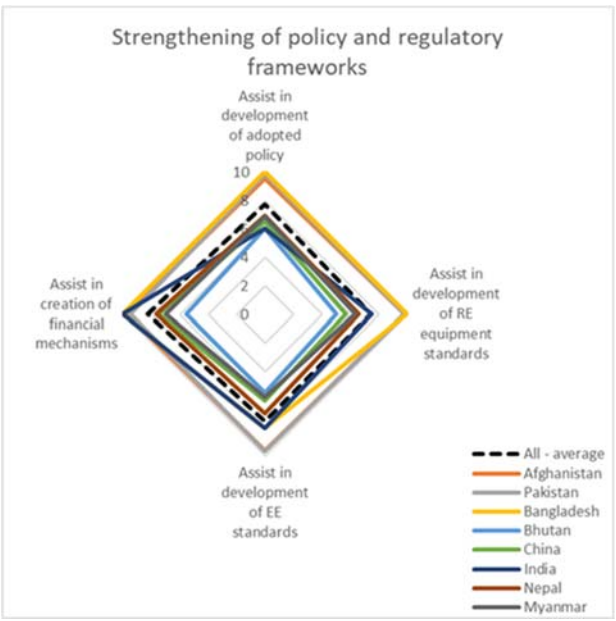


Figure 26: Policy and Regulatory Frameworks

[65] Including long-term behaviour change communication.

III. Strengthening regional coordination and harmonisation

- There is a strong consensus that REEECH should advance the coordination of donor activities at a regional level (ø almost 8) and create linkages between international climate and energy policy, as well as to function as a HKH mountain-specific hub for SE4ALL (both ø> 7.5)
- Afghanistan, Bangladesh, Bhutan and India, also emphasise the role of REEECH in providing technical support to the HKH region

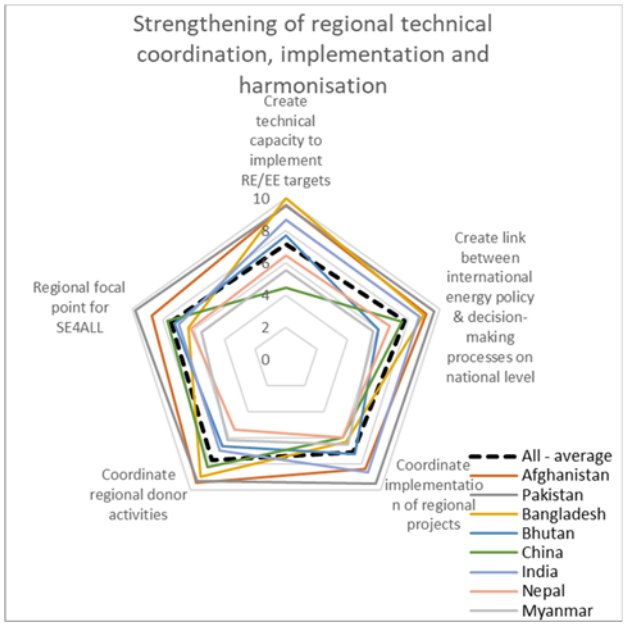


Figure 27: Desired Support - Regional Coordination and Harmonization

IV. Strengthening capacities and exchange of key institutions and stakeholders

- Stakeholders place a specific emphasis for the role of REEECH in research and innovation networks, with national institutions and with the private sector (ø>7). In addition, they expressed the need to focus on the rather HKH-specific aspect of community-based RE projects and the development of sustainable business models (ø=7), followed by the facilitation of cross border RE/EE partnerships and projects
- Support for women's participation in decision-making is also ranked high in some countries (Bangladesh, Afghanistan, India and Pakistan), but low in others

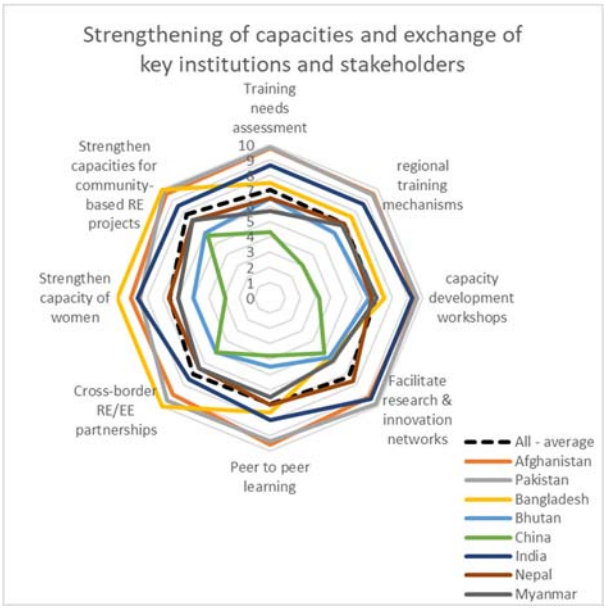


Figure 28: Desired Support – Capacity Development and Stakeholder Exchange

V. Strengthening energy investment and business promotion

- There is a generally affirmative and uniform picture of REEECH's potential role in supporting the private sector on RE and EE activities in mountain areas. Most emphasis is given to the development of financial mechanisms promoting decentralized RE and EE investments, which is followed by the potential development of a user-friendly investment portal (information system) for business opportunities (e.g. on hydro resources, both > 7)
- However, stakeholders also appreciate the promotion of innovative sustainable energy businesses, entrepreneurship and industry in the HKH region, through the establishment of investment forums (ø = 7)

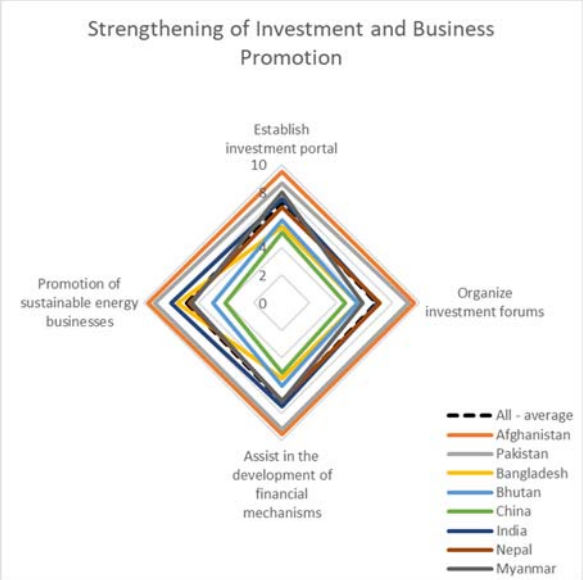


Figure 29: Desired Support – Investment and Business Promotion

It can be concluded that stakeholders from across the region, irrespective of their different institutional backgrounds, share a consensus that **REEECH could add value in the following ways**:

- By functioning as a state-of-the-art data, information and knowledge provider on RE and EE potentials and systems[66] in mountain areas
- Through supporting and lobbying for the development of mountain-specific policies, laws and regulations, pointing to the need of appropriate financial mechanisms and services
- Coordinating and synergizing donor activities, as a mountain-specific hub for SE4ALL, and enabling mountainous HKH regions to benefit from climate finance to address their energy concerns
- Through the facilitation of research and learning networks, and South-South / peer-to-peer exchange on community-based business models and sustainable operation approaches for decentralized systems
- By supporting business promotion, where there is again a focus on data (e.g. for hydro resources) and financial aspects

7.3.2 Country-specific needs

Asides from the stakeholder convergences on the role, expectations and desires of REEECH, specific national needs and expectations have also been identified – owing to the different energy governance approaches; state of national technical, institutional and market development; as well as the level of exposure to the HKH mountain region, in each of the HKH countries. These can be grouped, as follows:

- **Capacity development and technical cooperation** (needs assessments, regional training, workshops and peer-to-peer exchanges) are important for Afghanistan, Pakistan and

[66] This shall be done supporting the relevant national energy institutions as well as statistical institutes, which have been mentioned by all countries.

Myanmar, but also for Bhutan, which seeks to learn from other HKH countries and catch up based on best practices, where applicable.

One common theme is that all these countries wish to engage in a capacity needs assessment. The desire for technical cooperation with neighbouring countries is less strongly emphasised in the more industrialized countries such as Bangladesh, China and India, though the latter still see great advantages in regional exchanges. For those strongly in favour of capacity development, three key themes can be identified:

- Firstly, awareness creation for successful business models, best practices, and joint capacity development activities, to allow for cross fertilization
- Secondly, training of trainers for multiplicators and key experts from respective HKH countries being provided by other regional trainers, equipment providers or other key international experts "first hand"
- Finally, the creation of university networks and support to curricula development

- **Technical standards and technical capacity development** are highlighted as needs by Bangladesh and Afghanistan; while Bhutan emphasises only the latter. Pakistan and Myanmar place strong emphasis on the need to learn from community-based and other business models for decentralized RE and EE. The results from Nepal also indicate such needs, though these are balanced in terms of priorities over other categories.

  Overall, stakeholder hope that REEECH can offer help to their national institutions, particularly in the adoption standards to the specific conditions in the HKH region. This applies to specific local RE technologies (especially for micro hydropower components) and for local enterprises, as well as for the EE of buildings (green building codes), whose necessity has been frequently underscored by stakeholders[67]. The testing of equipment appears a problem in Nepal, but potentially also in other countries.

- **Financial schemes:** Nepal, like India, China and Myanmar, place strong emphasis on the development of sustainable financing schemes for renewable energy systems and EE approaches in mountain areas. For this, they also rate high quality data, mapping of RE systems and resources as well as R&D as important. Such information and data are required to develop markets, facilitate investments and allow for scaled business operations.

  Finally, stakeholders consider that regional or foreign partnerships should also help to unlock investments. As such, the cross fertilization between countries, business-to-business workshops (B2B) as well as business incubation centres with a focus on mountain areas are perceived to be useful to generate investment portfolios[68].

[67] Results and "HKH standards" should be published online.
[68] Pakistan and Bhutan do not show specifically high or low values in view of support for mobilizing the private sector while support. The development of financing schemes is perceived as less important in Afghanistan and Bangladesh – most probably for different reasons. While Bangladesh already has one of the world's leading financial sector for decentralized energy systems and rural EE, Afghanistan may put less priority on it in view of other challenges in the sector, the difficult financial environment in general, and the limited opportunities to mobilize foreign investments outside of the existing business community.

8 Multilateral, Regional and Non-governmental Organisations

There are several bilateral, regional, multilateral and intergovernmental entities, as well as international NGOs engaged in supporting access to modern energy, the use of renewable energy sources, and energy efficiency in the HKH mountain region. Building on the gaps and needs described, as well as the analysis of literature and data, and the challenges voiced by stakeholders from the HKH countries, this chapter explores which regional or global intuitions exist and could potentially be leveraged, in order to overcome the persistent challenge of energy poverty in the HKH mountain region.

Multilateral, regional and international non-governmental organisations as described below should be seen in conjunction with national, governmental institutions and agencies highlighted in Chapter 6[69]. By doing so, the chapter provides a HKH mountain-specific lens to better understand the specific requests from HKH stakeholders (Chapter 7), in view of energizing the area by regional approaches in a sustainable and non-polluting manner.

8.1 Regional intergovernmental institutions

Founded in 1985, the **South Asian Association for Regional Cooperation** (SAARC) is the regional intergovernmental organisation and geopolitical union of nations in South Asia, with a secretariat based in Kathmandu, Nepal. Its member states include Afghanistan, Bangladesh, Bhutan, India, Nepal, the Maldives, Pakistan, and Sri Lanka. Thus, it covers six of the eight HKH countries, though China and Myanmar are observers in the SAARC.

The **SAARC Energy Centre** (SEC) was launched in Islamabad, Pakistan, in 2006, to support the realization of SAARC's vision to establish an Energy Ring in South Asia. The SEC aims for an energy cooperation programme that seizes and provides renewable energy opportunities including hydropower, by offering a common platform for officials and experts from its member countries. In addition, the SEC postulates the following goals:

- Strengthen South Asia's capacity to address global and regional energy issues
- Facilitate energy trade within the SAARC (regional electricity grid & natural gas pipelines)
- Promote more efficient use of energy and the development of RE
- Serve as a focal point for providing reliable energy data and promoting private sector investment

While the goals of SECs may indicate a potential duplication of scope with REEECH, a closer look reveals potential synergy in case SEC advances its operations as well as the need for a less high-profile approach towards regional cooperation and a stronger focus on mountain aspects in energy. Two aspects can be identified:

- SEC is primarily focused in regional power and gas trade issues rather than renewable energy and energy efficiency
- Starting off with high ambitions, SEC has fallen short of high aspirations for advanced energy cooperation in the region as well as on delivering on more operational aspects such as data management or peer-to-peer learning. While there is a need to coordinate between

[69] Analysing the regional institutional landscape for the eight HKH countries, which host approx. 2.5 billion people (out of which approx. 200-270 million reside in the HKH mountain areas) can only provide a snapshot of the energy-related engagement of larger institutions in the region.

various agencies of national and sub-national governments, SAARC's SEC appears not to be recognised as a platform and mediator[70]

- SEC does not have a focus on decentralized renewable energy and energy efficiency issues in rural/remote areas nor a specific mountain focus.

It has been observed by the authors that smaller mountain countries and the mountain population of HKH countries find themselves sitting on the fence of geopolitical and economic power plays in SAARC.

Learning from the politicisation of SAARC's SEC, we recommend that REEECH may be facilitating bilateral or multilateral cooperation on mountain topics content-wise, perusing a neutral political stand, and avoiding political high-level profiles. This does not mean operating below the radar of political attention, but to seize cooperation opportunities where feasible and to make the mountain population's needs visible. As such, REEECH can add specific value for these areas and does not duplicate mandates, but rather fill a niche.

ICIMOD was established as a regional intergovernmental learning and knowledge-sharing organisation in 1983, with a focus on mountain development issues. As already mentioned, ICIMOD serves eight Regional Member Countries (RMCs), which are the same eight countries which constitute the HKH mountain region. ICIMOD brings together RMCs, the donor community and a diverse set of partners with a commitment to the development of mountain communities, to help shape a better future for mountain people and environments in the region. Though ICIMOD has limited engagement on energy issues, energy has become increasingly recognised an important component area for ICIMOD's engagement on mountain development and environmental sustainability. As such, ICIMOD is well-positioned to host REEECH[71].

8.2 Global and Multilateral Organisations

Sustainable Energy for All (SE4ALL) is a global initiative launched by the United Nations (UN) in 2011 and co-chaired by the World Bank Group. Its goals can be briefly summarised as 1) Achieving sustainable access to electricity and cooking energy for all, (2) doubling the RE share in the global energy mix, and (3) doubling the global rate of improvement in energy efficiency. The SE4ALL initiative builds on Regional and Thematic Hubs as well as the **Global Network of Regional Sustainable Energy Centres** (GN-SEC), facilitated by UNIDO in partnership with various regional organisations in the context of the implementation of the SDGs.

The relevant SE4ALL regional hub for the Asia and Pacific region is hosted by the Asian Development Bank (ADB), the UN Development Programme (UNDP), and the UN Economic and Social Commission for Asia and the Pacific (ESCAP). Hubs typically bring together development banks, UN agencies and regional organisations, who work in a coordinated way with country focal points.

The Regional Sustainable Energy Centres under the GN-SEC provide a potential umbrella organisation for REEECH, as for other regional sustainable energy centres (e.g. ECREEE operated by

[70] Recently India boycotted the SAARC's General Summit (2017). This led to increased politicization, hardened positions of blocks within SAARC, and further stalled SECs operation and impact. Various countries have recently shown more interest is alternative regional organisations. India has been showing more interest in the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (Bimstec). China is also pushing forward its ambition of the One

[71] More analysis of their institutional capacities and constraints of ICIMOD will be provided in the Feasibility Study for REEECH.

ECOWAS). Such regional energy centres enjoy a stronger level of regional ownership as they are hosted and operated by regional inter-governmental organisations.

The SE4ALL Hub focuses on an area much larger than the HKH (Asia and Pacific) and does not provide specific emphasis on the HKH. Furthermore, it appears that the HKH topics have not received sufficient attention despite the prevailing energy poverty there. As such, the development of REEECH as a regional centre would not duplicate the mandate of the SE4ALL Hub, but rather add on to it through a well-practised model of co-existence and mutual recognition while placing focus on HKH mountain topics.

The **International Renewable Energy Agency** (IRENA) is an international intergovernmental organisation that supports countries in their transition to a sustainable energy future; and serves as the principal platform for international cooperation, as a centre of excellence, and a repository of policy, technology and financial knowledge on renewable energy. More than 170 countries and the European Union are actively engaged in IRENA.

IRENA helps countries address sharply rising energy needs in an effective and sustainable manner, through the provision of renewable energy data and statistics, advice on best practices, policy development, insights on financial mechanisms, technological expertise and capacity building programmes. Though there are areas in which IRENA and the potential REEECH could both be active, there is generally a more synergetic relationship possible, as the latter would shed light on a currently neglected area and focus of global energy policy actors.

While IRENA acts at a global scale for the sake of increased RE shares in the energy mix, REEECH may consider RE as a priority to strongly focus on energy access, energy efficiency and the wellbeing of the HKH's mountain populations and environment. Since the energy concerns of the HKH region are rather unique and their population suffers from marginalisation, it appears a good match to support RE in mountain areas in close cooperation with IRENA.

In addition, many donor, and bilateral, technical and financial assistance programmes are operational in the region. In order to map out regional programmes, the portfolios of USAID[72], the European Union[73], the United Nations Development Programme (UNDP)[74], as well as those of the following bilateral development partners has been analysed with regards to their activities on sustainable energy of relevance to the HKH region:

[72] USAID places special emphasis on the energy sector development in Pakistan, in particular on large hydro power. It is also strongly engaged in Afghanistan, but with no specific emphasis on energy. It is furthermore active with energy programmes in Bangladesh (mainly on clean cookstoves), India (Partnership for Clean Energy), but has no programmatic activities on energy in Myanmar and Nepal.
[73] No structured information about programmatic activities can be obtained from the web-presence (https://ec.europa.eu/europeaid, accessed on 02 March 2018).
[74] The UNDP supports the energy sector's market transformation through a range of interventions on policy, finance, capacity development and awareness creation. Examples for UNDP projects in the HKH region are India's "Increasing Access to Clean Energy for Productive Use" (Budget: USD 46.98 Million), the Rural Energy Development Programme (REDP) in Nepal and Afghanistan, called "Sustainable Energy for Rural Development project (Budget: USD 3.7 Million). UNDP also operates the Sustainable Energy for Rural Development (ASERD) programme in Afghanistan and recently finalized a biogas programme in Bhutan.

- The Norwegian Agency for Development Cooperation (NORAD[75])
- The Department for International Development (DIFID)
- The Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ)[76]
- The multi-donor funded Energizing Development Programme (EnDev)[77]
- SNV - Netherlands Development Organisation (SNV)
- The Swiss Development Cooperation (SDC)[78]
- The Austrian Development Agency (ADA)[79]

No programmatic activities covering the HKH region, multiple HKH countries or HKH mountain affairs could be specifically identified in the scope of this BNA. The analysis of technical and financial support programmes was hampered by the lack of structured data publicly accessible with these agencies, as well as the incoherent and fragmented way in which they were presented. Stakeholders from the region frequently expressed that advanced coordination among such actors is required, and this is an area which they perceive that REEECH may be able to facilitate and coordinate, with a focus on mountain regions, to avoid duplication and to identify further synergies for regional impact. Further discussions with the aforementioned development partners, as well as other actors, is recommended as one of REEECH's formative activities.

The following table provides a concise overview of the relevance of some of the major global and multilateral actors of concern:

Name	Relevance to Sustainable Energy	HKH Mountain Region Relevance and Country Coverage
Asian Development Bank	The ADB is engaged in clean energy, access to energy and energy efficiency as part of its Infrastructure Programme. The ADB operates country-level portfolios and regional cooperation programmes focused on energy and is a key actor and potential partner for REEECH. It runs the South Asia Subregional Economic Cooperation (SASEC) and Central Asia Regional Economic Cooperation (CAREC) Programme, which both have coverage in several HKH countries80. The Asian Development Bank	ADB is a key partner when it comes to the cross-border trade of power and gas in Central and South Asia, as well as energy governance and market development for RE and EE. The ADB acts as the regional hub of the SE4ALL Network, covering relevant programmes and projects of all eight HKH countries with. However, it has no not specific work focused on addressing energy issues in mountain areas, specifically with a focus on the HKH region

[75] Being active in Afghanistan, Bangladesh, China, India, Myanmar, Nepal and Pakistan with and energy and environment portfolio in all of the aforementioned countries, except for Afghanistan.
[76] Operating energy programmes in Afghanistan, Bangladesh, China, India, Myanmar, Nepal and Pakistan.
[77] Operating energy programmes in Bangladesh and Nepal as well as soon in Pakistan.
[78] Operating programmes in Bangladesh, Myanmar, Nepal, but with no emphasis on energy.
[79] Operating an energy programme in Bhutan
[80] The SASEC includes Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal and Sri Lanka in a project-based partnership that aims to promote regional prosperity and improve economic opportunities. It seeks to strengthen multimodal cross-border transport networks that boost intraregional trade and open up trade opportunities with East and Southeast Asia. The Central Asia Regional Economic Cooperation (CAREC) Programme is a partnership of 11 countries (Afghanistan, Azerbaijan, People's Republic of China, Georgia, Kazakhstan, Kyrgyz Republic, Mongolia, Pakistan, Tajikistan, Turkmenistan and Uzbekistan) supported by six multilateral organisations. It aims to connect Central Asia to the dynamic

	(ADB) also hosts the Power for All Initiative, which provides practical opportunities for Energy Entrepreneurship and is engaged in large-scale power projects across Asia. It supports several transnational projects in the HKH region81.	
IRENA	IRENA is an intergovernmental organisation supporting the sustainable energy future globally. Its membership includes 155 countries. IRENA is a centre of excellence for statistics on RE and RE policies and support tools	IRENA is a relevant cooperation partner for the development of HKH specific data, policy reviews and market assessments. All HKH countries except for Myanmar are members. IRENA has no specific focus or programmes on mountain energy, however it offers great cooperation potential for REEECH, especially in terms of synergies in developing data inventories and for drawing attention to the problem of energy poverty and opportunities in the HKH and globally
SE4ALL	The SE4ALL initiative supports faster action towards the achievement of SDG 7. It supports the SE4ALL Tracking Framework and Regulatory Indicators for Sustainable Energy (RISE) monitoring (→see The World Bank Group below). On a regional level it cooperates with the Asia-Pacific Hub for SE4ALL, which is led by the ADB, UNDP and the UN Economic and Social Commission for Asia and the Pacific (ESCAP). The Hub's Secretariat is hosted at the ADB Headquarters in Manila, Philippines	The SE4ALL initiative offers a Global Energy Efficiency Accelerator Platform for appliances and equipment, helps to identify high-impact opportunities and has deep knowledge on gender and social inclusion aspects. It also works on thermal energy aspects, however more in terms of cooling ("Cooling for All"). As a global initiative, SE4ALL supports all HKH countries, however, it currently has no focus on mountain-specific activities (though they are currently considering the initiation of a mountain space heating-oriented programme in which SE4ALL may act as an accelerator)
The World Bank Group	The World Bank Group is a key development partner in energy and operates as a financial lending agency and technical assistance facility, particularly through its Energy Sector Management Assistance Programme (ESMAP). It plays an essential role as a partner of the SE4ALL initiative, by facilitating the SE4ALL Knowledge Hub, the Global Tracking Framework 2017 (GTF)	The World Bank Group is providing massive support in terms of finance as well as technical assistance in the energy sector throughout the HKH countries. It actively promotes renewable energy technology of different sizes in the HKH region[82] and its programmes often have a formative character for energy governance as well as markets. Examples include the National Electrification Programme in Myanmar. Though it

markets at its boarders and to realise their significant potential by promoting regional cooperation in four priority areas: Transport; Trade Facilitation; Energy and Trade Policy.

[81] Currently, there are 22 running hydropower projects, 37 solar power projects and 31 wind power projects in the eight countries, though not exclusively located within the countries' mountainous areas.

[82] In Nepal, the WB focuses on supporting the capacity goals of the MHP sector (50MW/2017). In Myanmar, the WB supports rural electrification through the NEP, which comprises of USD 5.8 Billion in support of universal electrification. In Bangladesh, it supports rural electrification and RE development with USD 191 Million and conducted rural electrification projects until 1997. Nowadays they contribute to the PPAF

	and the Regulatory Indicators for Sustainable Energy (RISE) monitoring	supports multiple large-scale programmes, no mountain-specific projects on energy for the HKH could be identified within the scope of this BNA.

Figure 30: Mapping of Global and Multilateral Actors of Regional Relevance

It can be concluded that while there are countless sustainable energy programmes and initiatives involving several HKH countries, as well as a number of programmes with some focus on the region (e.g. Reducing Emissions from Deforestation and Forest Degradation Programmes which are relevant for sustainable forestry), there is no comprehensive approach to systematically address the specific challenges of the HKH mountain region. Moreover, there is hardly any overview, coordination and learning ongoing, between the various programmes and actors.

8.3 Non-governmental organisations

When speaking of larger, international, non-governmental organisations (INGOs) and networks, there are many stakeholders working in the region, though only few explicitly work on issues related to modern energy and energy efficiency. The list below is therefore not exhaustive but highlights non-governmental actors that have significant resources and focus on RE and EE issues in the HKH.

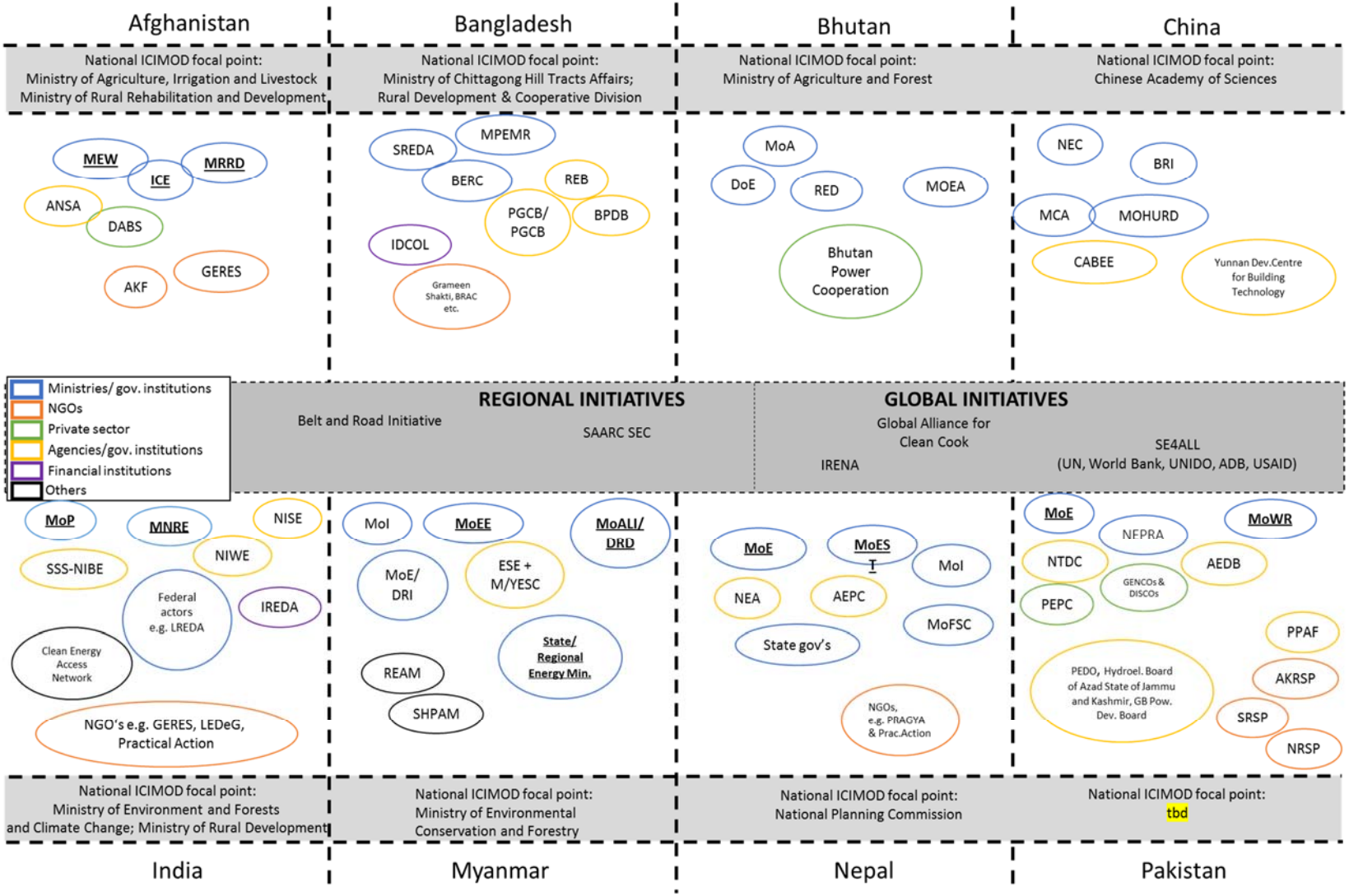
- **Practical Action** is one example of an INGO using technology to tackle poverty and poverty-related problems in developing countries, including in the HKH mountain area. Practical Action is active in India and Nepal, promoting improved cooking stoves
- **The Aga Khan Foundation (AKF)**, actively working in many communities in Afghanistan, Bangladesh, India, and Pakistan currently supports over 2,500 villages, directly benefiting almost 1.4 million people. Among their energy-related activities is the promotion of MHPs, fuel-efficient stoves, solar cookers, and solar water heaters
- **The Groupe Energies Renouvelables, Environnement et Solidaités (GERES)** has a strong portfolio in energy saving solutions and the strengthening of small entrepreneurs. It includes low cost solar passive house installations and is working on improved cook stoves. GERES operates in North India, Myanmar, and Afghanistan
- The **Global Alliance for Clean Cookstoves** is active in mountain and non-mountain areas in Bangladesh, as well as in China and India. It aims to increase access to cleaner

8.4 Stakeholder mapping and synergy potential of REEECH

In the absence of a regional mountain-specific institution focused on energy in the Hindu Kush Himalaya region, ICIMOD currently offers a natural home for REEECH, which due to its intergovernmental setup, is likely to play a significant role in the creation and establishment of the centre. To ensure the value-addition and impact of REEECH, it will also be necessary to further consider how REEECH will build partnerships with key energy actors and stakeholders already engaged in the region.

Building on the analysis of national actors in Chapter 5 and the stock-taking above, Figure 31 illustrates the key stakeholders in the HKH region per country and regionally. It also lists the current ICIMOD focal point (RMC's designated institutional representative). The stakeholder map already indicates the need to set-up an adjusted steering and governance structure for the potential creation of REEECH.

Figure 31: HKH Stakeholder Landscape[83]



[83] The complete names and their roles of the organizations mentioned here can be found in Chapter 5.1 at the respective country profiles (see *energy governance*).

As can be noted, there are a plethora of actors engaged in energy-related activities and governance, particularly at the national level of the respective HKH countries. Fewer actors are engaged at the regional level i.e. with region-wide focus on mountain energy issues, though several international donors and financial institutions are active at the global level.

To assess the potential synergies that could be leveraged between existing actor-led initiatives and REEECH, as well as to understand the further value-addition of REEECH itself, it is necessary to understand the role of existing energy-related actors in the HKH countries, vis-à-vis the needs expressed by regional stakeholders. While by no means fully conclusive, the following table provides a first assessment of the synergetic potential of REEECH with existing actors, as well as the gaps in information, knowledge, expertise and support which REEECH could potentially add further sectoral value to.

HKH-specific Priority Needs	Countries & National Actors with Relevant HKH Expertise or Experience	Identified Deficits	REEECH Value Addition (+ - / 1-5)
Technical standards for EE equipment, products and building standards	Afghanistan: ANSA Bangladesh: SREDA/BERC China: CABEE, Green Building Union, Mountain Cities' Building Energy Efficiency Myanmar: MoI Nepal: AEPC	Lack of cross fertilization-peer to peer learning and HKH focus	++++ Promotion potential - regional dialogue on the energy efficiency of mountain buildings; green construction
Harmonization of legal & regulatory frameworks, and targets for mountain areas	Afghanistan: MEW/RED Bangladesh: BERC Bhutan: DoE/DRE China: NEC India: State gov's Myanmar: MoEE Nepal: Nepal Electricity Regulatory Commission (planned) Pakistan: NEPRA	Lack of peer to peer learning and south-south cooperation. HKH topics often not addressed in national laws and regulations	++++
Joint research, learning, best practices and knowledge transfer on RE and EE	-	Presumed deficit on RE and EE in the HKH	+++++
RE and EE investment promotion mechanisms for mountain-settings	Afghanistan: - Bangladesh: IDCOL, IDF Bhutan: - China: Multiple programmes India: IREDA and REC with nodal agencies Myanmar: MoALI/DRD Nepal: AEPC and REF Pakistan: AEDB, PPAF	While regional champions exist (e.g. IDCOL and AECP), little knowledge transfer takes place beyond national boundaries.	+++ Learning potential: consider successes of current schemes for mountain settings, rural poor and women's empowerment
RE & EE entrepreneurship, business incubation and innovation	Afghanistan: AREU (initial stages) Bangladesh: IDCOL, IDF Bhutan: - China: Golden Sun Programme and other progr. India: Clean Energy Access Network	Efforts appear still rudimentary and do not represent the state-of-the-art of other sectors.	+++ (learning: consider successes of current schemes for mountain settings, rural poor and women's empowerment)

	Myanmar: REAM (initial stages) Nepal: REF/AEPC Pakistan: PPAF		
HKH Mountain-specific energy information system	Afghanistan: RED (energy database) Myanmar: MoALI/DRD (initial stages) Others: Dispersed efforts / unknown	Gap, limited experience by ICIMOD (HIMAP) Relevance to SE4ALL tracking	++++ Drawing on experiences globally (e.g. SE4ALL), collaboration with national institutes, remote sensing and data management support

Figure 32: REEECH Indicative Synergy and Value Addition Assessment

Focusing more on technologies and approaches rather than functions, there is considerable potential for learning from REEECH member countries and stakeholders (e.g. on sustainable forestry in Nepal, on RE mini-grids in Bangladesh and India, on clean cookstoves in China), and from the leveraging of global initiatives (e.g. Global Alliance for Clean Cookstoves or the HP Network). However, efforts would need to be made in an institutional manner with the long term aim to create a knowledge hub within a centre of excellence.

It can be concluded that relevant experiences already exist among the national institutions of several HKH countries, however, our assessment suggest that limited regional learning has taken place to date. The assessment also suggests that no appropriate institutional vehicle exists for it, which underscores one of the key roles of REEECH, as identified by regional stakeholders. This is to firstly take stock of, and learn from, national experiences and the engagement of international actors, and to facilitate joint actions, partnership synergies and mutual learning on mountain energy solutions, wherever possible.

9 Conclusions

As elaborated by this BNA and confirmed by regional stakeholders, the uniqueness of mountain ecosystems, as well as the socio-economic realities of mountain populations and the widespread energy poverty in the HKH region, necessitates an integrated approach to energy management that is either different from existing national energy policies that often neglect mountainous areas. In some smaller HKH countries, where mountain areas constitute the most of national territories, the fragmentation of markets and the lack of knowledge exchange consider substantial development barriers.

9.1 The need for REEECH

Indeed, the relevance of energy, to many other developmental challenges implies that REEECH may have a unique role to play in providing more insight into nexus solutions to energy, linked not only to climate and environment-related aspects, but also to the water-food-energy nexus (for upstream and downstream linkages) and productive uses. To achieve global policy aspirations, such as the SDG 7 in the HKH area, the BNA reveals that more focus on mountain-specific clean energy access approaches is required:

SDG target 7.1: "*By 2030, ensure universal* ***access to affordable, reliable and modern energy services***"

Little is known about the actual rates and qualities of access to sustainable electricity and cooking energy in mountain areas as data is fragmented, outdated or at least not location specific. It is of utmost importance to establish multi-tier, mountain-specific assessment frameworks and make energy poverty visible and measurable for national, regional and global public policy makers. There are substantial opportunities to learn from existing experience through more south-south cooperation.

SDG 7.2: "By 2030, ***increase substantially the share of renewable energy*** in the global energy mix"

The trend of shrinking RE shares (see section 2.1.1) in the energy mix of most ICIMOD member countries cannot be turned around without the utilization of hydro-power, ranging from small to large. Institutional capacities and mechanisms for sustainable implementation, which are adopted to climate change regimes, beneficial to mountain populations and transcend national boundaries are instrumental for this target. The potential of the emerging solar sector has, furthermore, not been tapped sufficiently due to the lack of appropriate support mechanisms.

SDG 7.3: "By 2030, ***double the global rate of improvement in energy efficiency***"

The extreme climatic circumstances in the HKH region and the prevailing dependency on (unsustainable) biomass use for cooking and space heating in conjunction with poor energy efficiency of buildings leads to the highest energy use at lowest energy efficiency. Without harnessing the hidden potential of energy efficiency for cooking and space heating, which is grossly neglected across the HKH region, attempts to reach adequate levels of energy access will fall short. The long-term changes required call for knowledge sharing and developing cross border markets, e.g. through trade opportunities and common standards.

The HKH mountain belt connects countries with diverse political systems and interests. The challenges encountered in the HKH mountain region, however, appear to be shared by the majority of HKH countries (see Chapters 5 and 6). There are two unequivocal arguments that underline the importance of REEECH and the positive perception of stakeholders for its role in achieving both national and global policy aspirations:

- First, there is **no regional, cross-border organisation covering mountain-specific** issues for the HKH region
- Second, the willingness for **multilateral cooperation between the eight states** outside the umbrella of REEECH has been limited. Sustainable energy offers common ground

Both arguments place ICIMOD in a privileged and responsible position. The high level of national ownership required for REEECH, supported by ICIMOD's existing status as an intergovernmental organisation are a strong advantage in this endeavour. To ensure the **sustainable use of one of the world's largest common pool resources**, a regional institution is required for facilitating the participation of the mountain population in modern energy systems, increasing their socio-economic inclusion and testing waters for transboundary cooperation, wherever opportunities arise. The development of regional mountain energy systems and markets, mechanisms to better participate in regional economic dynamics through connected energy systems, and the development of a mountain energy knowledge management body, have the potential to uplift the long-neglected mountain regions in the long run.

This must also become a priority for the entire region: **overcoming the vicious cycle of energy poverty** which reinforces poverty, and the continued degradation of natural resources, is necessary to reduce the tremendous repercussions of climate change in an environmentally inter-dependent region – the HKH region is the source of 10 major river basins feeding 1.3 billion people. Channelling climate finance to serve the undisputable need for more energy security and **improved climate change resilience of mountain populations** and downstream economies, presents a win-win opportunity for the whole region.

The focus on opportunities rather than persistent political tensions as well as on mountain-energy subject matters may allow for institutionalized regional cooperation and the development of new work-coalitions on the ground. Applying the lens of local economic co-benefits and regional resource conversations makes REEECH's formation indispensable. While REEECH may aim for neutrality, its foundation must, nevertheless, be seen in the greater context of connecting mountain economies located in the HKH belt towards political rapprochement.

Institutional Value Potential of REEECH

As this BNA indicates, REEECH has the potential to add value at multiple levels (local, national, regional and international) and cater to the needs of a broad set of stakeholders, including governmental institutions, the research and education community, civil society groups, NGOs, private sector actors, donors, and most importantly, energy users themselves. Thus, REEECH should act as a **regional centre of excellence** in support of the HKH mountain population and should facilitate cooperation among energy actors to seize new opportunities.

This implies giving utmost importance to all regional mountain and energy issues and promoting dialogue instead of focusing too narrowly on specific national or local challenges and agendas. The institutional value potential of REEECH can be summarized, as follows:

1. Specialized profile on "mountain energy" with work areas that seek to complement existing actor initiatives, support coordination and reduce duplication

2. As an international (and regionally-based) knowledge and learning hub with a focus on:
    a. Best practices
    b. Replicability
    c. Technical knowledge
    d. Policy-influencing and awareness raising
3. As an innovation and business incubator
4. Acting as a regional funding channel for renewable energy and energy efficiency-related investments

9.2 Potential Focus

While the related Feasibility Study for the establishment of REEECH will shed more light on its proposed work-streams, the findings of this BNA, as verified by the recent Validation Workshop, suggest that REEECH should focus on the following key activities and services:

9.2.1 Energy resource and resilience observation

Establishing an up-to-date and comprehensive energy database for the HKH mountain areas is a necessary first step toward creating new strategies for sustainable energy provision. Policy makers need accurate data on supply and demand, resources, and technology in use in a spatially disaggregated manner for evidence-based policy interventions. A regional mountain-specific data management system supporting national actors in data gathering and their handling of mountain-specific methodologies (survey types, remote sensing etc.) is of utmost importance.

To make energy poverty visible and thus addressable, it is proposed to track advancements on access to modern energy along the “Tier Framework Methodology” developed by the SE4ALL initiative and, thereby, act as a hub or thematic centre for the latter with a specific focus on mountain areas. This implies focusing on access to modern cooking energy, electricity, renewable energy systems in place, as well as on energy efficiency, with a strong focus on the latter as it appears to represent the blind spot in mountain energy poverty.

A data repository with an open data policy and web-service should, however, also include more relevant data, among which the population settlements and movements with estimated location-specific energy demands and current consumption patterns should also be considered. Latest geo-spatial tools for integrated planning of rural electrification are highly desired by stakeholders. Existing planning tools will, however, require adaptation to the challenging topographic environments and in view of the analysis of natural energy resources. Therefore, and to support overall investments, an inventory of local RE sources with a focus on hydropower represents strong value additions.

In view of connected downstream economies, it is proposed to widen the scope towards the observation of hydrology, biomass resources and ecosystem services that affect energy and water systems regionally, which are heavily impacted on by both, local energy consumption patterns (e.g. bio-mass over-utilization) and climate change (hydrology and water discharge). With regards to the latter, strong links to regional causes and local impacts of climate change on energy systems, with a focus on black carbon, is also recommended.

Preserving ICIMOD’s recognition as science-based but practice-oriented actor, REEECH may serve as an **observance centre for energy security and resilience** for both, the mountain population and those depending on resources from the HKH region.

9.2.2 Energy policy and market support hub/platform

Measures to enhance energy supply in the HKH have often failed to address mountain-specific challenges, in part because mountains have generally been less prioritized, but also because no conducive institutional arrangements which meet the actual socio-economic realities of mountain communities can be identified. National energy strategies and instruments which are not specifically designed for mountain areas, are likely to be distortionary in the HKH. Energy policy in the HKH must be tailored to contexts considering local needs and resources alongside existing institutions and capabilities to create effective markets for RE and EE.

Support to governments in developing sustainable energy policies, financial support schemes and sustainable energy targets, along with easy mechanisms for progress monitoring is an unequivocal need and niche for REEECH. In addition, stakeholders highlight the need to create effective linkages between international climate finance and regional energy policy, with a specific emphasis on financial mechanisms that incentivise RE/EE effectively. To avoid distortive incentives competing with national schemes, it is recommendable to pursue an indirect approach for both, support in policy advancement and availing climate finance for mountain energy matters.

As the technical needs of national and local governments vary intensively, the creation of a platform or knowledge and support hub in which best practices are shared as a common repository "first hand", will create awareness for options at hand and facilitate the adoption of successful approaches. In addition, the hub may offer reviews of policies, laws and regulations in view of mountain-specific aspects as requested by stakeholders. The following knowledge services are likely to meet the needs of HKH energy stakeholders:

- Stakeholders from all HKH countries named financial incentives for the investment in RE and EE as key to success. Today, many financial schemes are not responsive to specific challenges, thus REEECH may collect best practices and advocate for the creation of mountain-specific financial incentives, as well as the engagement of the financial sector to support market development
- Scaling up modern energy services depends on the existence of effective governance and policy frameworks that create an enabling environment for increased adoption and investment in energy access. Laws and regulations are often not mountain-specific or fail to address the needs of essential stakeholders. REEECH may thus provide a platform to sharpen the view on such issues and provide technical assistance, as requested
- Mountain areas which often have artificial borders within similar population structures can benefit substantially from local and regional cross-border cooperation in energy systems. Aspirational approaches have, however, often failed due to regional tensions. It is thus deemed more effective to identify windows of opportunities and support building trust in bilateral or trilateral arrangements, for which REEECH may offer room and establish a code of conduct for transboundary projects in view of fairness and sustainability
- Doubts about the efficiency of the innumerable small and medium-sized non-governmental organisations alongside the multiple international development partners were expressed. The lack of oversight is viewed as a risk to development with NGOs and INGOs assuming responsibilities of the public domain. Mapping out such initiatives, and providing overview and transparency, can greatly support programme planning and alignment with governmental initiatives. REEECH may also offer to host such regional initiatives

9.2.3 Sustainable fuels and EE in mountain buildings

Even ahead of the need to increase access to electricity, there is an urgent need to look at solutions for either **improving the efficiency of biomass use, making it more sustainable or substituting it completely**. Excessive biomass usage for cooking and space heating and the resulting deforestation and biomass loss are widespread in HKH, resulting in major impacts on ecosystem services, climate change, and impacting on human health. Despite the urgency, a focus on efficient biomass use and sustainable forestry, appears to be systematically neglected in HKH countries.

Sustainable energy has now emerged as the centre-piece of mitigation and adaptive responses, but while countries of the region have experimented with improved cookstove programmes, their adoption and success has remained below expectations. There is a growing consensus among practitioners that the aspect of sustainable cooking fuels has been neglected for too long while cooking devices were promoted. As of today, there are interesting approaches ranging from community forestry management (Nepal), the use of liquified petroleum gas (LPG) in India, to the use of electrical power for cooking in Bhutan and China.

In contrast to cooking energy, energy efficiency in buildings has never received the required attention and remains the blind spot of mountain energy in most countries. Addressing the issue of sustainable fuels, energy efficient buildings and cooking devices requires a long-term perspective as they are deeply rooted and linked with livelihood strategies, energy security in harsh climatic and economic environments, and are linked to perceptions of socio-economic status. They are furthermore location-specific with regards to cooking preferences, traditions and local architecture. Thus, increasing energy efficiency calls for a range of activities including:

- optimizing effective use of biomass
- upgrading the quality of biomass fuels
- promoting sustainable fuelwood forestry
- migrating up the energy latter once systems are viable
- preservation and advancement of traditional building techniques
- introduction of new environmentally-friendly insulation
- supporting innovative approaches by architects and planners
- capacity building for construction companies

REEECH's support for advanced energy efficiency must be a long-term commitment linked to the behavioural change of consumers, market creation and policy chance. There are, however, several mid-term opportunities, which may prevent that more and more concrete buildings with poor energy attributes (large windows, wrongly dimensioned and poorly located) are built in higher altitude areas, which migrating labours associate with economic achievements.

9.2.4 Sustainable power systems

Three distinct characteristics stand out in terms of power systems in the HKH mountains: (1) Large-scale hydropower supplies Asia's growth centres but often fails to include local populations in its benefits, (2) small, micro and mini-hydro power systems are installed in vast numbers but often suffer from operational issues, and (3) the lack of private sector engagement as small power producers (in particular in PV systems), which is an emerging market in Asia and Africa, has not made significant progress in the HKH mountain areas. These deserve REEECH's special attention:

(1) Large hydropower: While large hydropower projects are far from uncontroversial due to their severe environmental and social impacts, the chances for their accelerated implementation remain high across the HKH region. An integrated approach ensuring project development in mountain areas within environmental limits, management of existing negative environmental and social impacts, and the participation of local areas in revenue sharing, is greatly needed. By positively addressing these aspects, large hydropower has the potential to mitigate the energy challenges in the entire region while generating revenues for alleviating the poverty of mountain communities and maintaining biodiversity. REEECH may support governments in adopting sustainable approaches as a neutral mediator and advisor.

(2) Micro, mini and small hydropower: A particular feature of the HKH mountain region is its topography, hydrology and settlement patterns, which make small, mini and micro hydropower technically and economically more preferable options in comparison to solar solutions. Though a vibrant sector for their development exists across the HKH region, quality issues in hydrological, electrical, and structural engineering aspects, often decrease their impact, prevent productive uses and make centralized power systems more preferable from a user's perspective.

An action- and quality-oriented approach to small, mini and micro hydropower should be taken. If the mandate of REEECH goes in the direction of promoting sustainable energy markets, industries, and innovation, the centre should adopt a private sector-oriented approach to help overcome chronical problems, with a focus on producer and project implementation markets. Strong practitioner hydropower networks already exist[84] and may be integrated into REEECH. A database on small scale hydropower sites based on site identification with flow-data would be highly effective.

(3) Small power producers and community-based models: Besides hydropower, it is the emerging decentralized solar sector that brings new dynamics through new delivery models. While progress has been made with decentralized projects in individual HKH countries, developments are still fragmented and have not yet transformed into economies of scale and vibrant markets in mountain areas. The BNA reveals that mountain areas pose high opportunity costs for private investors, who tend to prefer investments in more densely populated plains.

As highlighted by most stakeholders, the mountain energy sector lacks innovative capacities. It is for this reason that community-based operation models are still prevailing although they often face substantial challenges[85]. It is therefore suggested to focus on the promotion of appropriate business models, which may be blended approaches[86]. It is proposed to foster decentralized power projects through business model incubators, to establish helpdesks for technical back-up services as well as to provide advice for local governments on how to best create enabling environments[87].

The results of this BNA and the recent validation workshop can be summarised as encouraging. A clear need for the establishment of REEECH, with a unique focus on mountain energy and energy-related issues, has been expressed by regional stakeholders. The potential and value-added of REEECH has also been echoed by key international stakeholders and major donors, since donor funded programmes often experience difficulty in reaching remote mountain areas, as well as from the duplication of efforts.

[84] The could be supported by REEECH. While the practitioner network hosts also non-mountain countries (such as Indonesia), it includes many HKH countries, which would benefit substantially from an increased focus on mountain areas.

[85] As they divide the responsibility between implementation and operation, do not incentivise well for replication and often suffer from operational problems due to lacking local capacities and after sales services.

Moreover, there is an expressed need articulated by almost all stakeholders, to exchange knowledge on decentralized renewable energy and energy efficiency solutions in the mountainous areas (e.g. the energy efficiency of buildings, cooking solutions and mini-grids). There are also manifold examples from which various countries can learn from each other (e.g. building material standards, portable solar solutions, micro-credit financing schemes etc.). The outcomes of the BNA and Validation Workshop will help to inform and refine the feasibility study for the establishment of REEECH, which will consider the technical mandate of REEECH, its institutional design, work programme and financial considerations.

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