Norad

NEPAL – NORWAY

60 Years of Energy Cooperation

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Cover photo: Espen Røst

Anne Beathe Tvinnereim,
Minister of International Development, Norway

"Nepal is a long-standing partner in Norway's development cooperation. This year we celebrate 60 years of cooperation in the energy sector.

During this period, Norway has contributed NOK 1.3 billion to the energy sector in Nepal. Perhaps even more important is Norway's contribution to capacity building in Nepal's energy sector, especially in hydropower. Today, Nepal can largely depend on its own human resources with regard to the development, construction and operation of its hydropower potential.

Without access to energy, there will be no economic development. Utilization of Nepal's hydropower and other renewable energy resources, also taking environmental and social issues into account, are important prerequisites for a socially inclusive economic development. Hydropower accounts for more than 95 percent of installed capacity in Nepal's electricity system. These resources are also important for combating climate change – in Nepal as well as in the region."

"Norway has been an important partner for Nepal in the energy sector in the areas of development of hydropower, power transmission lines and distribution systems. Today, there is a growing investment in generation, however, the per capita consumption is very low. The challenge now is to build capacity of transmission and distribution for increased domestic consumption, not just for lighting, but for more productive use and transitioning away from fossil fuels in transport and in cooking. We highly appreciate Norway's support in building transmission lines, substations, and distribution lines as well as in rural electrification. Also, to be mentioned, is Norway's support in preparing a distribution plan for entire Nepal; the distribution master plan is now being used as a basis for further electrification activities. We are thankful for all the support from Norway and hope that this cooperation will continue in future to provide reliable renewable energy access to all Nepali."

Mr. Kulman Ghishing,
Managing Director, Nepal Electricity Authority

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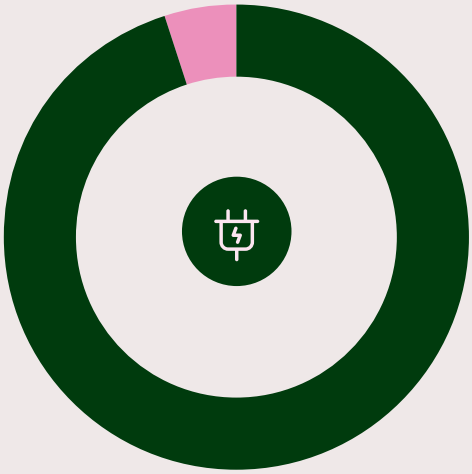
HIGHLIGHTS

Key results after 60 years

Nepal has:



Connected 95% of all households.

About 72% of the population to the grid and about 23% to off-grid solutions.

Built 5,000 kilometers

km of 66 kV and above high voltage transmission lines. 188,000 km of 33 kV and below high voltage transmission lines.

X 40

increased power production, from about 6 MW in 1963.

Installed 2,600 MW

of total power capacity, predominantly generated from hydropower.

In the 60 years of energy cooperation between Nepal and Norway, Nepal has had remarkable achievements within clean energy. Over the years, Nepal has built substantial hydropower capacity, and enabled energy infrastructure and rural electrification.

Norway has contributed to developing a professional hydropower industry, with high national competence and a legal framework. These contributions support Nepal's achievements and facilitate investments both in semi-public and private renewable energy developments.

Norway has contributed to:

700 & 1,000 kilometers

Construction of more than 700 km of transmission lines and 1,000 km of distribution lines, creating more stable connections and enabling more connections to the grid.

1/6

Facilitating over 500 MW of a total 2,600 MW installed hydropower capacity, though direct project support.

Training more than 10,000 students at Butwal Technical Institute.

Educating more than 3200 Undergraduate and Graduate students at Kathmandu University.

6 million people gaining access through off-grid solutions.

Electricity connection for 200,000 rural households via mini-grids.

Connection for 645,000 rural households through stand-alone systems.

Connection for 1 million households to improved cooking solutions.

More than 300,000 people with grid connection

gained access around Tinau, Andhi Khola, Jhimruk and Khimti power plants.

2 billion USD

Mobilized in semi-public and private investments for 1,500 MW power capacity through an enabling legal framework.*

*Assuming 1,500 MW hydropower developed with a direct or indirect contribution from Norway, and a unit cost of 1,5 million USD per MW

Contributions with different degrees of attribution.

Photo: Espen Røst

CHAPTER 1

Introduction

In 1960 less than one percent of Nepal's population had access to electricity. As of 2023, 60 years later, the World Bank reports that nearly 95 percent of Nepalis have access.[1] Today, the hydropower sector is a success story, with a vibrant electricity industry and highly skilled expertise within educational and research institutions. From 1 MW in 1963, installed capacity within hydropower has increased to more than 2,600 MW by 2023.

However there is still a considerable effort remaining to achieve the Sustainable Development Goals, such as eliminating poverty, providing universal access to clean energy, and sustainable industrialization and infrastructure development. Today, despite high rates of access to electricity, overall energy consumption continues to be dominated by use of biomass, such as fuelwood, agricultural residue, and animal waste, and 60 percent of the population is directly involved in agriculture.[2]

Installed hydropower capacity still constitute a small share of the estimated 40,000 MW hydropower potential.

The energy sector cooperation between Nepal and Norway began in the 1960s, long before diplomatic relations were initiated in the 1970s. This report describes the main achievements of a long-standing cooperation.

1 ESMAP, *Nepal: Beyond Connections, Executive Summary* (2019) p. 2
2 **Nepal Energy Sector Synopsis Report* (2022) (wecs.gov.np) p. ix-x

Higlights

- Capacity building and institutional development
- Hydropower generation and industry development
- Rural electrification and grid expansion increasing electricity access further

Electricity access vs. consumption

"Access rates" refers to the share of the population that is connected to the grid or within reach of the grid.

"Per capacity consumption" refers to actual usage of electricity and gives an indication of the rate of industrialization and household consumption. A person may have access and be connected to electricity but use it for very few daily tasks. Nepal has an annual per capita consumption of about 250 kWh, which is low in a global context.

About Nepal

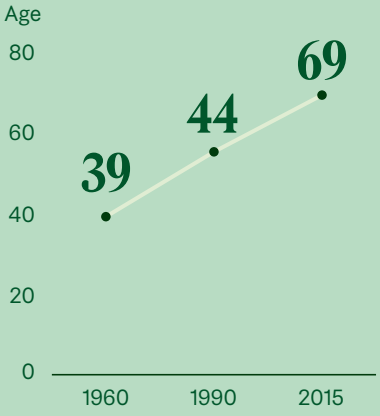
Capital:
Kathmandu

Population:
30,034,989

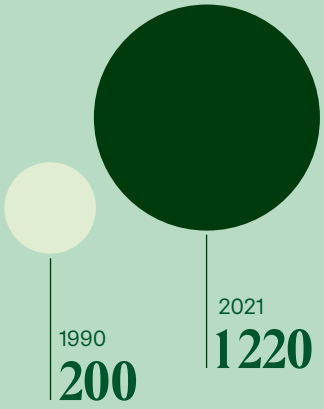
Area:
147,180 km²

Number of ecosystems:
118

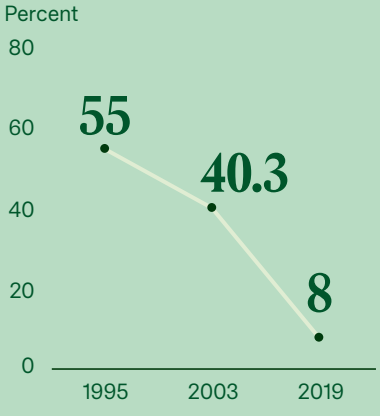
Government form:
Republic (since 2008)



Life expectancy
Source: World Bank (2023)



Gross National Income (USD)
Source: World Bank (2023)



Poverty head count ratio
People living under 2.15 US$/day
Source: World Bank (2023)

Photo: Espen Røst

CHAPTER 2

Overview and milestones

Nepal and Norway –
development partners since the 1960s

Energy cooperation between Nepal and Norway covers development of hydropower in parallel with capacity building, education, and rural energy access. The early periods of cooperation are characterized by development of hydropower production, as well as specialized education. Later, improving framework conditions and ensuring environmental and social safeguards became equally important areas.

After the 2000s, support for increased access to electricity and clean energy solutions was a priority. Grid expansion and off-grid solutions were both important, with attention to rural areas. Norway has supported several rural energy programs, as well as grid expansion, together with other partners.

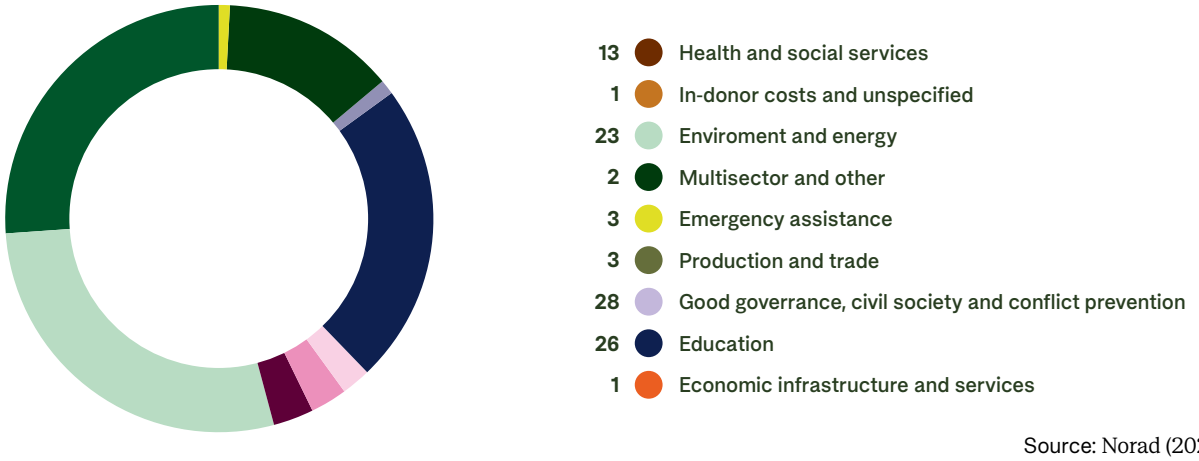
Norwegian official development assistance (ODA) to Nepal between 1963 and 2021 totals approximately 5.7 billion NOK.[3] Of that, about 1.3 billion NOK – or 23 percent – has been support to the energy sector.

3 In nominal terms. Note that the amount is higher in real terms. (Source: Norad, 2022)

→ **Rural access:** Wife and husband Ishwor Basnet and Manju Basnet from Namadi in Ramecchap district look at the fields where their animals graze. Being small-scale farmers in the area around the Khimti hydroelectric plant, they have had access to electricity for 14 years. Photo: Espen Røst

FIGURE 1

Total transfer of ODA to Nepal (1964-2021), share by sector.



Source: Norad (2022)

Name: Ishwor Basnet and Manju Basnet
Occupation: Small-scale farmers

Ishwor Basnet and Manju Basnet carry fodder up hilly tracks from Haluwa hydroelectric plant. Photo: Espen Røst

↓ Ishwor and Manju collect fodder for their animals almost every day, by foot. Photo: Espen Røst

"Having electricity is a big difference. We used to have kerosene lamps, but they are expensive and give poor lighting. We live a simple life, but we have everything we need."

– Manju Basnet

Manju and Ishwor own one buffalo, two calves, eight goats and three chicks. Photo: Espen Røst

1960s:

Absolute monarchy and the beginning of Norwegian energy cooperation

In the general context, a phase of ending isolationism implied that India and other countries, started to sponsor and support hydropower development in the late 1950s. In the 1960s, Nepal again became an absolute monarchy.

Hydropower has a long history in Nepal. Although there has been a boost in generation in recent decades, hydroelectric generation in Nepal has existed for more than a century. The first hydroelectric plant, Pharping (0.5 MW), was commissioned in 1912. Twenty-five years later, the second, Sundarijal (0.64 MW), was built.

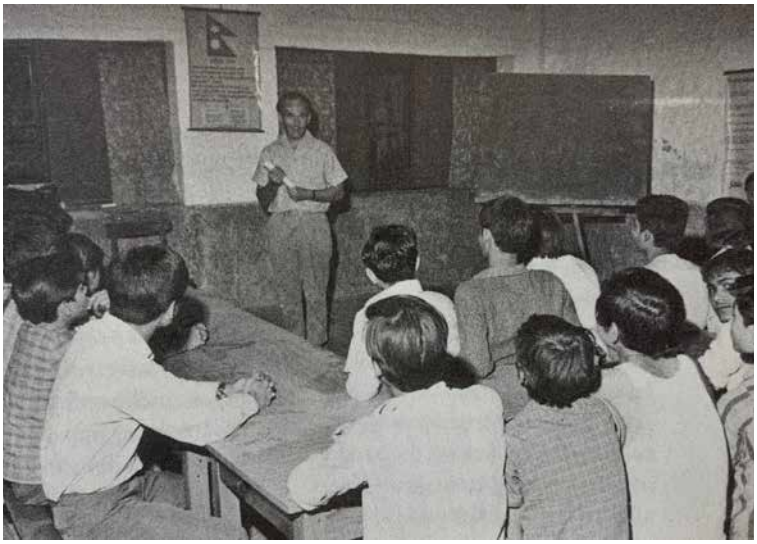
Compared to Norwegian energy cooperation with countries like Uganda, Bhutan, Mozambique and Tanzania, the beginning of energy collaboration with Nepal was different. The first activities in Nepal began with the personal engagements of engineer and teacher **Odd and Tullis Hoftun**, placed in Nepal by **United Mission** to Nepal (UMN), through **Tibetmisjonen** (now HimalPartner). The establishment of **Butwal Technical Institute (BTI)** in 1963 sparked the subsequent cooperation on hydropower continuing well into the 2000s.

With sufficient finance for the 1 MW Tinau hydroelectric powerplant in Butwal in 1968, hydropower development cooperation was a reality. BTI has since trained skilled and semi-skilled workers, and inspired other energy developments such as the first fully commercial hydroelectric enterprise, **Butwal Power Company Pvt. Ltd (BPC)**.

Capacity building has been at the core of the Norwegian development cooperation since the beginning. Moving to Nepal to support the establishment of a hospital in Tansen, the Hoftuns initiated projects within education, energy industry and hydropower development. An essential principle was to ensure local capacity building in each infrastructure project. In the early periods of cooperation, Norwegian support focused on development of in-country competencies within civil and electromechanical engineering, through on-the-job training and skills transfer from Norwegian counterparts and experts.

"To be an 'expert' is one of the most dangerous things to be. Whatever qualifications we have, we are not experts in knowing what will work in Nepal."

– Odd Hoftun in *Kraftverket* by Peter Svalheim



Odd Hoftun and students during the early days of Norwegian support. Photo: UMN

1970s:

Local skills for industrial development

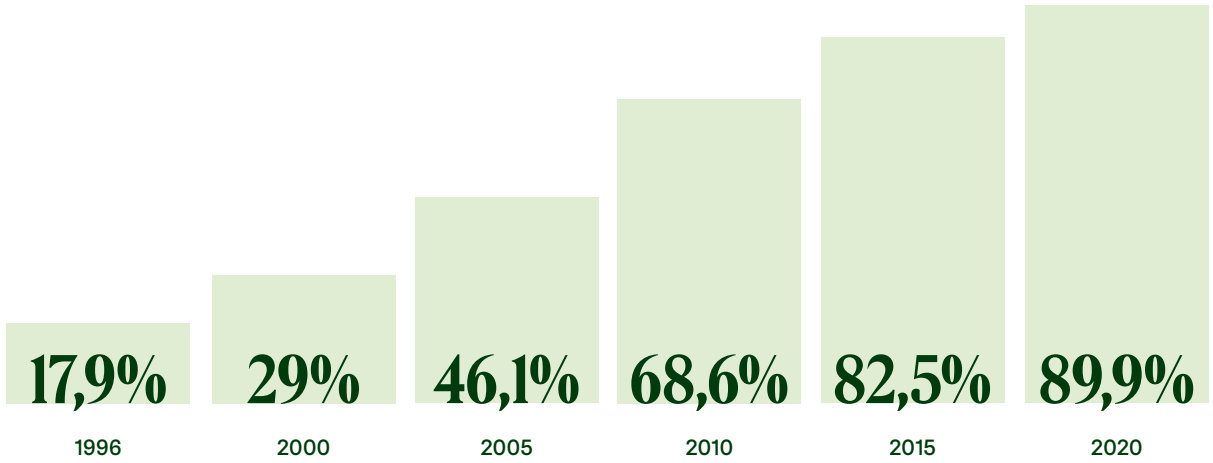
In the general context, Nepal implemented five-year social-economic development plans, which were introduced with the Panchayat system. Politically, focus was put on building basic infrastructure including power supply. A state-regulated market and public ownership was the norm.

Providing the first megawatt, **Tinau hydroelectric plant** supplied electricity for BTI and the town of Butwal. Starting at 50 kW installed in 1970, the capacity of Tinau hydroelectric plant increased gradually to a little more than 1 MW in 1978. The construction company **Himal Hydro** was established the same year. After Tinau, construction of other small-scale hydropower plants followed.

Now and then: Above, Tinau hydroelectric plant at the start of operation in 1978. Below, the Tinau dam in full operation today. Note the difference in water flow due to seasonal variation. Photo: HimalPartner and Espen Røst

FIGURE 2

Total population with access to electricity.



Source: World Bank (2023)

1980s:

Incremental hydropower growth

In the general context, Nepal moved towards a multi-party democracy. At the same time local people were empowered, and a demand for local involvement in infrastructure development projects emerged.

Two major hydropower projects were planned in the period, with Norwegian support – **Andhi Khola** (5.1 MW) and **Jhimruk** (12 MW). Andhi Khola led to the development of the company **Nepal Hydro and Electric (NHE)** in 1985, with links to BTI.

Capacity building was supported through a hydraulic laboratory for modelling the Jhimruk project, in cooperation with the **Norwegian University of Science and Technology (NTNU), International Centre for Hydropower (ICH)** and the Institute of Engineering at **Tribhuvan University (TU)**.

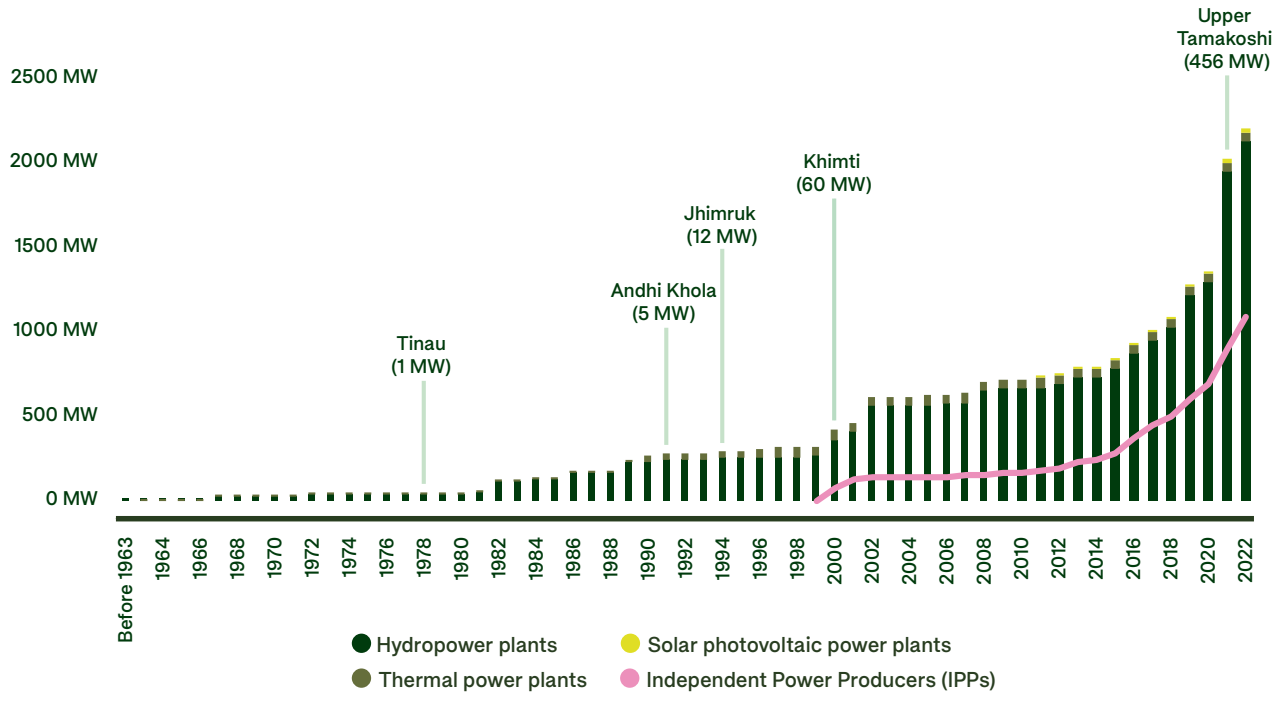
National energy legislation was introduced in 1984, followed by the establishment of the **Nepal Electricity Authority (NEA)** in 1985.

Nepal Electricity Authority (NEA)

The national public utility responsible for the development and operation of supply, transmission, distribution, and sales of electricity in most of Nepal.

FIGURE 3

Installed power generation capacity build-up, 1960-2022.



A little power, big difference: Idru Karki and her husband have a wheat mill and oil press in Khimti Bazaar. Idru and Prem Bahadur Karki help customers polish rice by removing the shells and pressing mustard seeds to oil. Photo: Espen Røst.

1990s:

Stronger cooperation and a new legal framework for the energy sector

In the general context, Nepal became a multi-party democracy by 1990 and the government regarded hydropower development as a tool for industrial and economic development. Less than 20 percent of the population had access to electricity.[4] In this decade Nepal became one of Norway's main development cooperation partners, with energy as a key focus area.

Andhi Khola and **Jhimruk** came into operation in 1991 and 1994. Addressing a demand for increased power supply, the larger **Khimti hydroelectric plant** (60 MW) was planned, developed, and constructed. Norway provided funding for the early phase feasibility study. **Himal Power Limited (HPL)** was created as a public-private partnership between Norwegian Statkraft and Butwal Power Company Pvt. Ltd.

Capacity building was strengthened through the continuation of the Jhimruk hydraulic laboratory, now set up as an independent company, **Hydro Lab Private Limited (Hydro Lab)**, with financial support from Norway. NTNU initiated the **international hydropower master's program**, where about 120 Nepali engineers have obtained their degrees.

Energy legislation was enacted in parallel with expanding hydropower capacity. **The legal framework for electricity** was enacted in 1992, prepared with assistance from the **Norwegian Water Resources and Energy Directorate (NVE)**. The act was important to ensure successful financial closure of the Khimti hydropower project and created a general framework for private investments in the energy sector.

4 World Bank (2023) Access to electricity (% of population) - Nepal | Data (worldbank.org)

2000s:

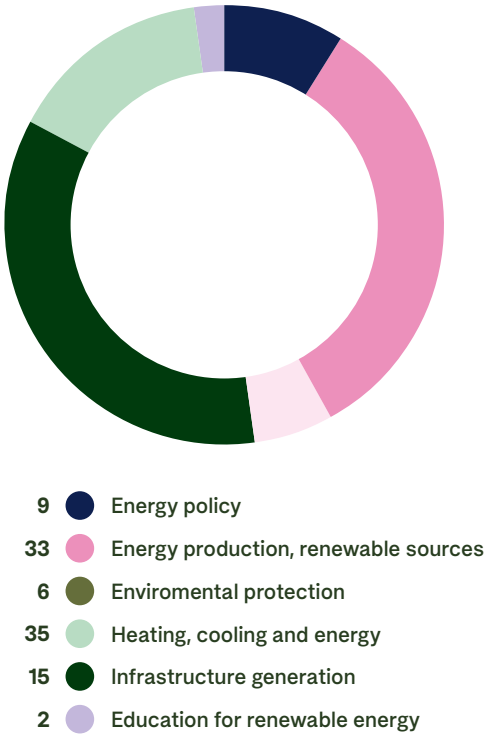
Environmental safeguards and rural energy access

In the general context**,** Nepal became a republic in 2008. In this decade, electricity supply could not keep up with growing demand, leading to load-shedding (black outs) of 12 hours or more. Political unrest made it difficult to start new on-grid projects, which are capital intensive and conflict sensitive. To a large extent, donor support shifted towards rural energy development.

The Khimti hydroelectric plant was commissioned in 2000, and at the time it delivered a quarter of the national electricity supply. Norway funded electrification

FIGURE 4

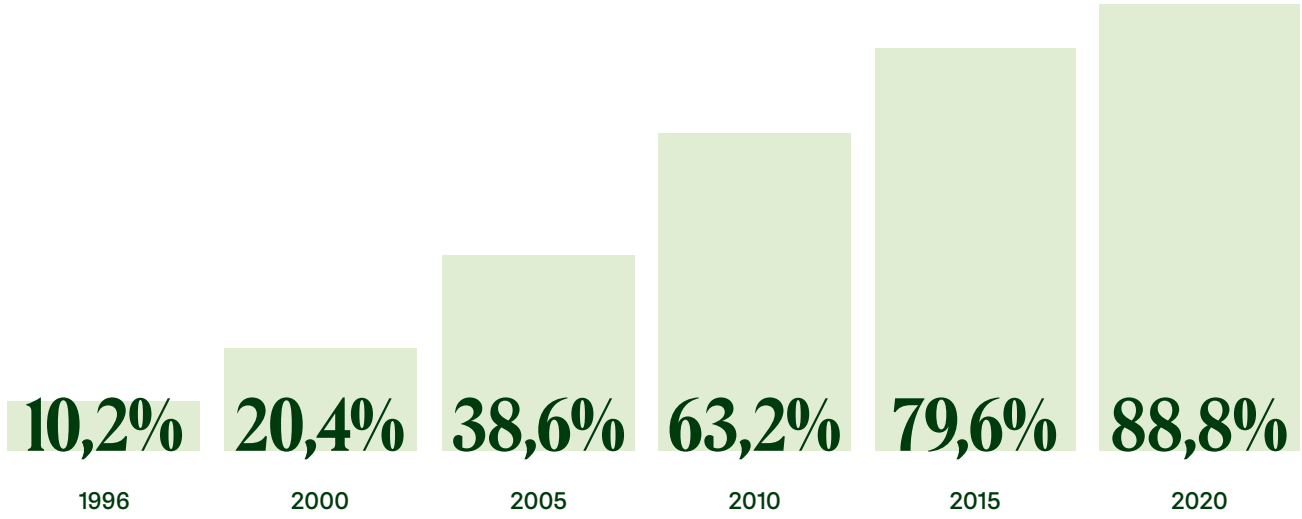
Total Norwegian energy support to Nepal (1964-2021), share by subsector.



Source: Norad (2022)

FIGURE 5

Rural population with access to electricity.



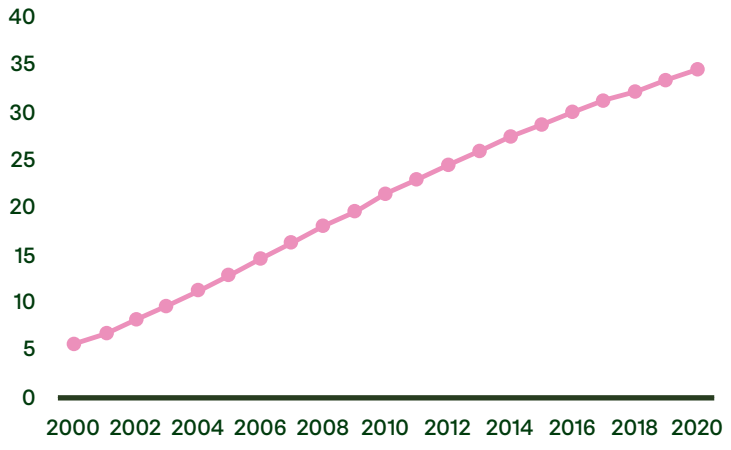
Source: World Bank (2023)

of adjacent villages to the plant through the **Khimti Rural Electric Cooperation (KREC)**, formed in 2004. Capacity building focused on strengthening institutions and building governmental capacity, especially on Environmental Impact Assessments and social sustainability. These were integrated into regulations and concession agreements for hydropower developments. The **Rural Energy Policy** was introduced in 2006.

Norway supported rural electrification amongst others through the **Energy Sector Assistance Programme (ESAP)** Phase I (1999-2007) and Phase II (2007-2012). By the end of Phase I, more than 275 000 rural households had access to improved cookstoves. More than 100 000 households had electricity from micro-hydro and solar home systems.

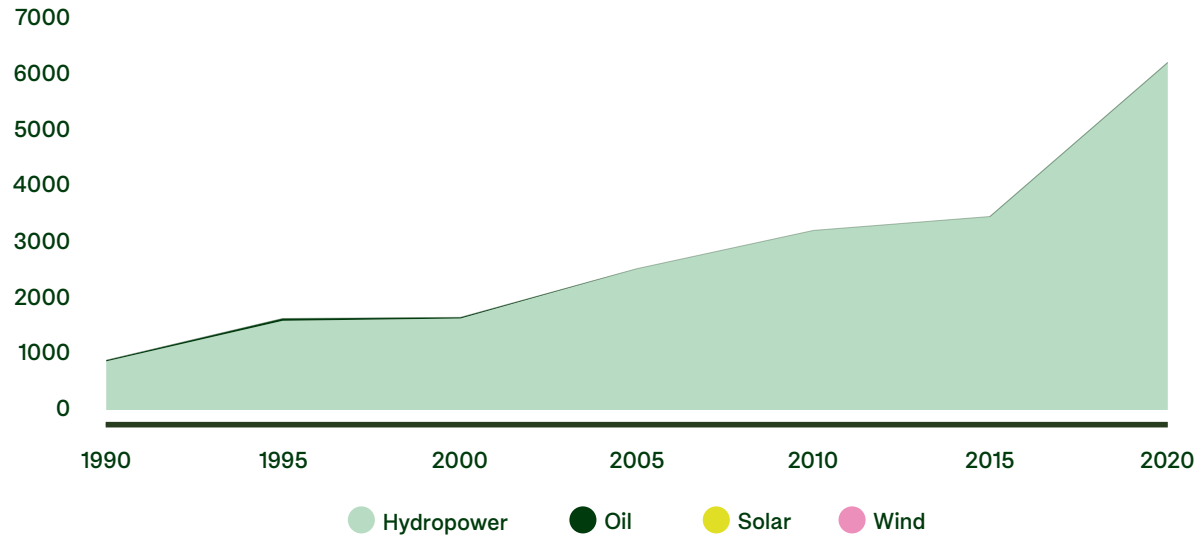
FIGURE 6

Access to clean fuels and technologies for cooking in the population, in percent.



Source: World Bank (2023)

FIGURE 7
Electricity generation in Nepal, by source (GWh)



Source: IEA (2023)

2010s until today:
Surplus and trade

In 2015 a major earthquake left central parts of the country devastated and damaged. The same year, a new constitution was enacted.

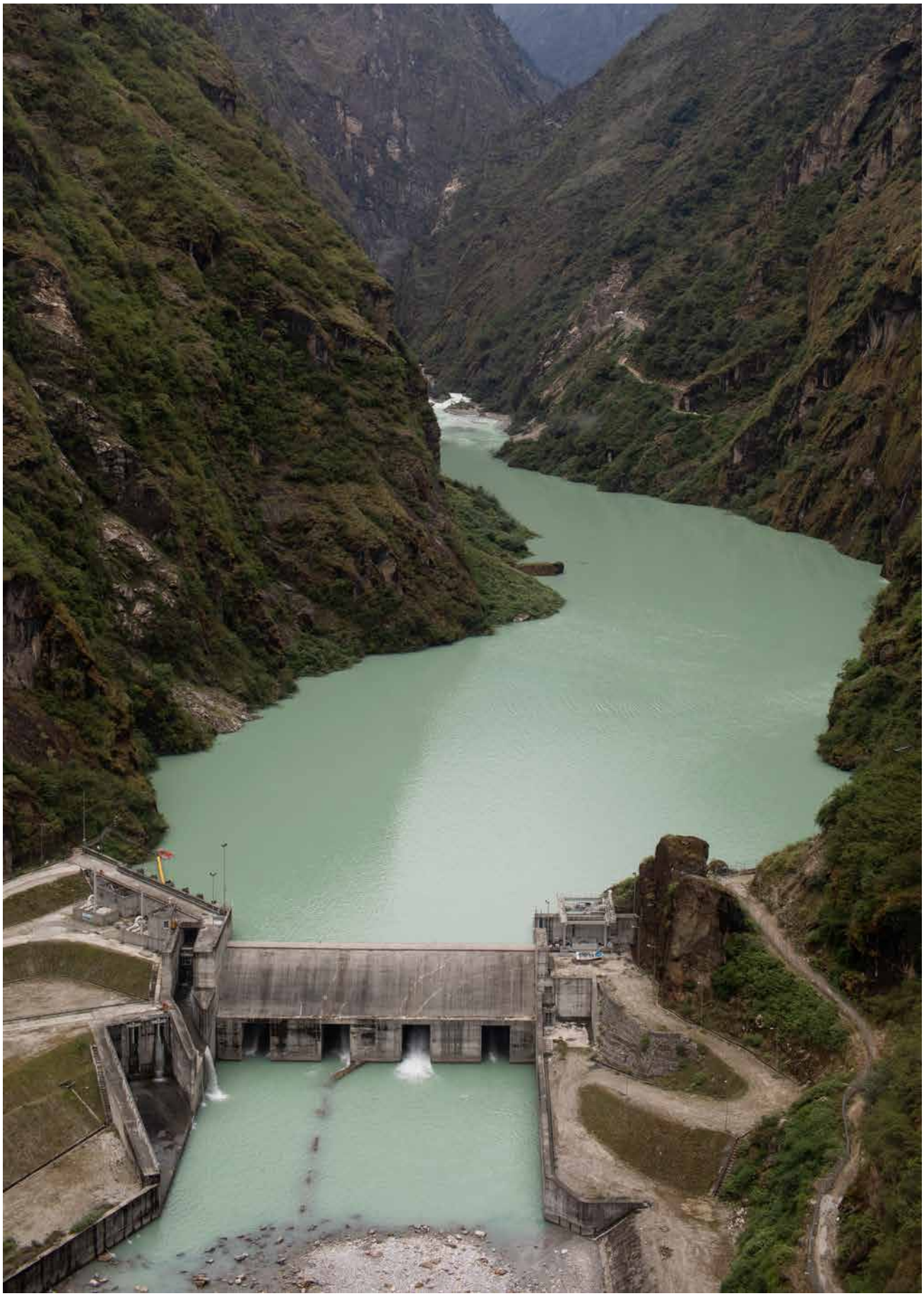
Towards the end of the decade Nepal Electricity Authority, the national utility, was able to end most of the load-shedding. A seasonal surplus situation emerged by the summer of 2021. In 2017, the first cross border transmission line came into operation, with the 400 kV Dhalkebar-Muzaffarpur (140 km). In the financial year of 2021/22, NEA reported that about 500 GWh of electricity was exported to India.

Energy legislation was updated in 2013 with the *National Energy Strategy,* followed by the *Renewable Energy Subsidy Policy* in 2016. A government white paper updated the strategy for electrification: New targets include a goal of increasing electricity capacity to 15,000 MW by 2028, of which 95 percent from hydropower. Electricity demand is expected to increase fivefold per capita. Alternative renewable energy sources are promoted, such as solar power.

Norway supported the planning and development of the **Upper Tamakoshi hydroelectric plant**. Upper Tamakoshi was commissioned in 2021, becoming the largest hydropower plant in Nepal with 456 MW of installed capacity. Norway continues to co-fund distribution and transmission projects through the Asian Development Bank: Norway also supports research and education for sustainable development of the energy sector.

Support for rural electrification continues, such as through the **National Rural Renewable Energy Program (NRREP)** between 2012 and 2017. The program focuses on access to clean energy for rural villages, gender equality and social inclusion.

→ **The Upper Tamakoshi** river flows from the Himalaya mountains. Norway financed the initial feasibility study, and Upper Tamakoshi has become Nepal's the first power plant to be built with local finance. Photo: Espen Røst



Name: Purnima Pandey
Occupation: Trainee at Butwal Technical Institute with work placement at Nepal Hydro and Electric
Location: Butwal

Few women: Purnima Pandley is building a distribution transformer and is one of few female trainees in electrical power technology at NHE. She worries that other women perceive practical studies as too difficult. While her parents wanted her to study economy, she enjoys practical work, and decided to work in the field rather than in an office. There is still a way to go for increased gender balance in the sector. Photo: Espen Røst

CHAPTER 3

Capacity building and institutional development

Norway has contributed to:

- **Training of 10,000 technicians** through the establishment of Butwal Technical Institute.
- **On-the-job training** in hydropower, transmission and distribution, building in-country competency and workforce within the civil, electrical and hydromechanical sector.
- **Establishment of a laboratory** for hydraulic modelling of hydropower projects, *Hydro Lab*, as well as high voltage and turbine testing laboratories at Kathmandu University.
- **Educating over 3200 Nepali students in engineering programs at Kathmandu University and Tribhuvan University** through stipend schemes and more than 180 students at NTNU and other Norwegian universities.
- **Professional training within hydropower and the general power sector** through the International Centre for Hydropower.

Early Days: Butwal Technical Institute
On the 7th of November 1963, the agreement establishing **Butwal Technical Institute (BTI)** was signed, marking the beginning of the Nepal-Norway partnership. Starting with four students and mainly foreign volunteers as staff, the institute today has 325 students in electrical, mechanical, and civil engineering. The institute offers engineering programs within diploma, pre-diploma and vocational short-term trainings. Longer programs have a duration of two to four years. Training programs follow a model of 20 percent theory and 80 percent practical training. Students are admitted according to their potential, based on a principle of non-discrimination, with an emphasis on inclusion of low income and marginalized groups.

The institute modernizes along with the digital developments in society, and now has computer labs and building workshops with computerized machines. This allows students to learn numeric coding and designing in programs such as AutoCAD. New buildings to house the machines are under construction, funded by Norway, through HimalPartner.

Since the first students started in 1965, over 10,000 students have graduated from BTI.

Skills development at BTI then and now: Above, students in the early days of BTI. Below, Kalpana Thapa started her first year at BTI in 2022. Photo: UMN and Espen Røst

Name: Resham Raj Tharu
Occupation: First-year student at BTI

Photo: Espen Røst

"I chose this education because there are good work opportunities after."

– Resham Raj Tharu

← **Measuring:** A student patiently carries out a task at BTI.
Photo: Espen Røst

"I am proud and privileged to be one of many individuals who have benefitted from capacity building under the Nepal-Norway cooperation. It has strengthened my knowledge and motivation to contribute towards sustainable hydropower development in Nepal."

– Pratik Pradham, Vice President of BPC

Photo: BPC

Nearly 60 years in operation: Nepal Hydro and Electric was established by Odd Hoftun in 1964. Today NHE has 83 full-time employees. 81 trainees, and 71 hired on contract. Activities include producing and repairing machines and equipment for hydropower, roads, tunnels, and electric grids. Photo: Espen Røst

Nepal Hydro and Electric

In 1985 the mechanical and welding workshops were separated from BTI. This laid the foundation for Nepal Hydro and Electric (NHE). Students from BTI would conclude their education with a traineeship at NHE, which provided students with practical training, while the workshops got access to new employees. This model for practical education has been continued to date. The workshops deliver services to a range of industries, such as construction of the East-West highway.

NHE was originally established to handle the electromechanical work for the Andhi Khola hydroelectric plant. Manufacturing transmission poles and lattice towers for Andhi Khola was carried out in Butwal and NHE was tasked with overhauling and installing all secondhand equipment from Norway. The Norwegian turbine manufacturer Kværner sent staff from their workshop in Norway to BTI to train them in equipment refurbishing. Some of

Odd Hoftun's principles for capacity building in education, electrification and enterprise:

Slow and steady – investing in human capacity rather than technical equipment, even if it takes more time, for better long-term results.

Use what you have – refurbish existing resources rather than buying expensive new equipment. Build skills for maintenance and repair.

Start small and grow as you learn – using the insights from one project to slightly increase the ambition of the next, as seen in Tinau and BTI and into the 2000s.

Integrated development – build a whole ecosystem, from staff, institutions, operation and maintenance, rather than 'silos' for infrastructure and hydropower production.

Repairs:
At Nepal Hydro and Electric, repairs are being made on a turbine from the Jhimruk hydroelectric plant, damaged by erosion due to sediments. Photo: Espen Røst

BTI's staff came to Norway for training. Today, BTI students still train at NHE during their traineeships, and a large number are employed at the factory and workshop after completion of studies.

NHE manufactures and repairs equipment for hydropower, tunnels, roads, transmission, distribution, telecommunication and more. With 240 staff members, one third are fulltime employees, one third are apprentices from BTI and the last third are contracted workers. NHE is the largest and most experienced hydromechanical workshop and manufacturer in Nepal. NHE has been part of consortiums which have won construction contracts in the transmission and distribution projects where Norway provided co-financing with the Asian Development Bank and the Government of Nepal.. The off-grid sector also utilizes nationally manufactured equipment, and the deliveries of NHE are of significant national value.

"We receive numerous hydroelectric turbines which need repair. It is important that we do a good job so the hydroelectric plants can operate fully without problems and breaks."

– Ashok Gharti

Education and research cooperation
The Nepali-Norwegian university partnership and associated education and research programs emerged from a meeting between Professor Dagfinn Lysne (NTNU) and Odd Hoftun in Oslo in 1986, at a seminar about hydropower development in Nepal. Shortly after the meeting, NTNU and the Norwegian-based International Centre for Hydropower (ICH) started a partnership with BPC and Tribhuvan University in Kathmandu. The first goal was to establish a hydraulic model laboratory at the university campus. The initial project modelled the Jhimruk hydroelectric plant and soon others followed, such as the Khimti project. The laboratory became a shareholding company named Hydro Lab Pvt. Ltd., owned by BPC, Tribhuvan University and non-governmental organization People, Energy and Environment Development (PEEDA). Norway financed a multi-year program, which further strengthened Hydro Lab, and continued cooperation with NTNU and ICH.

Photo: Espen Røst

Today Hydro Lab is an internationally reputable institution and a research partner in **Energize Nepal**, funded by the Norwegian Embassy. Hydro Lab is registered as a non-dividend distribution company, with the sole purpose of providing services to hydropower developers and supporting research and academia in the field of sediment science.

NTNU and ICH provided Hydro Lab with advisors and specialized further education to Nepali engineers so that they could run the laboratory independently of Norwegian support in the future. NTNU offered a master's program in hydropower-related subjects, with support from Norway. Since 1993, more than 120 Nepali students have received a master's degree in

"Carrying out modelling for hydropower projects is important because most rivers in Nepal are steep and unpredictable. These types of tests were not done in Nepal before Hydro Lab was established."

– Dr. Ing. Meg B. Bishwakarma, managing director of Hydro Lab

Understanding the flow: Gonish Pudek and Nir Bahadur Shreshta are measuring how the stream and velocity are distributed and how sand and other objects move along the river at Hydro Lab. Photo: Espen Røst

hydropower development at NTNU, many with scholarships from Norway, while 10 to 20 students have completed a PhD. Over 60 Nepali students have received energy-related academic degrees from University of South-Eastern Norway and Norwegian University of Life Sciences.

A new turn

In the early 1990s, Vice Chancellor of Kathmandu University, Suresh Raj Sharma, with former rector at NTNU, Inge Johansen, established the School of Engineering. After a bachelor's program was established, initiation of a master's program followed, with support from Norway. NTNU graduates, seconded by HimalPartner, worked as lecturers at Kathmandu University. This paved the way for a Memorandum of Understanding between Kathmandu University and NTNU in 2000.

Between 2006 and 2011, cooperation grew. Norad's Program for Master Studies (NOMA) was initiated to develop and support master's degrees and programs in partner countries, through collaboration between Norwegian and local institutions for higher education. The program developed academic capacity alongside administrative and managerial competencies. Nepal has the highest number of NOMA-graduated students, second only to Tanzania.

NOMA courses have inspired classes at Kathmandu University. A PhD-level training has been included at later stages of the program. Norway also supported the establishment of a turbine testing laboratory and a high voltage laboratory at Kathmandu University, where industry and students research together.

Close relations between between NTNU and Nepali universities has led to broad collaboration. Student and teacher exchanges provides mutual aid and inspiration. By 2018, over 3200 students had graduated from engineering programs at Kathmandu University. Today components of the NOMA continue in the NORHED-programs, supporting partnerships between universities and higher education institutions both locally, and partnering with Norwegian universities.

Continuation of cooperation: Bhola Thapa (Vice Chancellor of Kathmandu University), Ole Gunnar Dahlhaug (professor at NTNU) and Petter Støa (Vice President of Research at Sintef) take part in an event organized by EnergizeNepal. Photo: Shiva Thapa Magar

The International Centre for Hydropower (ICH) has offered courses for Nepali participants since 1996. Since 2001, semi-annual courses have been held in Nepal, focusing on sediment issues. From 2016, some courses have been held in cooperation with the Independent Power Producers Association of Nepal (IPPAN), Kathmandu University and Hydro Lab, with a focus on sediment management, disaster preparedness, financing, environmental flows, gender and energy trade. Between 2016 and 2022, 580 people have participated in the courses. Female participation has been encouraged, resulting in an increase from less than 10 percent to nearly 30 percent in 2022.

Suresh Raj Sharma (left) and Inge Johansen (right) at the inauguration of Professor Inge Johansen's Building at Kathmandu University in 2010. Photo: Kathmandu University

→ **The Himalaya mountains in change:** climate impacts need to be researched further to anticipate and lower the risks from melting snow, affecting both power production and water availability. Photo: Espen Røst

Recent and ongoing programs funded by Norway include NORHED II and the research program EnergizeNepal. NORHED II started in 2021 and continues until 2027. EnergizeNepal commenced in 2016 and will improve research and education for the renewable energy sector in Nepal and the region. NTNU cooperates with Tribhuvan University and Kathmandu University in the NORHED II program. NTNU, Sintef, Kathmandu University and Hydro Lab are partneres in EnergizeNepal. Other programs include institutional cooperation.

Between 2008 and 2012, the Norwegian transmission system operator Statnett explored institutional cooperation with Nepal Electricity Authority. Norway has also provided early-phase core support to IPPAN. With Norwegian financing, the International Finance Corporation (IFC) cooperates with IPPAN on capacity building for adoption of framework conditions for private investors.

New challenges in the Hindu Kush Himalaya

Impacts of climate change on the Himalayas can affect as many as two billion people in the mountain region. There is a need to understand how the changes will affect water availability, agriculture, biodiversity, and hydropower, as well as which measures increase the possibility of adapting to the impacts. The International Centre for Integrated Mountain Development (ICIMOD) works in the Hindu Kush Himalaya region in Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. The Norwegian Water Resources and Energy Directorate (NVE) has partnered with ICIMOD and the Department of Hydrology and Meteorology (DHM) to implement measures for improved observations. Together, they model snow accumulation and melt dynamics in the Himalayan watershed, through *SnowAMP*. Measurement stations have been installed on glaciers in the Langtang catchment area. The cooperation has increased knowledge on snow and ice conditions in higher altitudes.

"I hope my research will be groundbreaking within the field of sediment erosion troubleshooting automation, improving the management of hydroelectric power stations."

– Aasma Bhattarai

NORHED I and II

Norwegian Programme for Capacity Development in Higher Education and Research for Development (NORHED). The program partners with local higher education intuitions to strengthen the capacity, research, and contribute to inclusive education. Phase I was carried out from 2013 to 2019, and Phase II runs from 2019 to 2026.

Khimti at work: Workers remove the sediment at the bottom of one of Khimti headworks' filtering pools. The Khimti river is dammed before it is lead through two filtering pools to take out sand and sediments. The pools must be cleaned twice a year. Rivers in the Himalaya area are steep, resulting in debris from the young surrounding mountains to be carried along with the river flow, especially during the monsoon season. Photo: Espen Røst

CHAPTER 4

Hydropower development

↑ **Hydropower projects** with specific support from Norway.

Norway has contributed to:

- **Construction of five hydropower plants** and **two mini-hydropower stations** with a total installed capacity of 534 MW (hydroelectric plants of Tinau, Andhi Khola, Jhimruk, Khimti, and Upper Tamakoshi, Jhankre and Haluwa).
- **Building transmission infrastructure** facilitating hydropower development and electricity access.
- **Establishing companies** related to hydropower and energy.
- **Building institutional and regulatory capacity** in hydropower development, developing standards for Environmental Impact Assessments, and a legal framework enabling private sector participation.

The first megawatt of hydropower with contribution from Norway was the Tinau project in Butwal. With the establishment of BTI in 1965, local workshops and manufacturers needed power supply. Soon, a small hydroelectric plant was planned on the Tinau river running through Butwal, which would supply both the institute and surrounding community with electricity. With a grant from Norway of 225,000 NOK, Odd Hoftun bought a 50 kW hydropower turbine. From there, the construction work started.

Butwal Power Company was set up with a 50 percent grant from Norway, and another 50 percent equity from the Nepal Industrial Development Corporation, in

↑ **Used and refurbished:** Tinau hydroelectric plant was commissioned in 1978 and has 1 MW of installed capacity. Inside the station, machines once used in Norway are still producing electricity. Photo: Espen Røst

addition to UMN and the Government of Nepal. It was established as an electricity utility to construct and operate the Tinau hydroelectric plant. The associated tunnel was built by hand, taking four years. Around 1975, Balaram Pradhan became the first general manager of BPC.

Tinau soon supplied over 1,000 households and 65 industrial customers, in addition powering the streetlights owned by the municipality. Ownership of the Tinau hydroelectric plant was turned over to the government in 1980 as per the agreement. Several companies have emerged from Butwal Power Company, such as the contractor company Himal Hydro and the consulting company Hydro-Consult.

Andhi Khola: hydropower and rural electrification

With the Tinau power station completed, BPC looked for other projects. The Andhi Khola project in the Syangja district was identified with a 250 m head. The preliminary design began in 1981, of a 5.1 MW run-of-river plant, with an annual generation of 40 GWh. About 80km of 33 kV lines were built as well as more than 100 km of low voltage distribution lines.

← **Steep waterfalls:** Nepal's mountainous landscape continues to create opportunities for renewable energy production. Photo: Espen Røst

The program extended to village electrification and community development, as well as water irrigation of 300 ha of non-arable land. To save costs, much of the work was done manually, even if it took more time. Health, drinking water and sanitation projects were coupled with educational programs for literacy and female empowerment. Efforts were made to raise awareness about conservation. In addition, an enterprise development program was launched to increase productive use of electricity. Norway contributed 25 million NOK to the project, about 60 percent of the total project cost.

Odd Hoftun used his network in Norway to acquire second-hand equipment, to refurbish in Nepal and re-use instead of scrapping. For example, three 1.7 MW Pelton turbines from the Mesna power station in Norway and one unused crane originally ordered for a shipbuilding yard, were sent to Nepal. About 2,700 hours of volunteer work went into dismantling, packing, and shipping of the equipment from the Norwegian side. Valued 10 million NOK, the equipment was refurbished at NHE by Nepali technicians.

Andhi Khola was commissioned in 1991. Safety was a key priority during construction, becoming especially relevant when digging the 250-meter-long vertical shaft, first of its kind in Nepal.

The value of electricity sold by 2007 reached more than ten times the initial investment. Other positive outcomes include increased agricultural production due to irrigation as well as rural electrification of local communities. The project won the **Blue Planet Prize** in 2005 for "*its excellence in socio-economic benefits, environmental consideration and capacity building in hydropower development of Nepal*". Upgraded in 2016, Andhi Khola today has a total of 9.4 MW of installed capacity.

Jhimruk hydroelectric plant: a commercial project

Following Andhi Khola, BPC built the larger Jhimruk hydroelectric plant in Pyuthan District in central western Nepal. The run-of-the-river plant has 12 MW of installed capacity and annual generation of 72 GWh. Requested by the government of Nepal, Norway contributed 129 million NOK of the total 134 million NOK. The rest was funded by the Government of Nepal.

While Jhimruk was bigger than the previous two projects, it was also a commercially managed project. This time, new equipment was used, providing more modern technology. Machines were used for drilling tunnels. BPC Hydroconsult (consultant), Himal Hydro (civil contractor) and NHE (electromechanical contractor) collaborated on commercial terms.

The Norwegian-based companies Kværner and ABB Energi were among the suppliers. Staff from Norway provided training, supervision, and quality control of the production of certain turbine components, and the NHE staff got training and

Power lines across rice fields in Butwal. Photo: Espen Røst

technology transfer. NHE manufactured pipes, steel gates, valves, transmission towers and poles as well as the turbines themselves. During construction, most staff were Nepali, demonstrating Hoftun's philosophy of developing a self-sufficient industry.

The importance of environmental and social concerns

While Jhimruk had positive outcomes in terms of capacity building and commercial success, considerable negative environmental and social impacts emerged. The diversion of water from the river to the hydroelectric plant resulted in a large area of farmland no longer receiving enough water for irrigation, with serious consequences impacting livelihoods, as crops could no longer be cultivated during the dry season. To mitigate effects, power production would stop during dry phases. In 2006, Norway provided 13 million NOK to rural electrification and irrigation projects in the areas of Jhimruk and Andhi Khola to mitigate for impacts, through Butwal Power Company.

Khimti Bazar at night: Shankar and Maiya Vitrikot's sewing workshop lights up the bazar at night. Their children Bibek and Bina help them when they are not doing homework or playing with their friends. Photo: Espen Røstt

In the early 2000s, the Jhimruk hydroelectric plant, the intake at Khimti headworks and the Jhankre mini-hydropower plant were damaged during civil unrest. The attack on Jhimruk occurred as negotiations started on the privatization of BPC. Norway granted 22.2 million NOK for repairs to enable the transaction, and the deal was signed.

"With the electric machines, we are able to produce 50 percent more. The dream is to expand our business and hire employees, but we would need to save up further, to do so. The business is important for our family, and for our children's education."

– Shankar Vitrikoti

Khimti and a new legal framework
The 1990s came with increasing power demand and Nepal facing a looming power crisis. Upon request from the government, BPC identified the 60 MW Khimti project. Switzerland had financed a road making the site accessible, and Japan supported an early phase reconnaissance study. The size of the project and associated risks made it challenging for the government, donor agencies, or domestic commercial sources to finance it fully alone.

The Norwegian state-owned hydropower company, Statkraft, had started to look for investment opportunities abroad, preferably in partnership with a locally experienced developer. The result: Himal Power Limited (HPL) was established as a joint venture between BPC and Statkraft in 1992. Norway funded a feasibility study, including Environmental Impact Assessment, enabling initial discussions on financing.

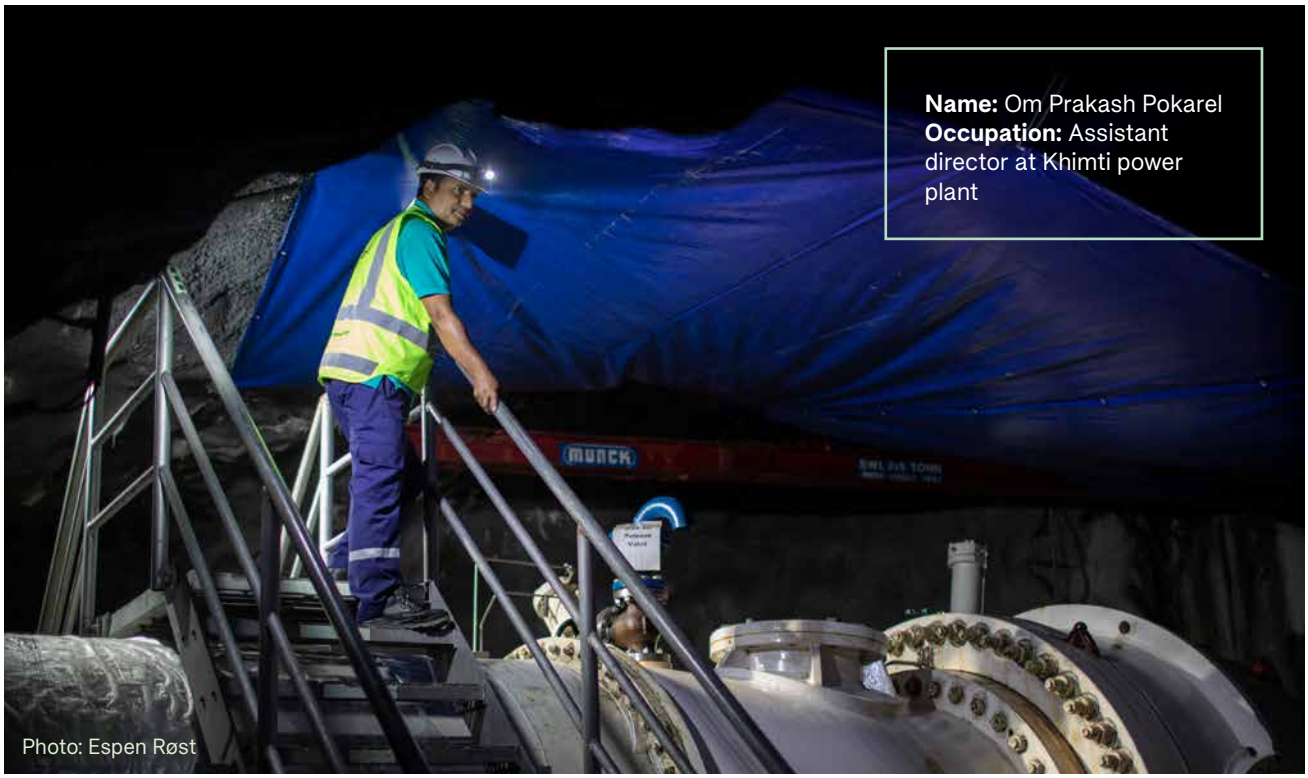
Having no legal framework for private sector independent private power producers (IPPs), NVE gave technical assistance to the Nepali Ministry of Water Resources. In 1992 the legal framework for electricity, Water Resources Act and Hydropower Development Policies were passed by the Parliament. The Nepalese authorities thought wider than just enabling the Khimti project. The legal framework for electricity was adapted to cover general support for hydropower projects, opening for private investments in the power sector.

Khimti was debt financed by the International Finance Corporation, the Asian Development Bank, the Nordic Development Fund, and the Norwegian Export Financing Agency as lenders into the project along with guarantees from the Multilateral Investment Guarantee Agency (MIGA) and the Norwegian Credit Export Guarantee Agency. Due to the perceived risk, lenders required a high interest rates, which contributed to a significant increase of project costs. Norway gave a low-interest loan of about 30 million NOK, later transferred to the Norwegian development finance institution Norfund.

Inspection: Assistant manager at the power station, Om Prakash Pokharel, inspects the Khimti hydroelectric plant. He has worked at the station since it was commissioned 25 years ago. Photo: Espen Røst

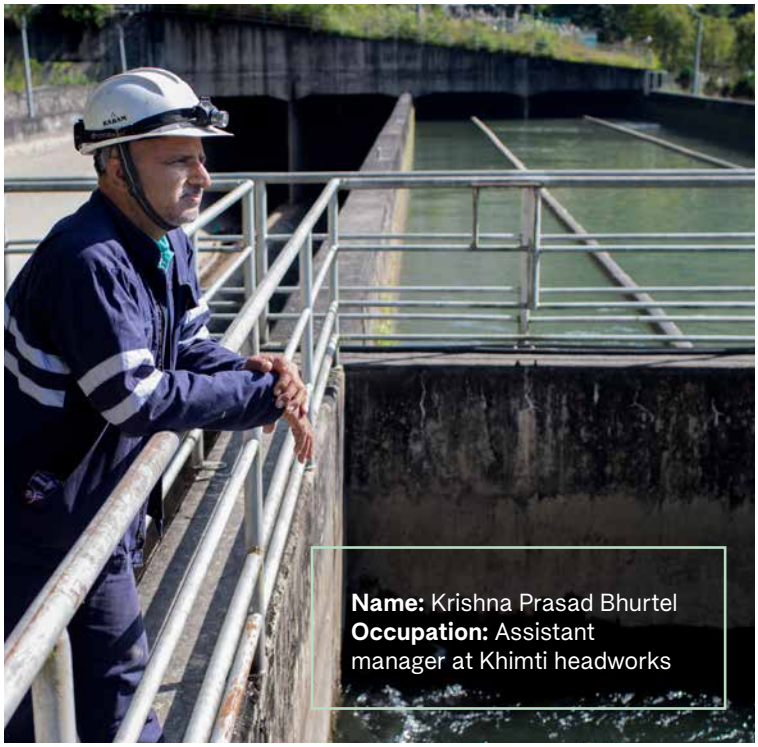
The USD denominated PPA of Khimti has been viewed by stakeholders as unreasonable. As the loan financing was dollar-based, investors also needed USD-based revenues. Over the years, the Nepali Rupee, being pegged to the Indian Rupee, has depreciated considerably. The Indian Rupee to USD exchange rate increased from 56 to 75 from 1996 to 2000 during construction. In 2020, the exchange rate had risen 120.

Construction started in 1996, with strict deadlines and financial penalties from lenders in case of delays. Statkraft subsidiaries Statkraft Anlegg (civil construction) and Statkraft Engineering, along with Norwegian manufacturer Kværner, oversaw supervision of work. Norwegian experts worked with, managed, and trained



Name: Om Prakash Pokarel
Occupation: Assistant director at Khimti power plant

Photo: Espen Røst



Name: Krishna Prasad Bhurtel
Occupation: Assistant manager at Khimti headworks

"Khimti is the most efficient hydropower station in Nepal, with 99,3 percent efficiency. With focus on preventive maintenance and reparations, we are able to avoid problems."

– Krishna Prasad Bhurtel

"Khimti has contributed enormously to the power production in Nepal."

– Om Prakash Pokarel

← **Khimti headworks:** Krishna Prasad Bhurtel in front of the two filtering pools at Khimti. Twice a year the pools are emptied to remove sand at the bottom and in the sediment filters in the intake ports. The full process takes five to seven days. Photo: Espen Røst

Nepali counterparts and workers in BPC, Himal Hydro and NHE. Norway provided finance for training of personnel with the Nepali sub-contractors and operational and maintenance personnel within HPL.

Several semi-skilled and unskilled construction workers got training both abroad and on the job. International experts, many of whom were Norwegian, worked closely with local staff. The result was robust knowledge transfer along with efficient work performance.

The building of Khimti is considered to have advanced the overall hydropower sector development in building national competencies.

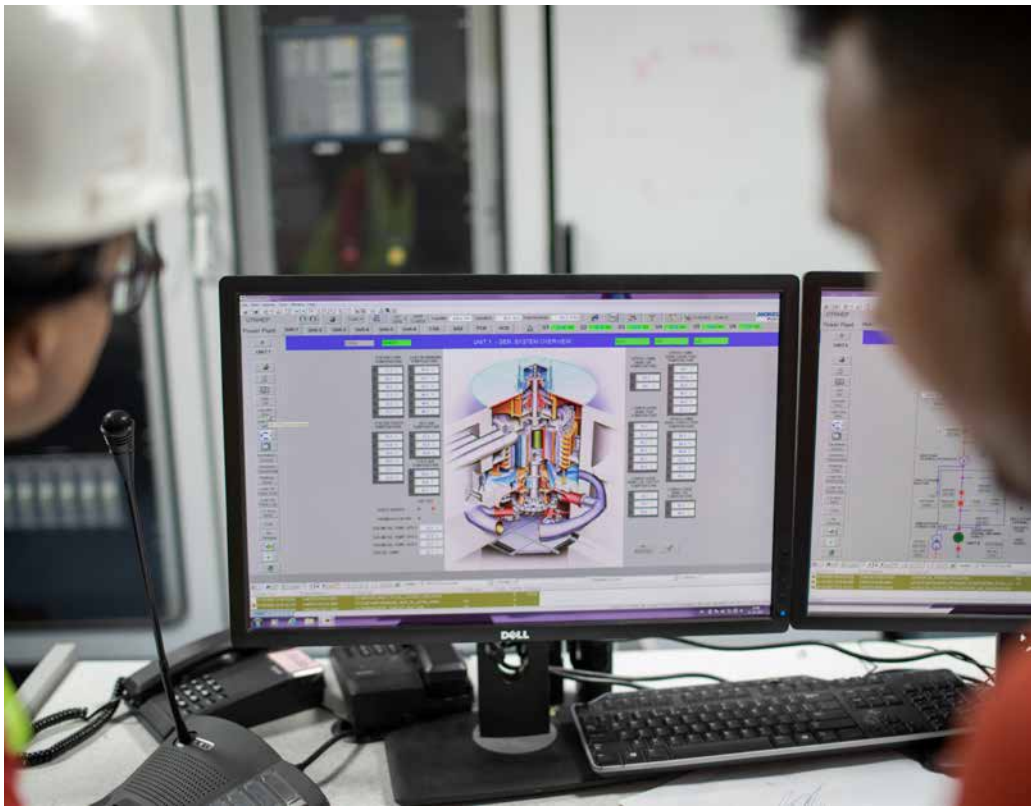
Commissioned in 2000, Khimti supplied much needed generation capacity to the grid. At the time, it increased the installed hydropower capacity by one fifth and supplied almost one fourth of the country's generation. Since 2010, Khimti plant managers have been Nepali. The successful construction and operation of Khimti paved the way for additional IPP projects. More than half of existing hydropower plants in Nepal today are owned by IPPs, and 90 percent of 300 projects licenses are held by Nepali investors. These can to a large extent rely on domestic financing, and accept a lower PPA rate.

Upper Tamakoshi: largest hydropower plant

Upper Tamakoshi has a capacity of 456 MW. Norway financed a feasibility study in 2003. Raising funds through an Initial Public Offering (IPO), Upper Tamakoshi is financed 51 percent by NEA, Nepal Telecom, Citizen Investment Trust and Rastirya Beema Sansthan, under the legal framework of 1992. The general public and residents of Dolakha District owns 15 percent and 10 percent, respectively. Except for the feasibility study, the project was developed without donor funds or foreign capital. Since the commissioning of Upper Tamakoshi in 2021, Nepal has had a power surplus in the monsoon summer season. Thus, it could be relevant for Nepal to increase industrial and household use of electricity, particularly in the monsoon season, increase cross-border exchange capacity, and to develop reservoir projects.

Inside the Khimti power station: Owned and managed by Himal Power Limited, which again is owned by Statkraft, BKK and BPC. From 2000 to 2015, the power station produced about 10 percent of Nepal's power. Photo: Espen Røst

Mountain water: On a clear day, one can spot the Gaurishankar Mountain of 7131 meters behind the intake dam of Upper Tamakoshi. Two sediment pools catch sand and debris that may cause erosion on the turbines. Photo: Espen Røst



Inside: Upper Tamakoshi has a capacity of 456 MW and using a fall of 822 meters, there is a 8,4 km long tunnel between the intake and the power station. Photo: Espen Røst

Capacity: From the left, Padam Pokharel, senior building engineer, and Rajendra Giri, technician at Upper Tamakoshi. Rajendra supervises the operating system. If Rajendra gets a phone call from Load Dispatch Centre in Kathmandu about increasing or decreasing production, he responds immediately.
Photo: Espen Røst

→ **With the Asian Development Bank:** Norway has co-financed a 400 kV transmission line in the Tamakoshi valley, which is still under construction. The main challenge in this and many transmission projects is the management of land acquisition and compensation. Photo: Sharad Karmacharya

Cooperation with the Asian Development Bank
Since 2012, Norway has co-financed three transmission and distribution expansion projects together with the Asian Development Bank (ADB) and the Government of Nepal. Total contributions from Norway since 2012 is 690 million NOK.

Norad and the Norwegian embassy in Nepal

Before 2000, Norwegian energy assistance came from Norad. After the Royal Norwegian Embassy in Kathmandu was established in 2001, most bilateral funding has been channeled through the Embassy. Today, Norad has an advisory role on bilateral projects, but funds education programs such as NORHED and support for non governmental organizations. From 2017 Norad also finances multi-lateral organizations and global initiatives.

→ **Modern:** Inside a machine room in Upper Tamakoshi. Photo: Espen Røst

Smoke free cooking: Gita Khadka and her mother-in-law Som Kumari enjoy the first warm beverage heated on their new electric induction plate. Som has chronic obstructive pulmonary disease and tries to avoid inhaling the smoke in the kitchen. Gita hopes that it will take less time to heat water now. Photo: Espen Røst

CHAPTER 5

Rural electrification

Norway has contributed to:

- **Connecting** 200,000 rural households to electricity through mini-grids, 645,000 through stand-alone systems and about 72,000 through grid connection.
- **Access to improved cookstoves and biogas** for over 1 million households.
- **Gender mainstreaming** in the Nepali rural energy sector enabling 12,000 women to participate in income-generating activities through access to electricity.
- **Expansion of transmission and distribution infrastructure:** more than 700 km of medium and high voltage lines and more than 1,000 km of low voltage lines.
- **Increasing economic productivity** and income through promoting and supporting productive energy use.
- **All in all, about than 6 million** people have benefited from the rural clean energy access support.

Transmission and distribution infrastructure is fundamental for the generated power to reach people. Generally, this is handled by public entities due to its monopolistic nature and high costs, often financed by the government. This type of infrastructure is costly to build.

From traditional fuelwood to electric cooking in one day: Dhan Bahadur Khadka looks at the family's newly installed induction plate. Photo: Espen Røst

"We will cook dal and other vegetables on the electric oven. The traditional oven will be used for rice and animal food, as we cannot afford only to use the electric plate."

– Dhan Bahadur Khadka

Checking on the internet connection: Dhan Khadka keeps his family's router up in the attic. Photo: Espen Røst

← **Distribution lines:** In Nepal, about 72 percent of households are connected to the national grid. Distribution lines enable electricity produced by hydropower to reach rural households. Photo: Espen Røst

"With the induction plate, we can put on a timer instead of watching it all the time. Electricity is the sign of development and modern society. We can charge mobile phones, have television and wifi, and now we can also cook with electricity."

– Dhan Bahadur Khadka

→ **Reduced price:** The Khadka family bought the induction plate at a reduced price from 4000 Nepali Reupees to 2000 Nepali Rupees through a national program by National Association of Electricity Users. Photo: Espen Røst

Energy Cooperative: Operations technicians Devendra Sundas (left) and Thankur Das Shreshta (right) are changing a valve seal in a leaking generator. Haluwa mini-hydropower plant of 400 kW is owned and operated by KREC. The energy cooperative is lead by local representatives elected by villages. Photo: Espen Røst

Local participation and cooperatives

As BPC developed the hydropower plants of Tinau, Andhi Khola Jhimruk and Khimti, rural electrification became a central component. Giving back to affected communities and to mitigate possible negative impacts, rural electrification involves special programs to construct infrastructure in the surrounding areas of the powerplant. In retrospect, it became evident that an integrated approach including electrification of surrounding villages, would be vital for local support (as seen Andhi Khola, Jhimruk and Khimti).

Best practice includes high local participation and ownership as well as training, empowerment of women, and other vulnerable groups, awareness raising on issues of social inclusion, health and sanitation, environmental conservation, and productive use of energy. Another successful approach is the model where rural electric cooperatives are run by the users themselves, although it may be challenging to decide on long-term electricity tariffs.

The Andhi Khola Water Users Association (AKWUA) is an example of an innovative and inclusive approach extending the benefits of hydropower development to the rural population. Measures to increase irrigation opportunities were made as part of the Andhi Khola project and Norway supported the project with 1.8 million NOK. In the scheme, local households are members in the association and takes part in negotiating the design. Water use rights are distributed regardless of land ownership, based on labor or monetary contribution into the building of the project. Water rights could then be rented out or sold between individuals. AKWUA also negotiated a land redistribution policy, where larger landowners would have to trade some of their land in exchange for water, which again was redistributed to those without land rights. In this model, locals take ownership of operation and maintenance of the scheme, which again makes it more sustainable in terms of long-term impact and use.

"I am proud of working for the power cooperative that provides the households and businesses in the community with access to electricity."

– Devendra Sundas

Haluwa mini-hydroelectric plant was partly financed by Norway. A number of locals contributed with workforce in constructing the mini-plant. Operation technician Devendra Sundas (pictured), comes from the surrounding district. Photo: Espen Røst

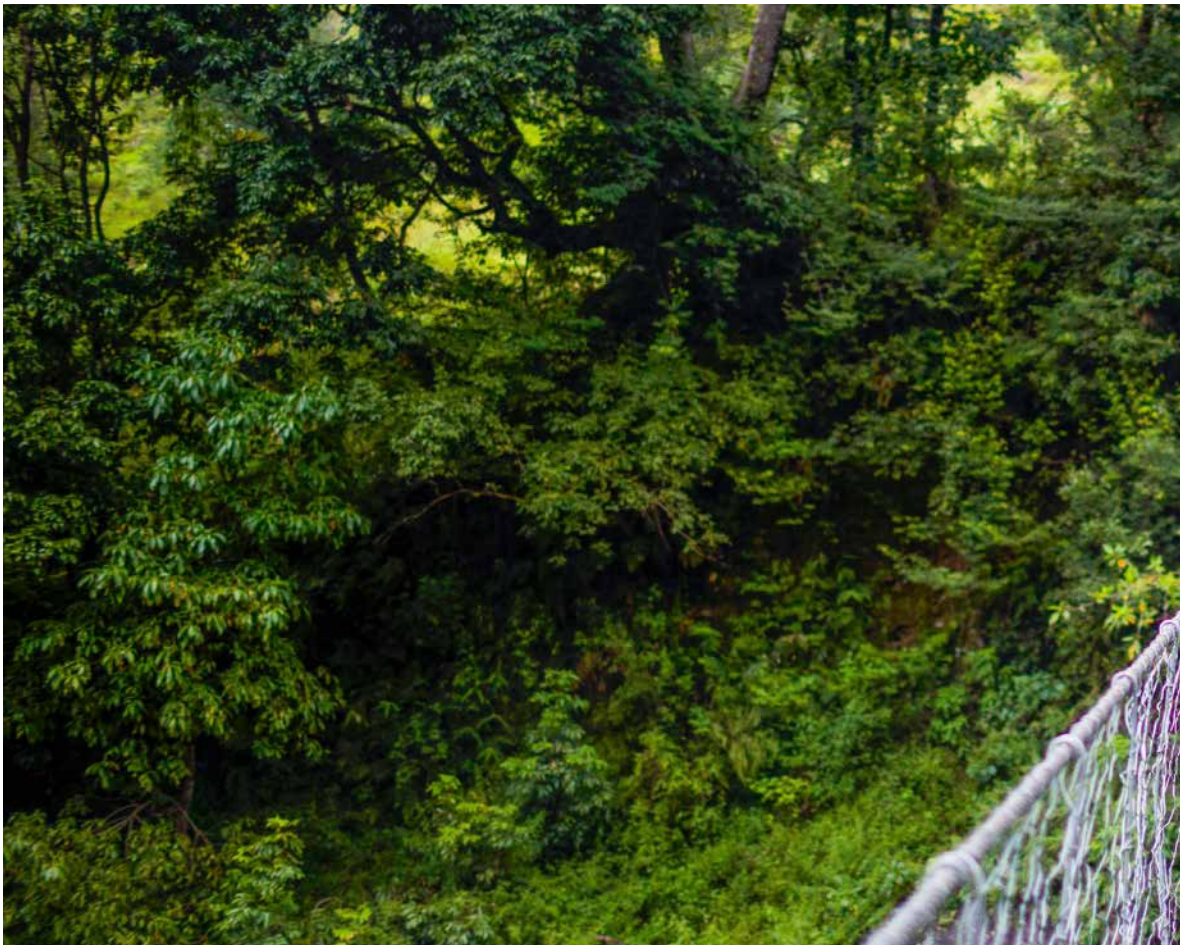
Jhimruk Industrial Development Company (JIDCO) was smaller than AKWUA and did not have the same success. It was established to work on rural development, promotion of electricity-based enterprises and provide basic electrical and mechanical training. As 48 of 52 enterprises in the scheme were grain mills, this led to an over-supply of the service, too much competition and lack of other types of businesses.

Rural electrification also became a central component of **Khimti I**, where a 500 kW mini-hydropower plant, **Jhankre**, was funded by Norway in 1996. The purpose was to support the construction of the power plant and provide electricity to households and enterprises, toilet facilities and a literacy program. Due to local demand, the program was continued and expanded even after construction ended. As a part of this, Norway supported the expansion of power supply to 4,000 rural households, along with implementation of community activities.

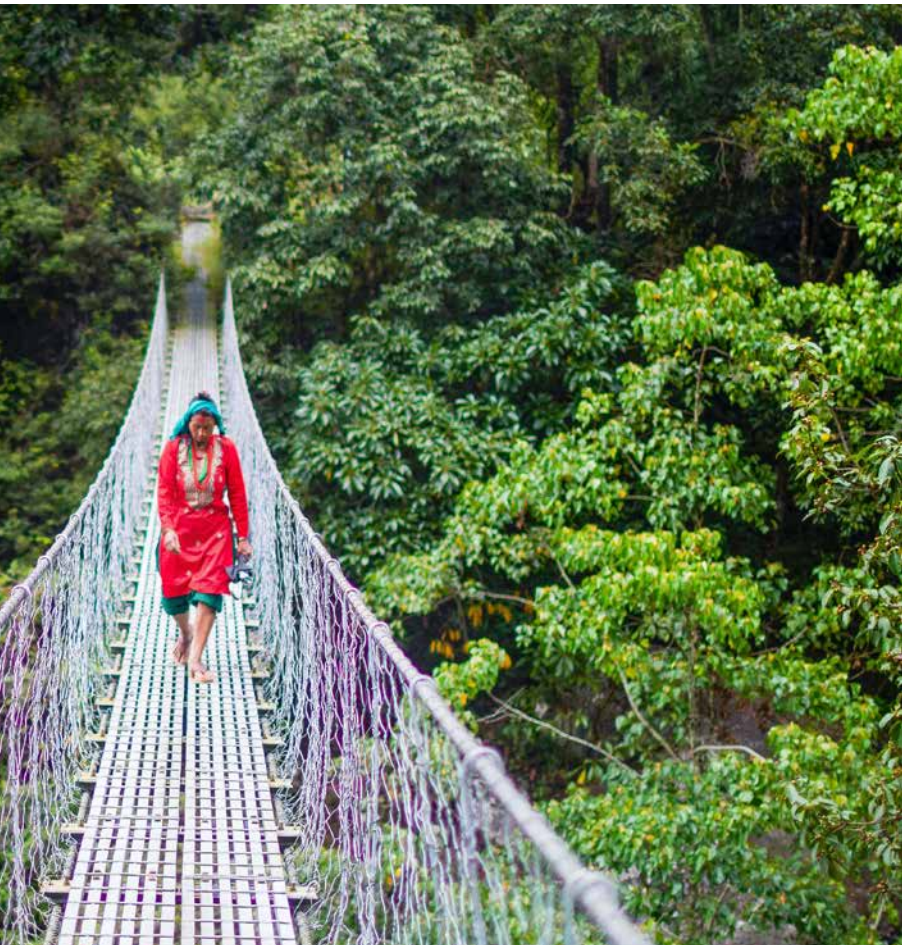
Khimti headworks and Jhankre were attacked during the insurgency in 2002. Jhankre was later refurbished and upgraded to 635 kW. To meet further demand in the area, HPL implemented a new "*Khimti Neighbourhood Development Project*", building another mini-hydro plant on the Haluwa river and connecting another 4,000 households to electricity in 2012.

Paying the electric bill: The queue is long in the Namadi village in Gokulganga, Ramechhap by the end of the month. Rabindra Khadka (from the left) is both a restaurant owner and hired by the electric cooperative KREC to receive utility bill payments. About 800 customers come to pay, and each bill is the size of about 150-250 Nepali Rupees. Customers such as Krishna Maya Kadhka walk for an hour to pay. Photo: Espen Røst

Building brigdes: To electrify the villages around Khimti, Norway supported small power stations and grid expansion, through the Jhankre Rural Electrification and Development Project. Access to water, irrigation, schools, roads and bridges were built as part of the project. Photo: Espen Røst



Gokulganga Village Hospital covers nearly 60,000 inhabitants of the Ramechhap and Dolakha districts. With 16 hospital beds, a test laboratory, an x-ray laboratory and oxygen machines, electricity has a crucial role in supporting health services for patients. Nanda Maya Shreshta walked for 10 hours to get treatment for chronic obstructive pulmonary disease and pneumonia. Photo: Espen Røst



"With electricity, we can offer oxygen day and night. The alternative is to transport oxygen tanks which are expensive and sometimes do not reach us at all."

– Adarash Yadav

Rural electrification today

As of today, **Butwal Power Company** serves about 62,000 customers[5] near the Andhi Khola and Jhimruk, while **Khimti Rural Electricity Cooperative** (KREC) serves around 10,000 customers near the Khimti hydropower plant. With support from from Norway, the KREC mini-grid was connected to the national grid. Through a Power-Purchasing Agreement, KREC can sell excess power to the grid and buy electricity in the dry season when production is low.

5 BPC annual report 2022.

Norwegian Co-Financing

Electricity Transmission and Supply Improvement Project (ETESIP)

Stringing of the second circuit of the Kohalpur-Mahendranagar 132 kV transmission line

Construction of the 400 kV Tamakoshi-Kathmandu transmission line.

Norwegian contribution of 150 million NOK, about 15 percent of the total budget.

Results also include 2,070 household on-grid connections or improved electric supply (documentation of total households connected is ongoing).

South Asia Subregional Economic Cooperation Power Transmission and Distribution System Strengthening Project (SASEC PSEP)

On- and off-grid electrification of the Marsyangdi and Kali Ghandaki river basins

Construction of the Marsyangdi-Kathmandu 220 kV transmission line and the Matatirtha and Markichowk substations supported in preparation of Distribution System Master Plan, which now is used as a baseline document for further electrification.

Norwegian contribution makes up five percent of the total budget.

Results also include 11 MW on-grid solar power constructed. Besides, mini-hydro power plants and solar-wind mini-grids provide 6,000 households with electricity, many which are female headed, below the national poverty line or belong to disadvantaged groups.

South Asia Subregional Economic Cooperation Power System Expansion Project (SASEC PTDSSP)

Financing of the 400 kV New Khimti, Barhabise and Lapsiphedi substations and rural electrification and distribution network reinforcement in Madhesh Province.

Capacity building of NEA to mainstream gender and social inclusion, support a strengthening of NEA's training center and technical programs for staff to manage new energy technologies. Support also includes improving NEA's capacity to monitor and supervise the construction of the project.

Norwegian contribution of 360 million NOK, about 16 percent of total budget

In-progress of commissioning of infrastructure

The way forward

Nepal is a long-term partner country for Norway. During the past 60 years of collaboration, hydropower has been a key priority and together we have achieved results that have changed the lives for hundred thousands of Nepali citizens.

The foundation for continued collaboration is strong. There is a potential to further develop the bilateral cooperation within the renewable energy sector as a key driver for sustainable economic growth in Nepal.

Nepal has gone from being a net importer to an exporter of electricity during monsoon periods since 2021. Yet, today per capita electricity consumption in Nepal is among the lowest in South Asia. Traditional biomass such as fuelwood dominates the energy mix. In addition to strengthening systems on the supply side, a priority should therefore be to promote productive use of renewable energy, such as energy usage in agriculture and for industrial development. Ways to facilitate productive use of energy will gain importance as the availability of renewable energy increases.

For example, there is a large potential to replace imported liquified petroleum gas with electricity for cooking. Electric vehicles are slowly entering the roads in Nepal, but many places have a low electric distribution capacity. Continued support to develop both transmission and the distribution networks is therefore needed, supporting an increased domestic use of electricity.

This requires an energy governance system which can plan for diverse and seasonal national needs and opportunities and adjust for market imperfections.

While Nepal is blessed with numerous rivers, consequences of climate change are increasingly affecting the livelihoods of millions of people living in fragile mountain environments. Joint research between Nepali and Norwegian academic institutions continues to deliver new knowledge about the effects of climate change on hydropower production as well as identifying critical investment areas moving forward. The evidence informs choices about how best to mitigate and adapt to climate change in the coming years.

Public financing and support development from partners alone is not enough to achieve Nepal's development goals. Private sector investments are also needed.

Norway aims to continue to be a partner to Nepal, acting together on future possibilities, to ensure access to and use of renewable energy for all.

Opportunities and challenges: With numerous hills, valleys and a hydropower sector successfully established, Nepal has opportunities for cross-border electricity trade in the coming years. At the same time, climate change poses new challenges for the Himalaya region. Photo: Espen Røst


UPAKAR

Store light: Sita Jirel and Unisha Tamang in Kirne. Sita opened her shop 10 years after the village was electrified. Her husband works at Khimti power station and they have a daughter and two sons. Unisha, who is the daughter of the owner of the neighbouring restaurant often comes to play. Sita explains that the extra income from the shop helps her family to support the education of their children. Photo: Espen Røst

Annex I: Norwegian support through other channels

Besides bilateral energy assistance to Nepal, Norway also supports Nepal's energy sector through multilateral organizations, global funds and other partnerships. In the following, important contributions are listed.

Multilateral Organizations

Asian Development Bank (ADB)
Norway is a shareholder of ADB, which has an extensive presence in Nepal, including the energy sector. In addition to the transmission and distribution (T&D) projects co-financed by Norway, ADB is also co-financing several hydropower reservoir projects of a total of more than 1,000 MW (ca. 4,000 GWh). One of the projects is the Dudh Koshi hydropower reservoir project panel, of which Norway is financing a panel of experts to review technical designs.

The Energy Access and Efficiency Improvement Project (EAEIP) received a grant (USD 4.2 million) from the Clean Energy Financing Partnership Facility (CEFPF) to which Norway has provided NOK 362 million (about USD 40 million) between 2007 and 2020.

World Bank
Norway is a shareholder of the World Bank Group (WB), in which International Development Association (IDA) is a part. The WB has an extensive energy sector presence in Nepal. Together with the Government of Nepal, WB is developing the 1,060 MW (ca. 4,500 GWh) Upper Arun hydropower project, which is a run-of-river project with daily peaking capability. Particularly, Norway also contributes to development of the Upper Arun project through the Hydropower Development Facility in WB's Energy Sector Management Assistance Program (ESMAP).

The WB has also provided loans and co-financing for transmission projects, and, a concessional loan in 2013 for a power interconnection project linking Nepal and India. A 400 kV line (so far operated with 220 kV) between Muzaffarpur in India and Dhalkebar in Nepal was commissioned in 2017.

Multilateral Investment Guarantee Agency (MIGA)
Norway is a shareholder in the Multilateral Investment Guarantee Agency (MIGA). For the Khimti project, the investor contracted a partial risk insurance (PRI) from MIGA to protect the equity investment against the risks of restrictions on currency convertibility and transfer, expropriation, and war and civil disturbance. Following the sabotage of the intake of the Khimti facility, compensation was received through the investor's PRI.

In 2019, MIGA issued a guarantee covering the equity investment in the 216 MW (1533 GWh) Upper Trishuli-1 Hydropower Project. The MIGA guarantee provides protection against the risk of Breach of Contract for a period of up to 15 years.

International Finance Cooperation (IFC)
Norway is a shareholder of IFC, which has done several transactions in Nepal's energy sector. In the 1990s, IFC provided loan financing of the Khimti Hydropower project. In 2009, IFC provided loan financing to Butwal Power Company for the upgrade of Andhi Khola hydropower plant, originally grant financed by Norway, from 5.1 MW to 9.4 MW. Currently, IFC is investing equity and debt capital in the 216 MW run of river Upper Trishuli hydropower project for which construction is about to begin.

United Nations Development Programme (UNDP)
Norway provides core funding to UNDP, which has had involvement in the micro-hydro sector in Nepal since the early 1990s. In 1996, the Rural Energy Development Programme (REDP), which was a joint initiative of the Government of Nepal and the UNDP, was initiated, targeting hill areas in Nepal. The World Bank also supported the project, which was completed in 2007.

In addition to local technical and institutional capacity

building, REDP contributed to the construction of 185 micro hydro plants, distribution of 2,119 solar home systems, establishment 4,022 biogas plants and of 9,795 improved cookstoves. All in all, energy services were provided to more than 23,000 households.

Through the Renewable Energy for Rural Livelihood (RERL) programme UNDP provided technical support to AEPC to implement the off-grid component of the SASEC T&D project already described. The program was co-financing the Global Environment Facility (GEF), of which Norway supports with core funding.

In 2007, Norway funded an electrification and livelihood projects adjacent to the Khimti hydropower plant, such as the Khimti Neighbourhood Development Project (KIND). UNDP was contracted by Himal Power Limited to implement the project.

Funds

Green Climate Fund (GCF)
Norway is provides core funding to GCF. The Alternative Energy Promotion Centre (AEPC) is an accredited institution eligible for GCF support. In 2022, AEPC and GCF signed an agreement for a USD 21 million grant to promote the adoption of Clean Cooking Solutions (CCS) in Nepal's Terai region for climate change mitigation and adaptation. Government of Nepal provides co-financing. Activities will include scaling up the deployment of clean cooking technologies through accelerated investment and market development. This includes installation of 500,000 electric stoves, 490,000 Tier 3+ ICS and 10,000-biogas plants.

Climate Investment Funds (CIF)
The World Bank is the Trustee of the CIFs, which works with most major multilateral development banks. The Scaling-Up Renewable Energy Program (SREP) in Low Income Countries is one of three programmes under the Strategic Climate Fund, which targets low-income countries. Norway provides about 15 percent of SREP's total budget.

Nepal is participating in SREP, with an investment plan of $48 million to support a variety of renewable energy initiatives including a large-scale biogas program, on-grid solar power and mini-grids.

Other Partnerships

Clean Cooking Alliance (CCA)
Norway is a core funder of the CCA, which works to drive consumer demand, mobilize investment, and support policies that allow the clean cooking sector. At the Government of Nepal's request, CCA leads the development of a Country Action Plan for transforming the cookstoves and fuels market in Nepal to help achieve universal access to electricity and electricity-based cooking by 2030.

Energising Development (EnDev)
Norway supports EnDev with core funding, amounting to about 10% of the total budget since 2011. EnDev is a partnership between the Netherlands, Germany, Switzerland, and Norway. Since 2009, EnDev has allocated EUR 9.8 million to improve energy access in Nepal. By the end of 2022, EnDev had contributed to access to electricity for 346,000 households and access to modern cooking for 159,000 households. Besides, more than 1,700 social institutions and 4,100 small and mediumsized enterprises got access to modern energy solutions.

International Hydropower Association
The International Hydropower Association (IHA) is a non-profit membership association which promotes sustainable hydropower. Since 2012, Norway has supported IHA with 9 million NOK. The support has contributed to IHA's development of the Hydropower Sustainability Assessment Protocol ("the Protocol") in partnership with project developers and operators, regulators, non-governmental organisations, investors and international agencies. Application of the Protocol will reduce conflicts associated with hydropower development and help attract international investments. IHA is working closely with Nepal's hydropower sector.

Norwegian Non-governmental Organizations (NGOs)
In addition to HimalPartner, Naturvernforbundet (Friends of the Earth Norway) and Utviklingsfondet (The Development Fund) have promoted renewable energy in Nepal with Norwegian support.

Appendix II: Methodology and sources

This report is intended for a general audience with an interest in Nepal's energy sector and the long-term cooperation between Norway and Nepal.

The report is not an evaluation or formal review. Rather, the report is designed to mark 60 years of cooperation with focus on the most significant achievements over the years summarized in one document, interspersed with anecdotes and images. The report does not aim to provide a critical evaluation of the entire support or its impact, although it does note some challenges.

The report has been prepared based on a visit to Nepal, interviews with stakeholders and a desktop review of existing material. Literature and reports have made available by the Norwegian Agency for Development (Norad), the Royal Norwegian Embassy of Kathmandu, Multiconsult, as well as secondary literature and interviews with key persons involved in Nepali and Norwegian energy cooperation over the years.

Written sources:

Bisht, Khadga Bahadur. *Hydropower Nepal* (International Power Producers' Association, Nepal: 2010)

Evaluation of Norwegian Power-related Assistance, Annex 3 Case studies Nepal (Norad: 2007)

Liechty, Mark. *What Went Right* (Cambridge University Press: 2022)

Svalheim, Peter. *Kraftverket* (Luther forlag: 2009)

Thapa, Dr. Bhola. *Engineer of Engineering Education.* (Mrs. Sama Thapa Thapagaun: 2021)

Interviews:

The following table provides an overview of persons that were contacted for the purpose of gathering information for this report, between August 2022 and March 2023. Information was gathered through interviews and/or written communication.

Name	Organization
Halvor Lauritzsen	Former SN Power
Tom Solberg	ICH
Line Amlund Hagen	ICH
Laura Bull	ICH
Leif Lia	NTNU
Oddbjørn Bruland	NTNU
Ole Gunnar Dalhaug	NTNU
Rita Kumar	NTNU
Meg B. Bishwakarma	Hydro Lab
Bhola Thapa	Kathmandu University
Om Prakash Pokharel	HPL
Krishna Prasad Bhurtel	HPL
Lakshman Devkota	Former NHE
Abhimanyu Bhimarjun Panthee	BTI Consultant
Ratna Sansar Shresta	Consultant
Sharad Karmacharyad	Norwegian Embassy in Nepal
Jan Erik Studsrød	Norwegian Embassy in Nepal
Suman Basnet	Consultant
Shreya Nagothu	Multiconsult
Leif Birger Lillehammer	Multiconsult
Bernt Lie	University of South-Eastern Norway (USN)

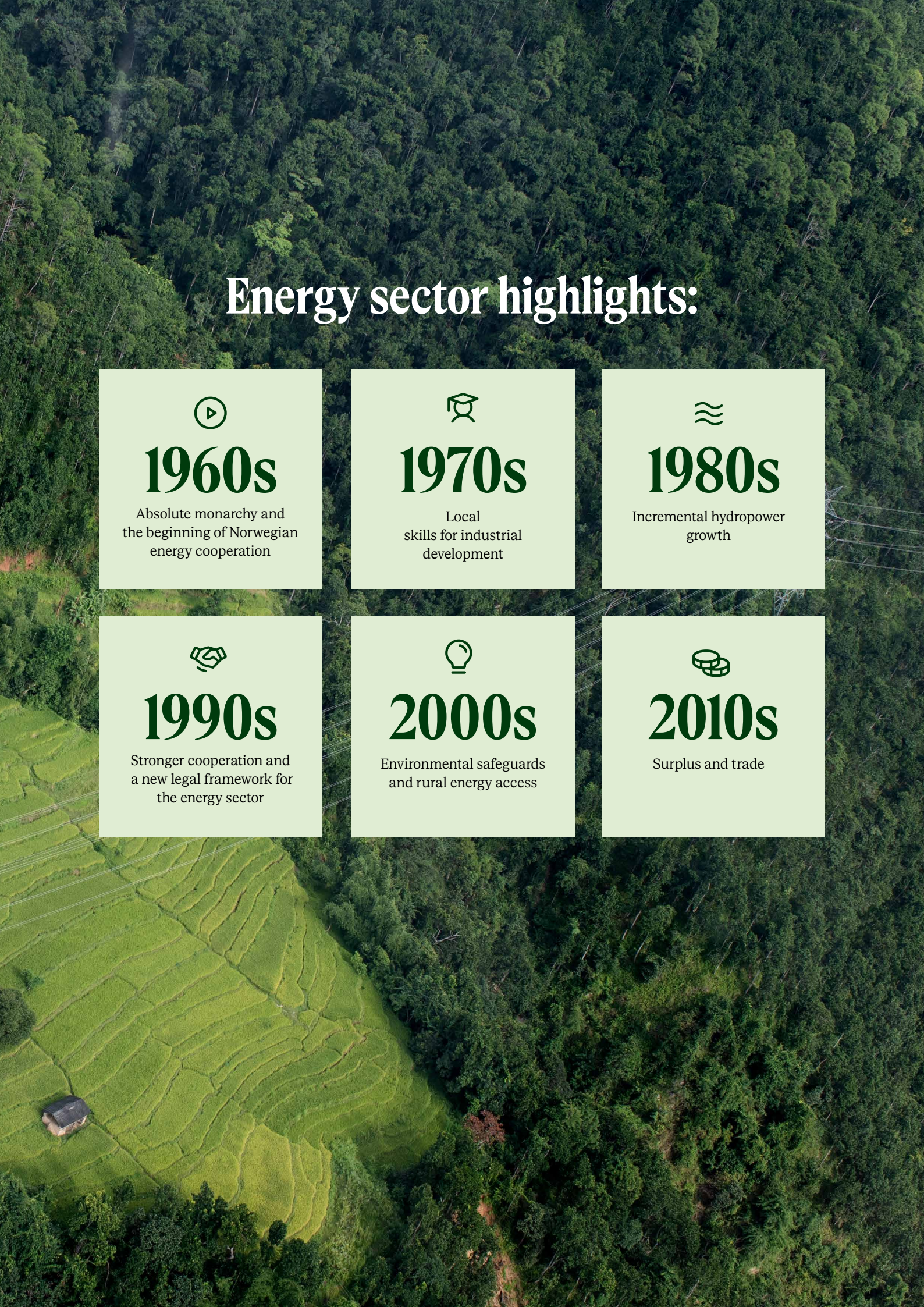
Annex III: List of abbreviations

ADB	Asian Development Bank
AEPC	Alternative Energy Promotion Centre
AKWUA	Andhi Khola Water Users Association
BPC	Butwal Power Company
BTI	Butwal Technical Institute
CREF	Central Renewable Energy Fund
ERC	Electricity Regulatory Commission
ESAP	Energy Sector Assistance Programme
GESI	Gender equality and social inclusion
HPL	Himal Power Limited
ICH	International Centre for Hydropower
ICS	Improved cookstoves
IFC	International Finance Corporation
IPO	Initial Public Offering
IOE-TU	Institute of Engineering at Tribhuvan University
JIDCO	Jhimruk Industrial Development Company
KREC	Khimti Rural Electric Cooperative
KU	Kathmandu University
NEA	Nepal Electricity Authority
NFP	Norad's Fellowship Program
NGO	Non-governmental Organization
NHE	Nepal Hydro & Electric
NIDC	Nepal Industrial Development Corporation
NOMA	Norad's Programme for Master Studies
NRREP	National Rural Renewable Energy Programme
NTNU	Norwegian University of Science and Technology
NVE	Norwegian Water Resources and Energy Directorate
PEEDA	People, Energy and Environment Development
PPA	Power Purchase Agreement
PRI	Partial Risk Insurance
SASEC – PTDSSP	South Asia Subregional Economic Cooperation – Power Transmission and Distribution System Strengthening Project
SDG	Sustainable development goal
TU	Tribhuvan University
UMN	United Mission to Nepal

Tullis and
Odd Hoftun.
Photo: UMN

This report is written in the fond memory of Odd Hoftun (1927-2023), who with his wife Tullis ignited energy cooperation with Nepal. Odd Hoftun initiated hydropower production, capacity building and establishment of Butwal Power Company. For more than 50 years, Hoftun cooperated with Nepali partners in a manner that was respectful of local traditions and practices. The idea of enabling local experts and specialized skills was a fundamental principle from the beginning. Much of the Norwegian energy cooperation with Nepal has had a direct or indirect link to Hoftun. His institutions and approach to education, local knowledge and hydropower development constitute pillars for cooperation to this date.

This report has been prepared by Norad (Matilde Solberg Clemetsen, Inge Harald Vognild, Vemund Vikjord), Multiconsult (Leif Birger Lillehammer, Shreya Nagothu, Suman Basnet), and with inputs from the Norwegian Embassy in Kathmandu (Jan Erik Studsrød, Sharad Karmacharya) as well as photographs by Espen Røst (Panorama nyheter). ●



Energy sector highlights:

1960s

Absolute monarchy and the beginning of Norwegian energy cooperation

1970s

Local skills for industrial development

1980s

Incremental hydropower growth

1990s

Stronger cooperation and a new legal framework for the energy sector

2000s

Environmental safeguards and rural energy access

2010s

Surplus and trade

Norad

norad.no