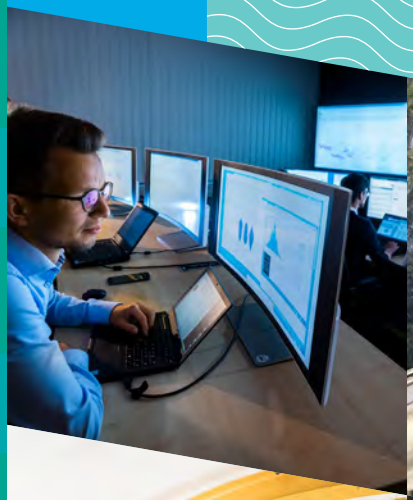
2021

Hydropower Status Report

Sector trends and insights



iha

international hydropower association

Contents

We are the voice of sustainable hydropower

Secure hydropower's place in the energy transition by joining the International Hydropower Association today

The International Hydropower Association (IHA) represents organisations and individuals committed to sustainable hydropower.

Since IHA was founded in 1995, the hydropower sector has more than doubled in size from 625 GW to over 1,300 GW. IHA's members operate around a third of current capacity at 450 GW.

Our mission is to advance sustainable hydropower by building and sharing knowledge on its role in renewable energy systems, responsible freshwater management and climate change solutions.

When delivered responsibly, hydropower offers clean, affordable and reliable electricity, while meeting our basic needs for water, irrigation, flood and drought control.

As the world's largest producer of renewable energy, hydropower ensures global decarbonisation goals remain within reach, while complementing variable renewables through its flexibility and storage.

100+
organisations
IHA's network of members

120+
countries
where our members operate

450
gigawatts
installed capacity of our members

iha

Find out more:
hydropower.org/join

Foreword

The message of this 2021 Hydropower Status Report is clear – at the present rate of hydropower development, the global energy pathway to net zero emissions will not be realised. This is a wake-up call for policy-makers, hydropower developers and project financiers and provides clarity for the public.

Investment in sustainably developed and responsibly operated hydropower is essential to support the massive expansion of variable renewables like wind and solar. However annual growth rates of 1.5 to 2 per cent cannot meet the doubling of installed capacity proposed by the International Energy Agency to achieve net zero by 2050.

Despite the challenge ahead, there is reason for optimism. Companies, investors and citizens increasingly recognise the need for fundamental change. We are witnessing a momentum and a unity of voice not seen before. In recent months, the US has rejoined the Paris Agreement and, together with China and other significant carbon emitters, is on the road to setting ambitious targets to reach net zero.

Sustainable hydropower must be part of this journey. It is green, clean, modern, affordable and reliable. The forthcoming Hydropower Sustainability Standard, the new certification and rating system, will give hydropower developers and operators a means to demonstrate this. In addition, the newly formed International Forum on Pumped Storage Hydropower will soon set out policies to guide how clean, green water batteries with long duration storage can back up variable renewables.

As we prepare for the landmark 2021 World Hydropower Congress, to be followed by the historic United Nations Climate Conference (COP26), we must harness the energy generated to put sustainable hydropower where it should be: at the heart of the transition.

Roger Gill
IHA President

Eddie Rich
IHA CEO

Executive summary

Now in its eighth edition, the 2021 Hydropower Status Report is published as the world continues to grapple with the Covid-19 pandemic. Signs of recovery are emerging but considerable disruption is expected to continue throughout 2021.

Beyond Covid, the challenge of climate change remains the dominant issue for the energy sector. The International Energy Agency (IEA)'s flagship Net Zero by 2050 report, published in May 2021, suggests the world will need 2,600 GW of hydropower capacity by mid-century to have a chance of keeping global temperature rises below 1.5 degrees Celsius. That means that we need to build the same amount of capacity in the next 30 years as in the previous 100.

It is now becoming increasingly clear that the role of renewable hydropower will undergo a qualitative shift over the coming decades. While it will continue to provide low cost, baseload electricity in many markets, hydropower will increasingly be valued for its flexibility and provide essential support to the huge growth in wind and solar that is needed to limit global warming.

Indeed, as recognised by the IEA, hydropower will become the dominant source of flexible electricity by 2050, so it is essential that investment steps up to ensure low carbon energy security over the coming decades.

Events over the past year have demonstrated that electricity systems need flexibility now. In Europe, in January 2021 a blackout event was avoided through the support of highly flexible sources of generation like hydropower, conversely in Texas in February supply failed in extreme weather and there was not enough flexible generation available to compensate.

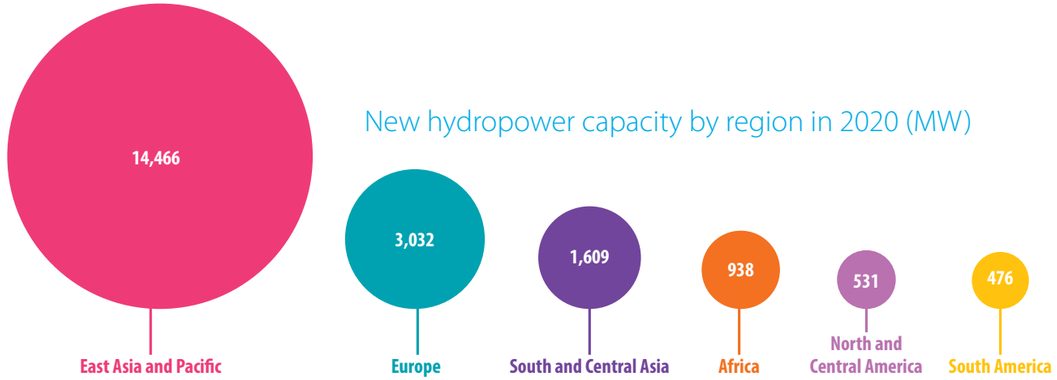
4,370 TWh
Electricity generated from hydropower in 2020
+1.1% on 2019

1,330 GW
Hydropower installed capacity reached in 2020
+1.6% on 2019

21 GW
Capacity added in 2020, including pumped storage
up on **15.6 GW** added in 2019

159.5 GW
Pumped storage installed capacity reached in 2020
+0.9% on 2019

1.5 GW
Pumped storage capacity added in 2020
up on **0.3 GW** added in 2019



New hydropower capacity by region in 2020 (MW)

This report shows the hydropower sector generated a record 4,370 terawatt hours (TWh) of clean electricity in 2020 - up from the previous record of 4,306 TWh in 2019. To put this into context, this is approximately the same as the entire annual electricity consumption of the United States.

Overall hydropower installed capacity reached 1,330 gigawatts (GW) in 2020. This represents year-on-year growth of 1.6 per cent - higher than 2019 but still well down on the more than 2 per cent needed to enable hydropower's essential contribution to tackling climate change.

During 2020, hydropower projects totalling 21 GW in capacity were put into operation, up on 2019's 15.6 GW. Nearly two-thirds of this growth came from China, which saw 13.8 GW of new capacity. Among other countries that added new capacity in 2020, only Turkey (2.5 GW) added more than 1 GW.

Pumped storage hydropower totalled 1.5 GW of the new additions in capacity, up on the 304 MW added in 2019. Most of this was in China (1.2 GW), with Israel also commissioning the 300 MW Mount Gilboa project under an innovative financing model.

Major projects completed in 2020 included the 2.1 GW Lauca facility in Angola, the 1.8 GW Jixi pumped storage facility in China and the Ilisu (1.2 GW) and Lower Kaleköy (0.5 GW) projects in Turkey. The single biggest increase in capacity was in China, where the Wudongde project put eight of its 12 units online, adding 6.8 GW to the Chinese grid. The remainder is expected to be commissioned in 2021.

China remains the world leader in respect of total hydropower installed capacity with over 370 GW. Brazil (109 GW), the USA (102 GW), Canada (82 GW) and India (50 GW) make up the rest of the top five. Japan and Russia are just behind India, followed by Norway (33 GW) and Turkey (31 GW).

Methodology

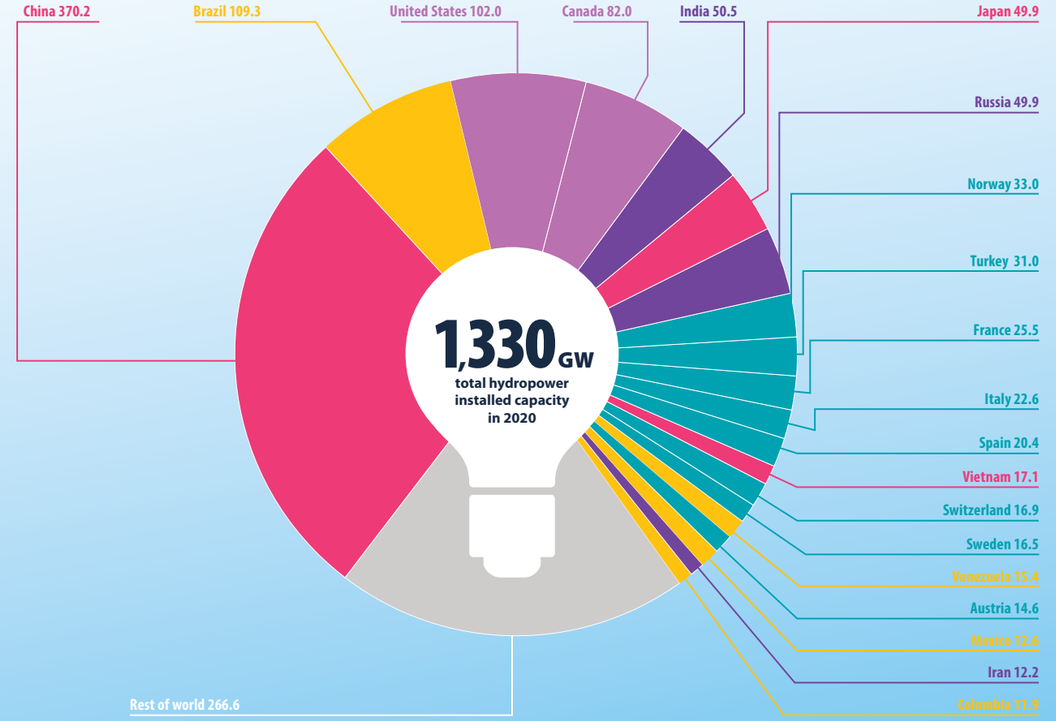
The data presented in this report were continuously tracked and updated to account for new information in our global hydropower database which tracks more than 13,000 stations in over 150 countries.

Data were compiled by a team of analysts using information sourced from (1) official statistics from governments, regulation agencies, transmission network operators and asset owners; (2) scientific articles and reports; (3) daily news reports involving hydropower plant development, official declarations of contracts, and equipment deals; and (4) direct consultation with operators and industry sources.

When generation data from primary sources are not available, estimates are prepared based on the previous year's figure, averaged capacity factors and regional meteorological events and data.

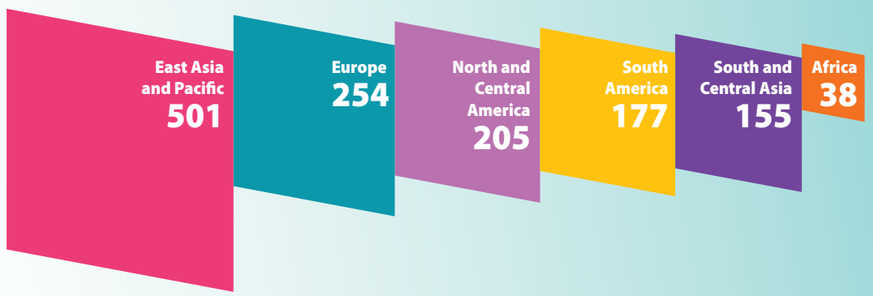
For a small number of countries capacity data from previous years has been updated with new information. This means that those countries will see a year on year increase compared to previous years' reports, but these increased capacity numbers are not treated as capacity added in 2020.

Hydropower installed capacity in 2020



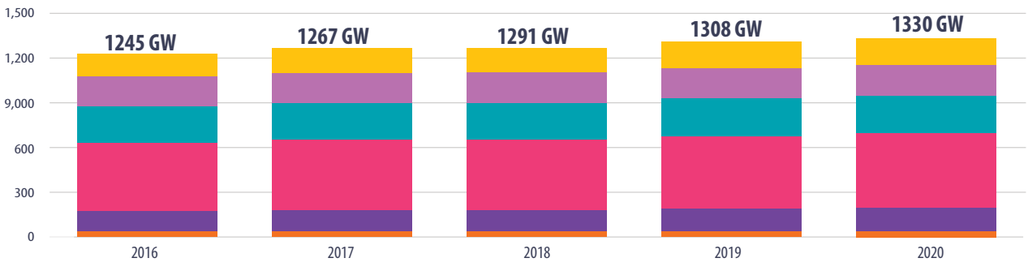
Hydropower installed capacity (GW) of top 20 hydropower producers and the rest of the world, including pumped storage (2020)

Hydropower capacity by region in 2020 (GW)



Hydropower growth in context

Hydropower installed capacity growth, 2016-2020 (GW)



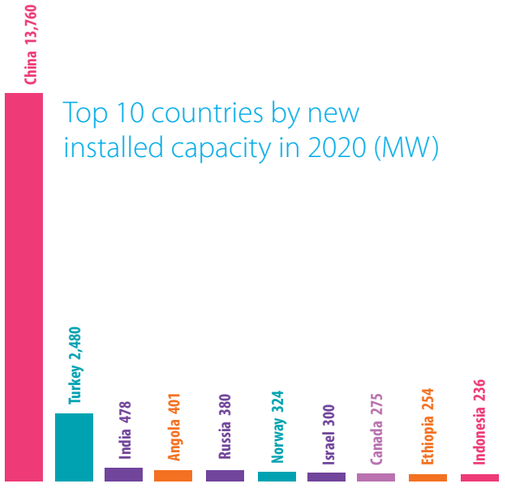
The rise of 21 GW in total hydropower installed capacity in 2020 represented an increase of 1.6 per cent on the previous year. By comparison, the average year-on-year growth in installed capacity in the five years between 2016 and 2020 was 1.8 per cent. It is important to note however that annual growth can vary considerably depending on when major projects, which are years in development, are commissioned.

Notwithstanding, the world needs significantly more hydropower, to be built at a much faster rate, if it is to tackle climate change. Multilateral bodies such as the International Energy Agency (IEA) and International Renewable Energy Agency (IRENA) have previously stated that the world needs around an additional 850 GW of new hydropower to keep global warming below 2 degrees Celsius. To reach this target would require yearly growth of around 2 per cent a year on average.

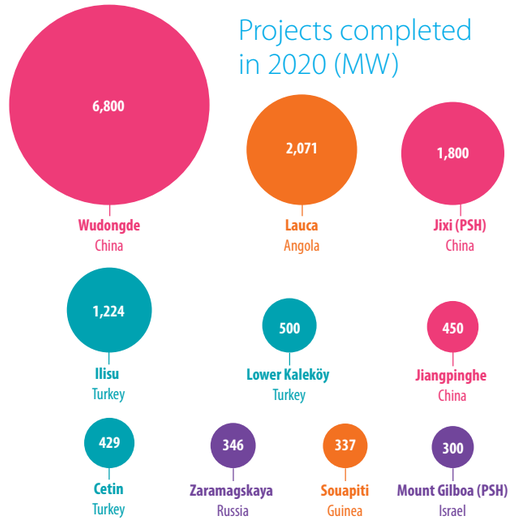
But if we want to limit temperature rises to 1.5 degrees the challenge is greater. The IEA's Net Zero by 2050 report now estimates some 1,300 GW of new hydropower capacity is needed by 2050. To achieve this more stretching target the yearly growth required increases to at least 2.3 per cent if the world starts building at this rate now.

In addition, the global hydropower fleet is ageing, and although much can be modernised it is inevitable that there will be some retirements, affecting future capacity.

Top 10 countries by new installed capacity in 2020 (MW)

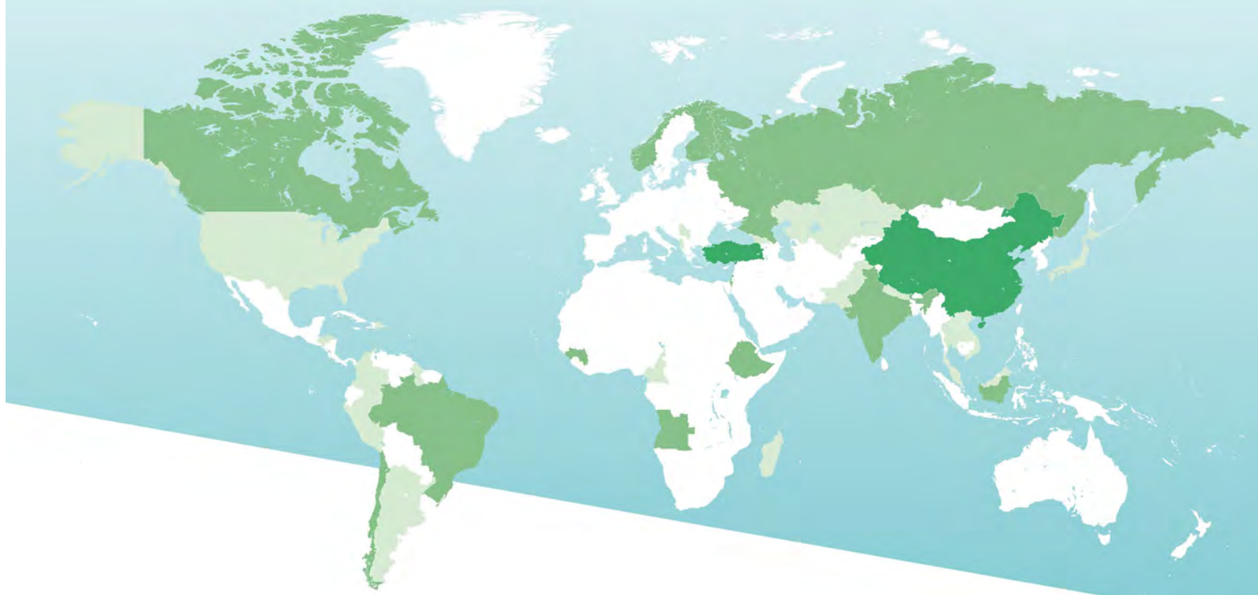


Projects completed in 2020 (MW)



Where was capacity added in 2020?

Thirty-five countries added hydropower capacity in 2020, down on the 50 countries that added capacity in 2019. The total amount of new capacity added however increased from 15.6 GW to 21 GW. The countries with the highest individual increases in installed capacity were China (13.8 GW) and Turkey (2.5 GW).



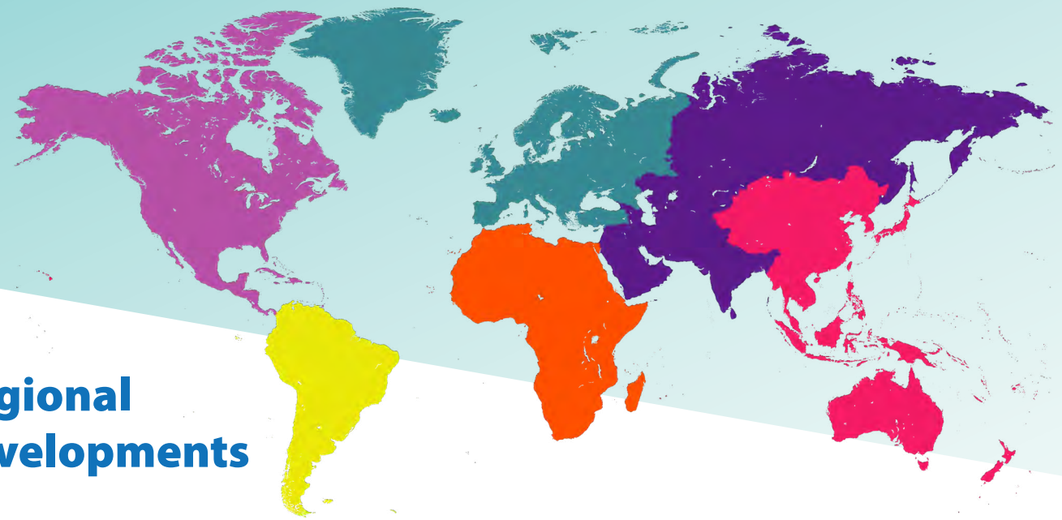
Key

No new additions | 199 MW and below | 200 MW to 1,999 MW | 2,000 MW to 9,999 MW

Ranking	Country	Capacity added (MW)
1	China	13,760
2	Turkey	2,480
3	India	478
4	Angola	401
5	Russia	380
6	Norway	324
7	Israel	300
8	Canada	275
9	Ethiopia	254
10	Indonesia	236
11	Guinea	225
12	Brazil	213

Ranking	Country	Capacity added (MW)
13	Chile	205
14	Albania	197
15	Georgia	178
16	Laos	176
17	Dominican Republic	123
18	Japan	111
19	Honduras	108
20	Pakistan	102
21	Malaysia	101
22	Viet Nam	80
23	Nepal	74
24	Uzbekistan	71

Ranking	Country	Capacity added (MW)
25	Cameroon	30
26	Argentina	30
27	Madagascar	28
28	Kazakhstan	26
29	Serbia	25
30	United States	24
31	Colombia	24
32	Finland	6
33	Thailand	3
34	Peru	2
35	Guyana	2



Regional developments

North and Central America

In the United States, hydropower industry and civil society stakeholders came to an historic agreement. The 'Uncommon Dialogue' will address climate change by advancing renewable energy while protecting rivers.

In Canada, the Québec government approved the Appalaches-Maine Interconnection Line project that will supply the United States with about 10 TWh annually of clean hydroelectricity.

Costa Rica nearly reached 100 per cent renewable electricity production in 2020. It was the sixth consecutive year producing over 98 per cent from renewable sources including hydropower.

Mexico continued with its focus on the modernisation of powered and non-powered dams with plans to equip 15 irrigation dams for hydropower generation.

In Honduras, the Inter-American Development Bank approved an US$18 million loan to modernise the 300 MW Francisco Morazán hydropower plant, the largest in the country.

South America

Itaipu, on the border between Brazil and Paraguay, continued setting records in production and production efficiency. In 2020, the plant celebrated the milestone of 2.7 TWh of electricity produced since it started operations in 1984.

In Brazil, Companhia Hidrelétrica do São Francisco (CHESF) commissioned Andritz to carry out the modernisation of the 1,050 MW Sobradinho plant.

The Inter-American Development Bank approved an extra US$900 million to finish the 2,400 MW Ituango project in Colombia which suffered a major construction incident in 2018 that may lead to one of the largest insurance claims in the history of civil engineering.

Bolivia resumed construction on the 290 MW Ivirizu and the 204 MW Miguillas hydropower projects in Cochabamba and in La Paz, with a total investment of nearly US$1,000 million.

Europe

In 2020, all renewable sources combined generated more electricity than fossil fuels for the first time in the EU, representing a key milestone towards decarbonisation.

While demand reduced during the Covid-19 pandemic, total hydropower generation was 4 per cent higher compared to 2019, largely due to increased output in the Nordics and Iberia.

Turkey added 2,480 MW new hydropower capacity, with major plants commissioned such as 1,224 MW Ilisu, 429 MW Cetin, 120 MW Alpaslan II and 500 MW Lower Kaleköy.

Major policy updates include the EU Green Deal, the EU Taxonomy Regulation for environmentally sustainable investment, and the launch of the Recovery and Resilience Facility.

Additional hydropower plants commissioned in 2020 included the 197 MW Moglice hydropower plant in Albania, and a number of facilities in Norway increasing national capacity by 324 MW.

Hydropower generation by region (TWh)

Africa

Despite the disruptions and changes caused by Covid-19, hydropower has shown resilience in the region with its share increasing in the electricity mix in several countries, such as Ethiopia, Angola and Guinea.

In 2020, 938 MW of hydropower capacity was put into operation across the African continent. Hydropower accounts for 16 per cent of the total electricity share and is expected to increase to more than 23 per cent by 2040.

With Lauca (2,071 MW) fully operational, Angola (3,836 MW) has become the second highest producer of hydropower on the continent, surpassing South Africa (3,596 MW) and behind only Ethiopia (4,074MW).

Ethiopia's Grand Renaissance Dam (6,000 MW) completed the first stage of filling its reservoir in July 2020 with 4.9 billion cubic metres of storage and is expected to become operational in 2023. The Genale-Dawa III multipurpose project (254 MW) also connected to the Ethiopian electricity grid.

South and Central Asia

In February 2021 a glacier burst in the Indian state of Uttarakhand tragically led to multiple fatalities and severely damaged two hydropower projects that were under construction.

In 2020, despite delays to a number of projects as a result of the pandemic, just over 1.6 GW of new capacity was commissioned, mainly in India, Russia, Israel, Georgia and Pakistan.

In India, a nine-minute mass dimming of lights to show solidarity during the pandemic resulted in a huge drop in demand of 31 GW and a subsequent swift ramping up. India's power system planners relied on hydropower to manage the extreme fluctuation in demand.

In Israel, the 300 MW Mount Gilboa pumped storage hydropower facility began commercial operations - the only pumped storage facility outside of China to commission in 2020. It operates under an innovative financing mechanism that pays for plant availability over an 18-20 year timeframe.

East Asia and Pacific

The momentum of divesting from fossil fuels continued to grow across the region, as China, Japan, South Korea and ASEAN countries announced pledges to accelerate the transition to renewable energy.

In 2020, China added a total of 13.76 GW of new hydropower capacity, including 1.2 GW of pumped storage from the last four units of Jixi project.

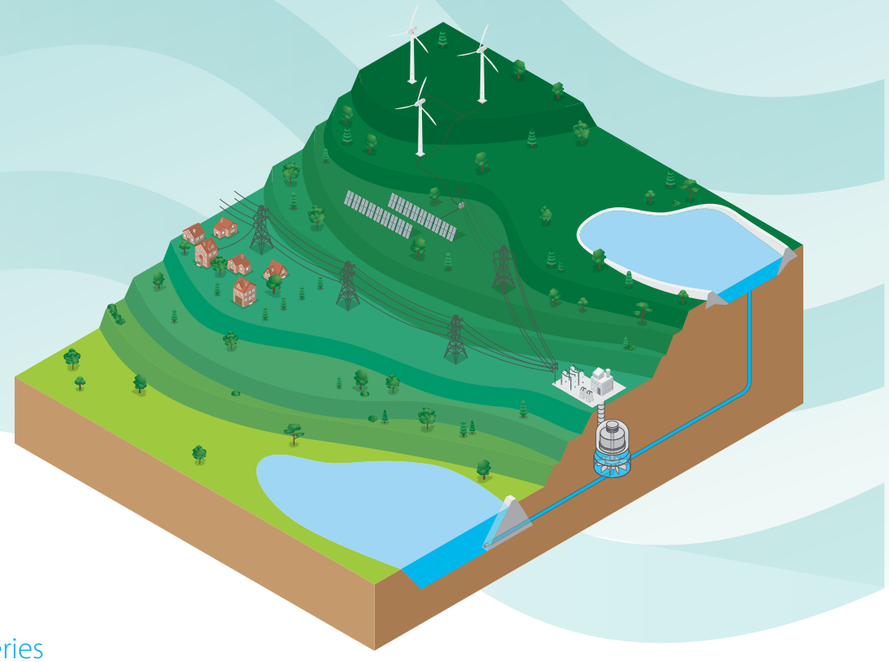
China's 10.2 GW Wudongde project is scheduled to be fully operational by July 2021 and will be the country's fourth-largest and the world's seventh-largest hydropower project upon completion.

Malaysia formally recognised 'large hydropower' as part of its renewable energy definition, in line with other countries internationally.

Pumped storage projects in Australia made significant progress, including Snowy 2.0, the Battery of the Nation and the Marinus Link.

Sector developments

A defining year for pumped storage hydropower



Clean, green water batteries

Pumped storage hydropower (PSH) currently accounts for over 90 per cent of the world's grid-scale energy storage applications, with 160 GW of installed capacity and 9,000 GWh in energy storage capacity.

PSH is a mature and proven technology capable of storing energy or daily cycles up to seasonal storage applications, as well as providing essential grid services for power system reliability.

The impacts of Covid-19 and extreme weather events over the past 12 months have demonstrated the solutions pumped storage hydropower can offer to combat a growing list of challenges facing grid operators.

During the height of global lockdowns, electricity demand declined by up to 30 per cent. Over these periods of low electricity demand, pumped storage was hailed by the Financial Times as the "first line of defence in the battle to keep Britain's lights on".

In the first quarter of 2021, the UK experienced a period of low wind, reducing wind energy generation to levels not seen in over ten years. Over this time period, PSH helped stabilise the UK electricity grid by supplying daily electricity inputs at record high rates.

Similarly, hydropower and pumped storage helped prevent a large-scale blackout in continental Europe on 8 January 2021. With the phase-out of fossil generation to reach climate targets, the importance of hydropower's storage and flexibility services will continue to grow.

Given the increasing number of net zero emissions targets being set, governments, industry and the wider sector need to work collaboratively and quickly develop PSH at scale to support the rapid roll-out of variable renewables.

Pumped Storage Hydropower International Forum

Launched in November 2020 and co-chaired by the U.S. Department of Energy and former Prime Minister of Australia Malcolm Turnbull, the International Forum on Pumped Storage Hydropower is a government-led multi-stakeholder platform to shape and enhance the role of PSH in future power systems.

The Forum brings together 13 governments – the USA, Austria, Brazil, Colombia, Estonia, Greece, India, Indonesia, Israel, Morocco, Norway, Sri Lanka and Switzerland – to develop guidance and recommendations on how sustainable pumped storage hydropower can best support the energy transition.

Partners include over 80 organisations from industry, academia and NGOs as well as five multilateral development banks: the World Bank, the European Bank for Reconstruction and Development (EBRD), the African Development Bank (AfDB), the Asian Development Bank (ADB) and the Inter-American Development Bank (IDB), and the International Renewable Energy Agency (IRENA).

Through convening three working groups, the Forum will deliver actionable recommendations and share best practice in 'Market and Policy Frameworks', 'Capabilities, Costs and Innovation', and 'Sustainability'. Final deliverables will be launched at the World Hydropower Congress in September 2021, with the aim of taking these key outcomes to the UN Climate Conference (COP26) in Glasgow a few weeks later in November 2021.

High-level stakeholders

At the inaugural meeting of the Forum, speakers urged governments and industry to move quickly to develop projects at the scale needed to support the rapid roll-out of variable renewables.

In his opening address, Mr Turnbull stated that "politicisation of climate policy has delayed global action and disrupted the orderly planning needed to move to a future of zero emissions and affordable and reliable energy".

The second meeting in May 2021 was opened by U.S. Secretary of Energy Jennifer Granholm with the statement that investing in hydropower, especially pumped storage, is a central part of President Biden's green energy jobs plan and "can help us take major steps forward while creating millions of new, good paying jobs and improving the quality of life for Americans everywhere".

The remarks by Secretary Granholm were followed by a high-level roundtable discussion with Mr Turnbull and Greek Energy Minister Kostas Skrekas, amongst other speakers. As part of national recovery plans, the Greek government is leveraging the EU Recovery and Resilience Facility (RRF) to finance pumped storage projects in Greece.

"As we shift how we power our countries and economies, the need to scale up and realise the power of hydropower has never been greater," said Kelly Speakes-Backman, Acting Assistant Secretary of Energy and Co-Chair of the Forum.

Learn more: hydropower.org/pumpedstorageforum

Forum's steering committee:

Sponsoring partners:

Sector developments

Clean energy systems

IEA report models a doubling of hydropower capacity to achieve net zero

To successfully limit global temperature rises to 1.5 degrees Celsius, reducing global CO_2 emissions to net zero is essential. The IEA's Net Zero by 2050 report was released in May 2021, modelling how the global energy sector may successfully decarbonise by 2050. In the Net Zero Emissions (NZE) scenario, while solar PV and wind are modelled as generating the vast majority of electricity, hydropower will continue to steadily grow, "doubling by 2050" and becoming the largest single source of flexible electricity generation. Further to this, the report emphasised the role pumped storage hydropower could play, stating that it "offers an attractive means of providing flexibility over a matter of hours and days". Hydrogen is described as potentially having an important role to play in longer term seasonal storage.

Coupling green hydrogen with hydropower could create a net zero future

Produced using decarbonised electricity and water through a process called electrolysis, green hydrogen is set to be an important component of the transition to net-zero carbon economies. As an emission-free gas it could provide a replacement for fossil fuels in key hard-to-abate sectors, including heavy industry, transport and shipping. In 2021 IHA released a research and policy paper, 'The green hydrogen revolution: hydropower's transformative role', outlining how hydropower could be pivotal in supporting growth in green hydrogen. Most hydrogen is currently produced from fossil fuels, but 2050 projections by IRENA, the Hydrogen Council and others suggest renewable and low carbon green hydrogen could grow dramatically over the coming decades. The concluding sections of the paper set out recommendations to scale up production and the opportunities in coupling projects with clean hydropower.

IDB: 'Significant potential' in Latin America for pumped storage hydro

Pumped hydro energy storage holds significant potential for large-scale energy storage applications in Latin America and the Caribbean (LAC), especially considering the vast existing hydropower infrastructure in the region, according to the Inter-American Development Bank (IDB). Their report titled 'State of Charge: Energy Storage in Latin America and the Caribbean' examined the current and potential roles for energy storage technologies in LAC grids and provided recommendations on the regulatory and policy changes to accelerate uptake in the region. The report also suggested that the size of the global pumped storage industry has been estimated at US$300 billion and projected to grow to US$400 billion by 2026.

Near-blackout in Europe shows hydropower's crucial role in green transition

In January 2021, a blackout event in Europe to rival that of the February 2021 Texas power crisis was only avoided by the narrowest of margins, according to an assessment by the European Network of Transmission System Operators (ENTSO-E). On 8 January 2021, the failure of a substation in Croatia triggered a dramatic increase in frequency in the south-east European grid and a corresponding drop in frequency in the north-west. Such a drop in frequency (or lack of supply) will normally result in major power failures and widespread blackouts if not resolved within a few seconds. Fortunately, disaster was averted thanks to the immediate ramping up of generation from flexible hydropower and gas peaking plants, as well as load shedding in France and Italy. While in this case the system worked as it was intended to, the narrowly avoided blackout highlights the importance of hydropower's flexibility and storage services.

Linth Limmern pumped storage project, Switzerland
Credit: GE Renewable Energy

XFLEX HYDRO: Major step forward for EU funded hydropower initiative

The EU-funded XFLEX HYDRO initiative to demonstrate how smart hydropower technologies can deliver a low-carbon, reliable and resilient power system published its first major report in November 2020. The report assesses the future ancillary services expected to be required by the European power grid, technical requirements and corresponding markets. In April 2021, a battery energy storage system (BESS) container for the project also arrived at EDF's Vogelgrun hydropower plant. Vogelgrun is a 142 MW run-of-river plant in France, where one of the plant's Kaplan turbine units will be hybridised with the battery.

Investing in pumped storage can save energy system costs

A study by independent researchers from Imperial College London found that just 4.5 GW of new long duration pumped hydropower with 90 GWh of storage could save up to £690 million a year in energy system costs by 2050, as the UK transitions to a net zero carbon emission system. Commissioned by SSE Renewables, the report found that 75 per cent of these cost savings came from the avoided capital cost of other sources of firm low carbon generation, further demonstrating the cost benefit and capabilities of pumped storage hydropower as a provider of short and long term system flexibility.

US DOE: New valuation guidebook for pumped storage

The new US Department of Energy published a valuation handbook, led by Argonne National Laboratory, that illustrates the value of investing in pumped storage. The guide measures both monetised and non-monetised value streams. For example planning a new project can examine effects of market rules and mechanisms, and the likelihood of recouping investment. Regulators can judge if a project is economical and predict when a new plant will have a positive impact on consumers' electricity rates. A financial institution can find assurances before it approves loans or loan guarantees.

Sector developments

Finance and modernisation

IRENA outlook report underlines need for renewables investment

Energy transition investment will have to increase by 30 per cent over planned investment to a total of US$131 trillion between now and 2050, according to the International Renewable Energy Agency (IRENA). The agency's '1.5°C Pathway' sees electricity becoming the main energy carrier in 2050 with renewable power capacity expanding more than ten-fold over the same period. The increase in investment would correspond to a global spend of US$4.4 trillion on average every year, including US$85 billion a year for hydropower, excluding pumped storage.

Hydropower sector receives green light for climate bond finance

The Climate Bonds Standard criteria for hydropower were launched in early 2021 representing a major milestone for the sector. CBI certified climate bonds are widely regarded as the best way to direct investment to infrastructure that supports the Paris Agreement while reducing negative impacts on the environment and communities. Following the announcement, developers, banks, governments and other investors can now issue certified climate bonds to finance or refinance hydropower projects that comply with strict social, environmental and climate criteria. Pumped storage, run-of-river and impoundment facilities of any size are eligible. The criteria stipulates use of the Hydropower Sustainability ESG Gap Analysis Tool for assessing gaps against good practice as well as the G-res Tool for reporting net greenhouse gas emissions.

EU recognition of sustainable hydropower in investment rules

The European Commission made changes to its proposed investment criteria for hydropower, releasing an update to the EU Taxonomy Climate Delegated Act – a classification system for environmentally sustainable economic activities. The criteria for hydropower are now more context specific. Run-of-river plants or plants with a power density above 5W/m2 will not have to undertake a life cycle based GHG emission assessment to prove that they comply with the 100g threshold. Plants with a reservoir and a power density below 5W/m2 will have to confirm that they meet the threshold. Importantly, the act also now recognises all types of pumped storage hydropower as making a substantial contribution to climate change mitigation. The act is now aligned with hydropower sector good practice requirements described in the Hydropower Sustainability ESG Gap Analysis Tool, compliance with which is necessary to secure green bond financing through the Climate Bonds Initiative.

New guide on hydropower investment in Africa highlights opportunities

While hydropower is the main provider of renewable electricity in Africa with over 38 GW of installed capacity, the continent has the highest untapped potential in the world, with only 11 per cent utilised. Addleshaw Goddard, with assistance from IHA, released 'An Investor's Guide to Hydropower in Africa' to provide investors with essential information to support the sustainable development of hydropower projects. According to the World Bank, around US$100 billion of infrastructure investment is needed in the region, however of the more than US$8 billion invested in infrastructure in 2017, less than 3 per cent came from the private sector. The new guide will help host governments, private investors, funding parties and in-country procuring entities understand the legal bankability issues, legal systems and law relevant to the hydropower sector of the 11 countries featured.

Kashimbila Multipurpose Dam, Nigeria
Credit: SCC Nigeria/Zutari

Credit: China Three Gorges Corporation

NHA paper identifies solutions for new pumped storage development

As part of the International Forum on Pumped Storage Hydropower, the National Hydropower Association has announced the submission of a pumped storage hydropower (PSH) policy paper aimed at identifying challenges and solutions to jump start development in the United States. NHA co-authored the U.S. Markets and Policy Paper with General Electric, the Pacific Northwest National Laboratory and PSH developers. The paper identifies the critical challenges, barriers and opportunities for accelerating pumped storage development in the U.S. Among these, the co-authors raise several challenges including: a lack of renumeration for various grid services, demonstrating the value of PSH over other storage technologies, inequitable policy treatment and revenue uncertainty as some of the barriers to PSH development. The paper identifies eight specific recommendations for policy changes across multiple jurisdictions including Congress, wholesale markets and state level policies.

Studies identify significant investment needs in hydropower modernisation

In 2020, IHA completed studies with the Inter-American Development Bank (IDB) and Asian Infrastructure Investment Bank (AIIB) identifying significant modernisation needs for the regions' hydropower. In the case of Latin America, over 15 GW of the existing capacity was identified in high and urgent need of modernisation, with estimates of over US$5 billion investment required in the electrical and mechanical hydropower equipment. With regard to Asia, more than 6 GW was assessed as in high need of modernisation and representing around US$3 billion of investment potential. The studies shed light on the global issue of ageing hydropower capacity, and the scale of effort that will be required to rehabilitate and upgrade existing infrastructure. The studies also point out that modernisation projects present opportunities not only in extending the life of generating assets, but also in adding capacity and optimising plants for their future role in a renewable energy mix.

Sector developments

Water and climate

Landmark agreement between US hydropower and conservation groups

The United States' hydropower industry joined forces with American Rivers, the World Wildlife Fund, and other environmental and river organisations released a joint statement of collaboration on U.S. hydropower to advance the renewable energy and storage benefits of hydropower and the environmental and economic benefits of healthy rivers. After a two-and-a-half year discussion, facilitated under Stanford University's Uncommon Dialogue process, the parties have agreed to work together to address a range of challenges, including licensing and relicensing, dam safety, and valuing hydropower's grid services.

HydroSediNET launches to promote sustainable sediment management

The HydroSediNET initiative launched as a global collaborative platform to connect experts and innovators supporting the planning, implementation and operation of effective and sustainable sediment management in storage reservoirs and run-of-river hydropower plants. Funded by the Austrian Federal Ministry of Finance and administered by the World Bank's ESMAP Hydropower Development Facility, the initiative will bring together organisations who publish research and develop strategies for sediment management. The network is supported by seven founding members including IHA.

IEA reports on climate impacts on Africa and Latin American hydropower

The IEA launched a series of publications on climate impacts with contributions from IHA. The reports recognise vast differences between regions and recommend systematic assessments and resilience measures. Countries are urged to scale up the resilience of hydropower plants, mobilise investment in modernisation, foster climate risk insurance, and support climate research to improve projection accuracy.

New World Bank risk management guidance

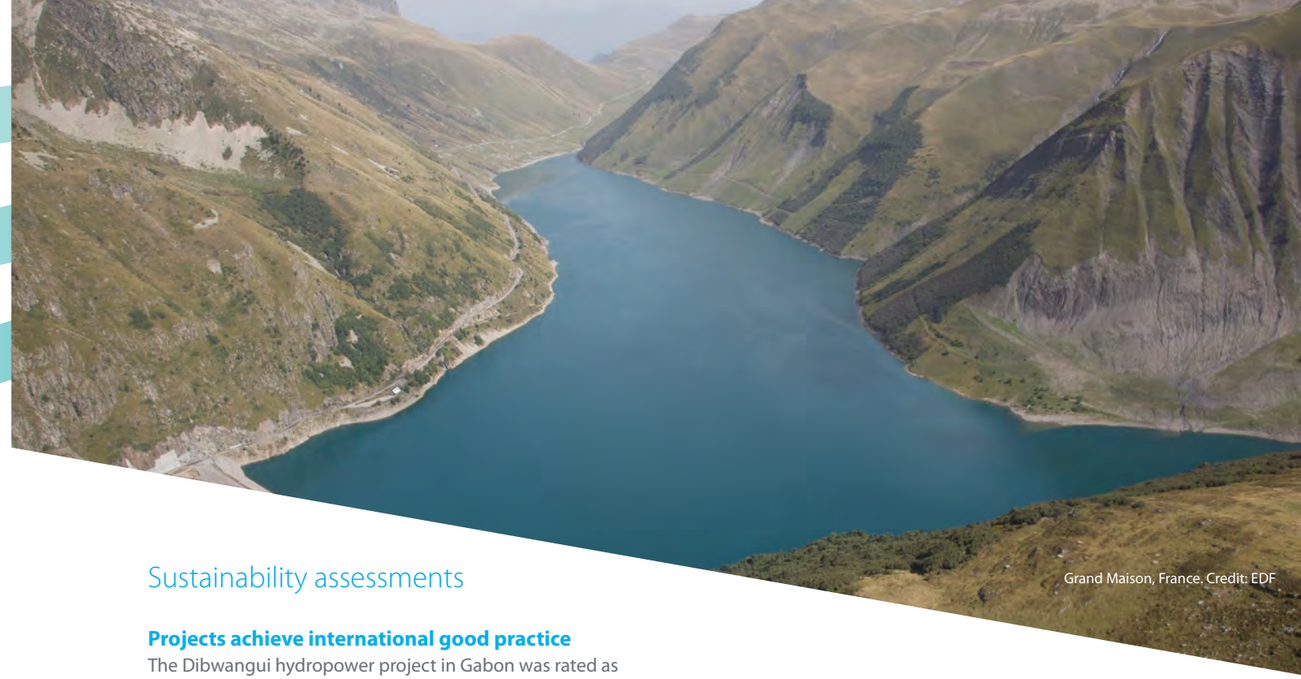
The World Bank Group issued a new good practice note on dam safety. The guidance is accompanied by seven technical notes that provide more detailed explanation and guidance on hydrological risk, geotechnical risk, seismic risk, small dam safety, potential failure modes analysis, portfolio risk assessment, and tailings storage facilities. Since 2003, the Bank has financed over US$50 billion worth of investments that involve dams, including rehabilitation and upgrading of existing dams, construction of new facilities, and financing for preparatory studies for proposed dams.

Resilience rating system developed by World Bank

The World Bank has developed a Resilience Rating System that provides guidance and specific criteria to assess resilience. This system rates the confidence that expected investment outcomes will be achieved, based on whether a project has considered climate and disaster risks in its design, incorporated adaptation measures, and demonstrated economic viability despite climate risks. In addition, it rates a project's contribution to adaptive development pathways based on whether investments are targeted at increasing climate resilience in the broader community or sector. IHA's Hydropower Sector Climate Resilience Guide is highlighted as a key reference document for achieving resilience.

Research project to mitigate impacts on fish

Hydropower is part of the solution to protect the planet's biosphere by tackling climate change. However hydropower projects need to avoid, minimise, mitigate or compensate for their impacts on freshwater species. A new FIThydro research project has been launched focusing on developing science-based cost-efficient environmental solutions and strategies to mitigate adverse impacts on the fish population.



Grand Maison, France. Credit: EDF

Sustainability assessments

Projects achieve international good practice

The Dibwangui hydropower project in Gabon was rated as an example of international good practice in sustainability design and planning, following an independent assessment using the Hydropower Sustainability ESG Gap Analysis Tool. In addition, the Stortemelk hydropower project in South Africa was recognised as an impressive example of sustainable small hydropower development following its assessment using the tool. The Stortemelk project was the first to be assessed remotely using new remote assessment guidance. The methodology, issued in response to Covid-19 travel and safety restrictions, allows assessors to use drones, videoconferencing, live video inspection, satellite images, as well as online interviews and surveys, to conduct project assessments.

New chair of the hydropower sustainability council

One of the world's leading experts on sustainable development, Dr Ashok Khosla, became independent chair of the Hydropower Sustainability Assessment Council, which governs sustainability guidance for hydropower. Dr Ashok Khosla was an adviser to the Brundtland Commission, chair of the NGO Forum at the Rio Summit and President of the International Union for Conservation of Nature (IUCN). One of the council's first priorities is to introduce a Hydropower Sustainability Standard, a certification system built on the Hydropower Sustainability Tools, which will be launched at the World Hydropower Congress in September 2021.

How-to guides released for hydropower practitioners

Three new guides have been released by IHA for hydropower practitioners based on the Hydropower Sustainability Tools. The How-to Guide on Hydropower Resettlement helps companies design and implement resettlement schemes that respect the dignity and human rights of communities affected. Good practice requires a participatory process based on fairness and equity, with the aim of achieving a sustainable improvement in the lives of resettles. The How-to Guide on Downstream Flow Regimes aims to equip practitioners with adequate knowledge in river management to minimise downstream flow impacts while maximising project benefits. The How-to Guide on Hydropower Biodiversity and Invasive Species helps developers and operators better manage biodiversity impacts of hydropower projects. It also addresses the assessment and planning for invasive species management.

Launch of new hydropower sustainability training academy

IHA launched a training academy for sustainable hydropower, building on its 25 years of experience in developing guidance on hydropower development, as well as its expertise in delivering training and capacity building programmes. The Hydropower Sustainability Training Academy offers courses based on the internationally recognised Hydropower Sustainability Tools in addition to the G-res tool, which was developed to assess greenhouse gas emissions of reservoirs. Online trainings are provided as a blend of live and self-paced learning, and participants can take part in virtual classrooms where trainers deliver live stream lessons, lead group activities and host interactive Q&A sessions.

Sector developments

The new global sustainability standard for hydropower

Hydropower Sustainability Standard

The Hydropower Sustainability Assessment Council is developing a new global sustainability standard for hydropower, with support from the International Hydropower Association (IHA).

Under the proposal, hydropower projects around the world will be independently certified and rated for their environmental, social and governance (ESG) performance.

The Hydropower Sustainability Standard will recognise leading projects, while giving all developers and operators the opportunity to strengthen their performance in line with international practices.

The Hydropower Sustainability Standard will build on the existing Hydropower Sustainability Tools, a set of guidelines and assessment tools aligned with World Bank standards.

June 2020

Established working group

The Hydropower Sustainability Assessment Council has established a working group to develop the design of the global Hydropower Sustainability Standard. Participants include representatives of Hydro-Québec, WWF International, the World Bank, Women for Water Partnership, the Government of Nepal and IHA.

November 2020 – February 2021

First public consultation

IHA and the Council launched a public consultation to gather comments from hydropower stakeholders. Respondents were from a variety of sectors including research and consultancy, hydropower industry, financial institutions, academia, government, NGO, and standards and certifications bodies. A compendium of all material issues raised in the consultation process will be posted on HydroSustainability.org.

March 2021 – May 2021

Drafting of design proposal

The working group considered public consultation feedback and began developing a draft design for the Standard. The working group is expected to provide a recommendation to the Hydropower Sustainability Assessment Council for approval.

July 2021

Second public consultation

A second public consultation will be conducted through the Council members and the wider public.

August 2021

Finalised standard

The Hydropower Sustainability Assessment Council will finalise the content and requirements for the Standard, as well as its certification and assurance processes, assessment tools and guidance documents.

September 2021

Global launch

The launch of the Hydropower Sustainability Standard will take place at the World Hydropower Congress in September 2021.

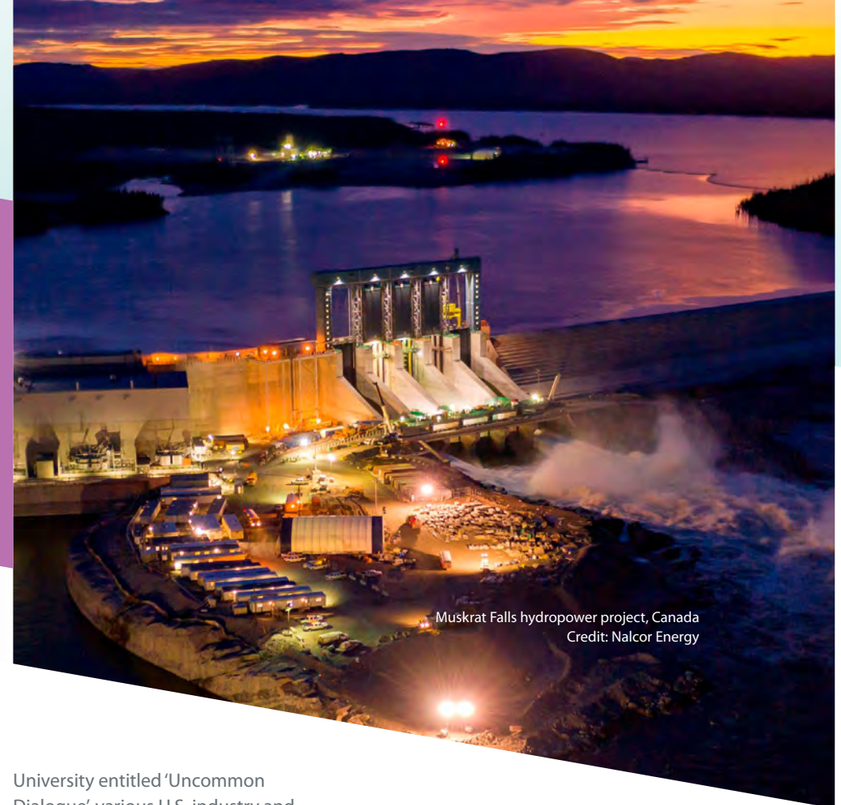
September 2021 – onwards

Implementation

The design and implementation of the standard will be continuously reviewed and improved in line with international accreditation and labelling codes. Its use will be promoted across renewable sectors.

North and Central America

Overview



Muskrat Falls hydropower project, Canada
Credit: Nalcor Energy

The abundance of natural resources in North and Central America makes the region highly suited for renewable energy production. A large portion of the electricity market is supported by hydropower and has been for decades.

Many countries throughout the region have adopted policies to increase the share of renewables to transition to a low-carbon economy. Modernising the existing hydropower fleet and developing new projects to meet energy demands and ensure renewable development is increasingly important.

Despite the reduction in demand due to the Covid-19 pandemic, hydropower remained vital for grid reliability and, in several countries, generation by hydropower even increased. Recovery plans across the continent have had a strong focus on the green energy transition, the reduction of fossil fuel imports, investment in transmission and distribution lines, digitalisation, and the strengthening of regional energy cooperation.

Under an initiative overseen by Stanford University entitled 'Uncommon Dialogue', various U.S. industry and civil society stakeholders have come together to identify solutions to decarbonise the country's electricity system while at the same time seeking to conserve the biodiversity and ecosystems of rivers. Three opportunities arise from this dialogue: rehabilitation of dams to increase safety and mitigate environmental impacts; retrofitting powered projects and adding capacity in non-powered dams; and decommissioning those dams that no longer provide significant benefits.

A recent transborder initiative between the U.S. and Canada highlights the importance of regional interconnections in contributing to the transition to a low carbon economy. The Appalaches-Maine Interconnection Line, approved in 2020, will increase the mix of hydropower in the total U.S. electricity share. To be commissioned in 2023, the transmission line will supply 9.45 TWh of hydropower from Quebec to Massachusetts and 0.5 TWh to Maine over 20 years, shrinking annual CO_2 emissions by three million metric tonnes.

In Canada, hydropower continues to provide around 60 per cent of the country's total annual electricity generation and represents more than half of total generation capacity. In 2020, despite the on-site health and safety challenges presented by the Covid-19 pandemic, more than 4 GW of projects continued to progress toward completion. The Lower Churchill project synced its first unit to the Labrador electricity grid in September 2020 with power from the three other units later coming online; together they are expected to reach 3,074 MW.

In April 2020 the Canadian government proposed a budget of C$17.6 billion (US$14 billion) for green recovery programmes for fiscal year 2021/2022.

Ranking by total installed hydropower capacity

Rank	Country/Territory	Installed capacity (MW)*
1	United States	102,000
2	Canada	82,000
3	Mexico	12,612
4	Costa Rica	2,331
5	Panama	1,786
6	Guatemala	1,559
7	Honduras	837
8	Dominican Republic	616
9	El Salvador	575

Rank	Country/Territory	Installed capacity (MW)*
10	Nicaragua	157
11	Puerto Rico	100
12	Cuba	68
13	Haiti	60
14	Belize	55
15	Jamaica	30
16	Guadeloupe	11
17	Dominica	7
18	Saint Vincent and The Grenadines	7

*including pumped storage

North and Central America

Developments

The proposals suggest an investment of C$40.4 million (US$33.15 million) in hydropower development over the next three years, which could advance several hydropower projects such as the Atlin Hydro expansion project in Yukon and a feasibility study of the Kivalliq HydroFibre Link project in Nunavut. Additionally, in December 2020 Canada released a new climate policy which expressed continued commitment to reach 90 per cent non-emitting electricity by 2030 and to achieve net zero emissions electricity before 2050. The plan also presents multiple initiatives that boost demand for hydropower including new transmission capacity to supply regions phasing out coal, and the electrification of transport, buildings and industry to achieve greenhouse gas emissions reductions.

Costa Rica almost reached its goal of 100 per cent renewable electricity production in 2020. It produced 99.78 per cent of electricity generation from renewables, with hydropower representing 72 per cent. Despite the Covid-19 pandemic resulting in a drop in electricity demand by 2.8 per cent compared to 2019, hydropower generation increased by about 6 per cent compared to 2019.

Mexico's hydropower fleet was identified as having a high potential for revitalisation in a joint study by the IDB and IHA conducted in 2020. The nation has an ageing hydropower fleet, with about 85 per cent of installed capacity over 10 GW commissioned over 30 years ago. The government has developed plans to upgrade 18 existing hydropower plants to achieve 26 GW of hydropower capacity by 2030.

The Mexican government is focused on increasing hydropower capacity through the rehabilitation and modernisation of the state-owned company CFE's existing assets as well as retrofitting the National Water Commission's non-powered irrigation dams. There is an agreement between CFE and the commission to equip 15 irrigation dams for hydropower generation, creating 200 MW of installed capacity, with plans to incorporate 10 additional dams. In addition, the government wants to promote projects under 30 MW as per an agreement with China that includes a collaboration with the International Centre on Small Hydro Power to study basin water availability and the feasibility of new projects.

El Salvador remains heavily reliant on fossil fuel imports, accounting for almost a third of its total electricity supply. Among the country's mix of renewables, hydropower however still represents the largest share. The government is developing a flagship hydropower project that will help in the decarbonisation of the country's electricity system: the 65.7 MW El Chaparral (renamed 3 de Febrero) project is expected to begin operation in 2021.

In Honduras, the Inter-American Development Bank approved a US$18 million loan to support the modernisation of the 300 MW Francisco Morazán hydropower plant, the largest in the country. Also known as El Cajon, the plant became operational in 1986 and its modernisation will boost its reliability and efficiency.

Puerto Rico faced an unstable year in 2020 as it faced the fallout from several natural disasters. Uneven energy demand due to Covid-19 led to an increase of fossil fuel generation. The country is however exploring options to revitalise hydropower facilities to meet a goal of 100 per cent renewable energy generation by 2050.

Jamaica's government announced plans to develop pumped storage hydropower that would help achieve 50 per cent of renewable energy generation by 2030, however this announcement came before the pandemic hit budget allocations.

Generation by hydropower
724 TWh

Total installed capacity*
205 GW
*including pumped storage

Capacity added in 2020
531 MW

Pumped storage installed capacity
23 GW

Pumped storage capacity added in 2020
00 MW

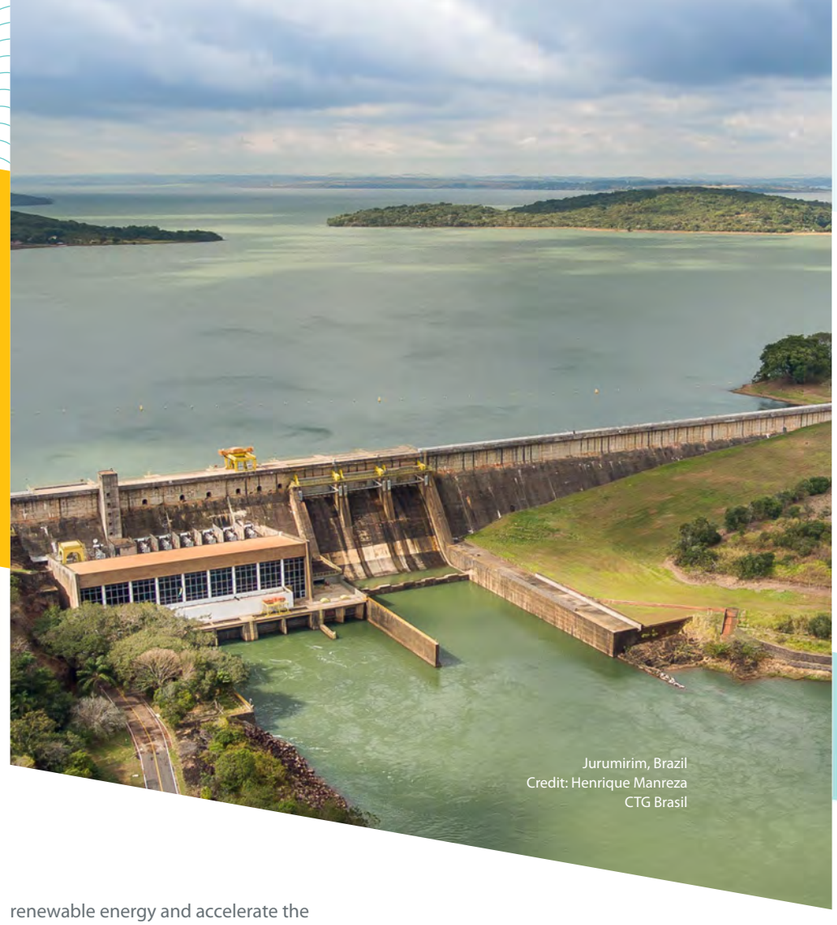
Romaine-4 hydropower plant under construction in Québec, Canada
Credit: Hydro-Québec

Top 4 countries by capacity added in 2020

1st **Canada** 275 MW
2nd **Dominican Republic** 123 MW
3rd **Honduras** 108 MW
4th **United States** 24 MW

South America

Overview



Jurumirim, Brazil
Credit: Henrique Manreza
CTG Brasil

South America has seen significant demand for hydropower development in recent years, making it one of the fastest growing regions. In several countries hydropower provides more than half of total electricity supply and it is expected to remain the region's largest renewable source for years to come.

With many hydropower facilities decades-old, modernisation remains a priority for plant operators and grid operators, as was highlighted in a recent joint study by IHA and the Inter-American Development Bank (IDB).

Due to the impact of the Covid-19 pandemic, South America saw a decrease in energy demand in 2020. This led to a drop in greenhouse gas emissions and pollution, however this impact was expected to be temporary as countries remain heavily reliant on fossil fuels. Covid-19 recovery plans were developed in response in order to decarbonise economic sectors, increase renewable energy and accelerate the transition to a low carbon economy.

Brazil has suffered from chronic drought in recent years, which has caused the lowest levels of precipitation in the wet season (from October to March) since record lows in 1991. Moving into the dry season in March 2021, the government declared that Brazil is undergoing a major hydrological crisis. The consequences of this are significant as the country relies on hydropower reservoirs to generate over 60 per cent of electricity. Reservoirs are currently operating at extremely low capacity due to decreased in-flow at similar levels last seen during a severe drought in 2015. Energy supply is at stake and the regulator is warning that the electricity tariff may increase in 2021 given the necessity to produce more expensive electricity from thermal power plants. The government is also authorising electricity imports from Uruguay and Argentina.

The Itaipu Dam, on the Paraná River on the border between Brazil and Paraguay, continues setting records in accumulated production and production efficiency. In 2020, the plant celebrated the milestone of 2.7 TWh of electricity produced since it began operations in 1984. Itaipu is the only plant in the world with accumulated production above 2 TWh.

Brazil is becoming a leader in hybrid energy projects with recent

Ranking by total installed hydropower capacity

Rank	Country/Territory	Installed capacity (MW)*
1	Brazil	109,271
2	Venezuela	15,393
3	Colombia	11,941
4	Argentina	11,340
5	Paraguay	8,810
6	Chile	6,944
7	Peru	5,396
8	Ecuador	5,076
9	Uruguay	1,538
10	Bolivia	735
11	Suriname	190
12	French Guiana	119
13	Guyana	3

*including pumped storage

South America

Developments

development of a solar floating photovoltaic plant on the Furnas-owned 52 MW Batalha hydropower project reservoir. Tractebel has been awarded the contract to build the 15-hectares floating plant of 30 MW installed capacity.

Colombia has moved forward with plans to rapidly increase the share of wind and solar in its energy mix, where hydropower currently accounts for about 70 per cent of electricity production. By diversifying, the government seeks to strengthen the resilience of the system while maintaining one of the cleanest electricity systems in the world.

Colombia's government published a 2050 roadmap in the Energy National Plan with a two-fold challenge: increase access to energy and tackle climate change by reducing greenhouse gas emissions. The target is to diversify the energy matrix by substantially increasing energy supply from natural gas and from renewable energy sources such as wind and solar, to surpass fossil-fuels generation. In the short-term, wind and solar installed capacity is expected to grow to 2,500 MW in 2022. Decarbonisation of transportation is also vital to reduce Colombia's reliance on fossil fuels.

Small-scale hydropower developments have strategic advantages due to Colombia's geography. The 19.9 MW San Andrés de Cuerquia became operational in September 2020. The Minister of Mining and Energy announced proposals for three more small-scale hydropower projects: Retiro I, Retiro II, and Chorreritas (each nearly 20 MW). In addition, the country's Ituango hydropower project received an additional US$100 million from its insurer after a serious construction incident in 2018; studies are ongoing to determine the causes and meanwhile the IDB has approved an extra US$900 million in financing.

In Peru, a US$438 million contract for the construction of the 187 MW San Gabán III in Puno was given the go ahead. Peru's renewable energy portfolio continues to expand, with over 2,000 MW in additions planned. Most of these are hydropower schemes, including the 84 MW La Virgen project to be commissioned in 2021, as well as Tulumayo IV (56.2 MW), Tulumayo V (83.2 MW), Anto Ruiz III (102.1 MW) and Anto Ruiz IV (103.8 MW) expected to start after 2022. Other projects include Lluclla (288 MW) and Tarucani (49 MW) in Arequipa, and Huallaga I (392 MW) in Huánuco. The investment cost of these ventures totals more than US$2,200 million.

Generation by hydropower
690 TWh

Total installed capacity*
177 GW
*including pumped storage

Capacity added in 2020
476 MW

Pumped storage installed capacity
1 GW

Pumped storage capacity added in 2020
0 MW

São Salvador hydropower project, Brazil
Credit: ENGIE Brazil

Top 5 countries by capacity added in 2020

1st **Brazil** 213 MW
2nd **Chile** 205 MW
3rd **Argentina** 30 MW
4th **Colombia** 24 MW
5th **Peru** 2.35 MW

Ecuador aims to attract private investment to construct and operate hydropower projects to achieve its Electricity Master Plan by 2027. The country is seeking US$5,300 million for the 2,400 MW Santiago project currently in the feasibility study stage and for the 596 MW Cardenillo and the 487 MW Sopladora project in the bidding process.

Bolivia resumed construction on the 290 MW Ivirizu hydropower project in Cochabamba and the 204 MW Miguillas hydropower project in La Paz, with a total combined investment of nearly US$1,000 million.

Venezuela continues with the rehabilitation of the electromechanical equipment units that were out of service since outages allegedly caused by cyber-attacks in 2019.

Among the growing interconnections across the South America, the long-distance high-voltage interconnections between Ecuador and Peru have now resumed development after being stalled due to the Covid-19 crisis. In addition, Itaipu Binational has offered to help develop binational projects between Bolivia and Brazil with an estimated capacity of up to 6,000 MW.

Europe

Overview

Hafslund vammaåpning
Credit: Voith Hydro

Hydropower continues to be a leading source of renewable energy in Europe, as the continent is transitioning towards a cleaner energy mix with contributions from wind and solar also increasing rapidly.

Hydropower capacity rose by 3 GW across the European region in 2020, made up mainly by new hydropower plants commissioned in Turkey and other additions in Norway and Albania. Generation from hydropower was almost 4 per cent higher in 2020 than the previous year, owing largely to increased production in the Nordics and Iberia.

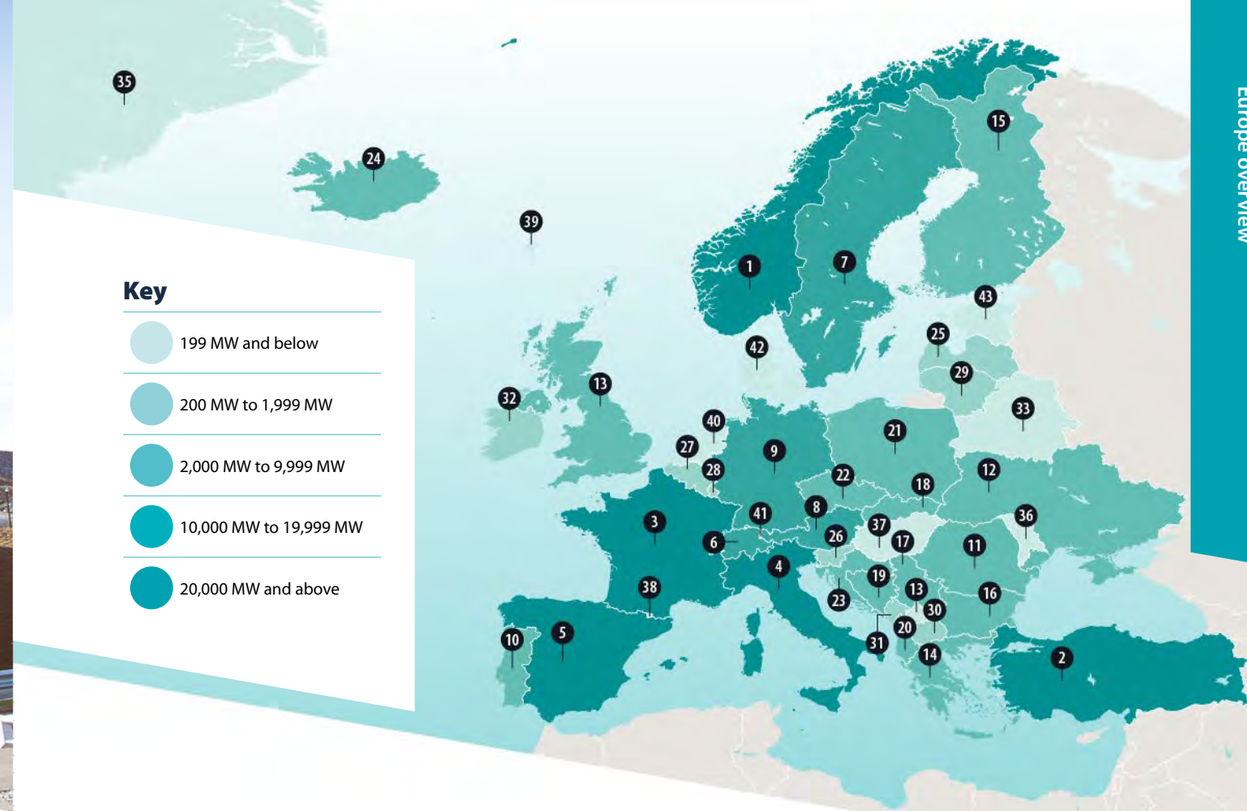
Across the EU-27 countries, a key milestone was reached in 2020 as all renewables together generated more electricity than fossil fuels for the first time. This was achieved with continued growth in wind and solar generation, which is expected to almost triple by 2030, and falls in production from coal-fired production. Hydropower contributed a 13 per cent share of total electricity generated, underlining its major role in the EU's energy mix. Developments in pumped storage hydropower and grid interconnection projects were also made last year as part of measures to ensure a more resilient and flexible energy system.

The Covid-19 pandemic caused demand to fall by 4 per cent across the EU in 2020. Its economic impact has spurred government action to support the recovery, with the EU launching a Recovery and Resilience Facility. EU countries can access funding through the facility by submitting national plans of investments and reforms, for which hydropower and other renewable projects are eligible.

Other EU policy developments include the EU Taxonomy regulation, which sets out criteria that different economic activities, including for hydropower, must meet to qualify as environmentally sustainable. In addition, the EU Green Deal was approved targeting green growth, environmental protections, and a carbon-neutral economy by 2050.

Turkey's hydropower capacity grew by almost 10 per cent in 2020, adding 2,480 MW with new reservoir storage and run-of-river projects entering into operation. The national Renewable Energy Support Scheme (YEKDEM) has helped bring forward large increases in renewable capacity, made up mainly by the hydropower additions. The incentive scheme also supports wind, geothermal, solar and biomass, and was originally due to expire on 31 December 2020, but was extended due to Covid-19.

The largest new addition was the 1,224 MW Ilisu hydropower plant, located in south eastern Turkey on the Tigris



Rank	Country/Territory	Installed capacity (MW)*
1	Norway	32,995
2	Turkey	30,984
3	France	25,508
4	Italy	22,593
5	Spain	20,409
6	Switzerland	16,881
7	Sweden	16,478
8	Austria	14,597
9	Germany	11,022
10	Portugal	7,193
11	Romania	6,313
12	Ukraine	6,229
13	United Kingdom	4,712
14	Greece	3,400
15	Finland	3,263

Rank	Country/Territory	Installed capacity (MW)*
16	Bulgaria	3,129
17	Serbia	3,123
18	Slovakia	2,522
19	Bosnia and Herzegovina	2,513
20	Albania	2,390
21	Poland	2,385
22	Czech Republic	2,268
23	Croatia	2,141
24	Iceland	2,086
25	Latvia	1,576
26	Slovenia	1,524
27	Belgium	1,427
28	Luxembourg	1,330
29	Lithuania	1,016
30	Macedonia	674

Rank	Country/Territory	Installed capacity (MW)*
31	Montenegro	658
32	Ireland	529
33	Belarus	97
34	Kosovo	92
35	Greenland	91
36	Moldova	76
37	Hungary	56
38	Andorra	45
39	Faroe Islands	39
40	Netherlands	38
41	Liechtenstein	35
42	Denmark	9
43	Estonia	8

*including pumped storage

Europe

Developments

river. The year 2020 was a significant milestone for the project ending 13 years since construction initially began in 2007. The site will play a vital role producing power for over a million homes and providing irrigation for thousands of farmers, thanks to its large multi-purpose reservoir and six turbine generators. Three other hydropower projects commissioned last year include Cetin (429 MW), Alpaslan II (120 MW) and Lower Kaleköy (500 MW). Projects including Orta (16 MW), Kovanlık (19 MW) and several others of similar size also went into service, along with a further 19 smaller-scale projects. Full rehabilitations of 123 MW Mendelez and 58 MW Kilavuzlu hydropower plants were also completed.

In Scandinavia, meteorological conditions such as mild weather and high levels of precipitation resulted in large volumes of water inflow into reservoirs. This, coupled with the decrease in electricity demand due to the Covid-19 pandemic, caused record low electricity prices and major fluctuations over the course of 2020.

Norway continued to increase its hydropower capacity through medium and small-scale developments, adding 324 MW in 2020. Notable stations include Nedre Otta (78 MW), Leikanger (77 MW) and Østerbo (48 MW), with consecutive growth over the years resulting in total installed hydropower capacity at 32,995 MW. Neighbouring Sweden, Finland and Denmark did not report significant growth in capacity in 2020.

The NordLink interconnector, a subsea high voltage (HVDC) grid transmission line between Norway and Germany, entered testing at the end of 2020. The project will link hydropower in Norway and wind energy in Germany, allowing the two countries to trade renewable electricity and thus improve energy security.

In the UK, early in 2020 the Cruachan pumped storage hydropower station in Scotland was awarded a six-year synchronous compensation contract to provide system support services to the National Grid. Services will include inertia and reactive power, helping to keep the grid stable under rising levels of variable renewables.

There were no major new hydropower additions in Western and Central Europe in 2020, although progress was made in several modernisation and construction programmes. In France, the 97 MW Romanche-Gavet project was commissioned; this is a replacement for six older hydropower plants and five older dams previously operating along the Romanche River near the Alps. The new site includes a dam and underground powerhouse, with much-reduced environmental and social impacts on the surrounding area. Elsewhere, modernisation programmes were completed at the 600 MW Zakucac project in Croatia and the 126 MW Zvornik project in Serbia.

Portuguese Prime Minister António Costa visited the Tâmega complex in 2020, a project under construction in the country's northern region involving three new-build dams and hydropower plants (Gouvães, Daivões and Alto Tâmega). The complex on the Tâmega river will add up to 1,158 MW, and includes the 880 MW Gouvães pumped storage plant, to help bolster the region's grid operations and security. Another pumped storage plant close to full commissioning is the 900 MW Nant de Drance project in Switzerland.

In the Balkans, the 197 MW Moglice hydropower plant was commissioned in Albania on the Devoll river. The scheme includes an underground powerhouse and 167 metre asphalt-core dam impounding its reservoir, the highest of its kind in the world. The project involved important investments in local communities, including roads, transmission, and social and environmental development programmes.

Generation by hydropower
676 TWh

Total installed capacity*
254 GW
*including pumped storage

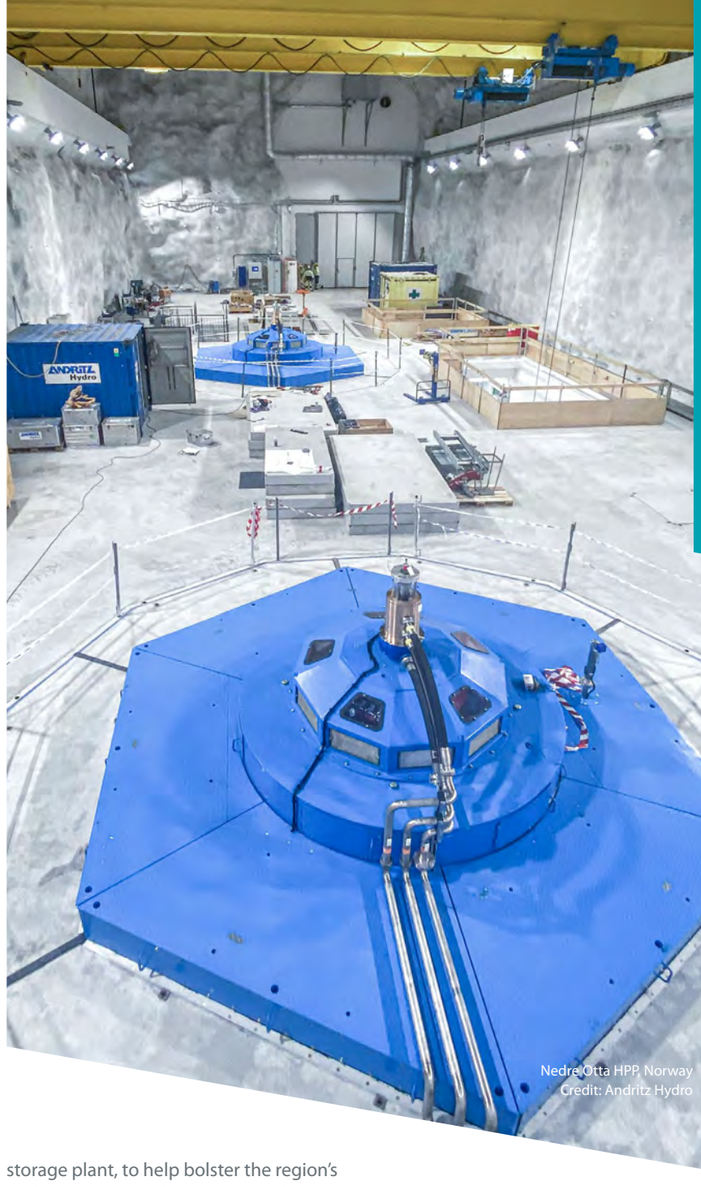
Capacity added in 2020
3032 MW

Pumped storage installed capacity
55 GW

Pumped storage capacity added in 2020
0 MW

Top 5 countries by capacity added in 2020

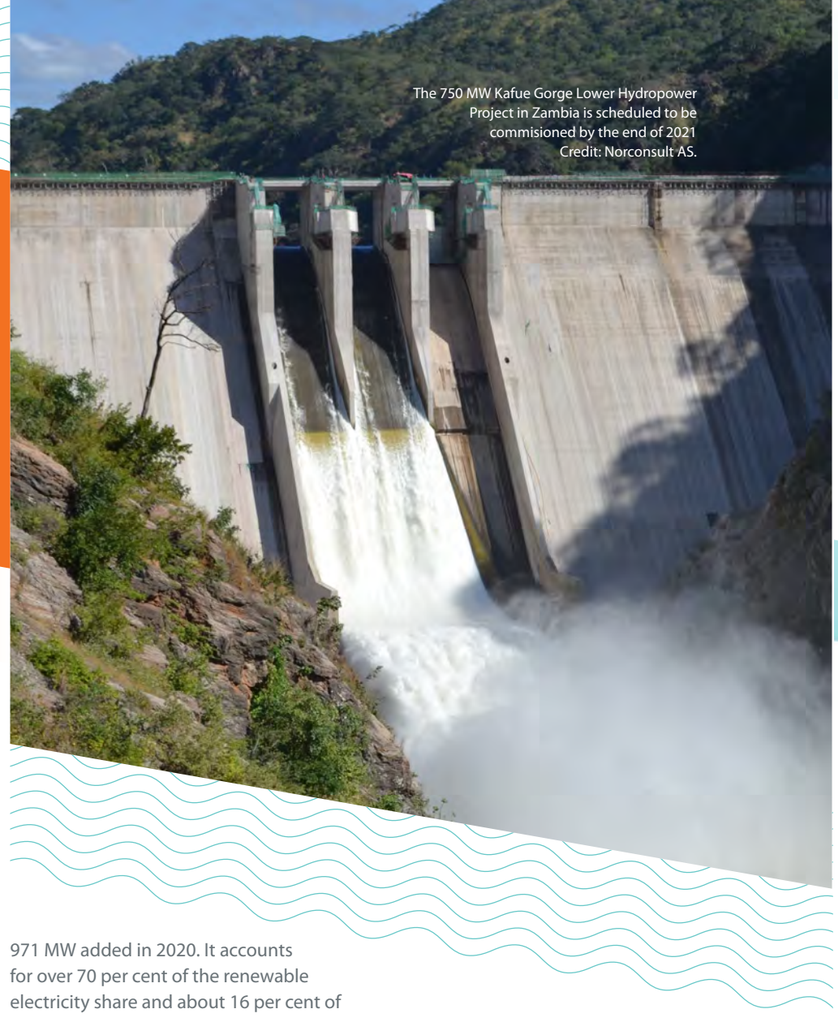
1st	Turkey	2480 MW
2nd	Norway	324 MW
3rd	Albania	197 MW
4th	Serbia	25 MW
5th	Finland	6 MW



Nedre Otta HPP, Norway
Credit: Andritz Hydro

Africa

Overview



The 750 MW Kafue Gorge Lower Hydropower Project in Zambia is scheduled to be commisioned by the end of 2021
Credit: Norconsult AS.

With energy demand growing twice as fast as the global average, Africa has a unique opportunity to adopt latest innovative technologies and take action to shape a sustainable energy future.

Despite being home to 17 per cent of the world's population, it accounts for just 4 per cent of global power. An estimated 579 million people remain without access to electricity in sub-Saharan Africa. The United Nations predicts that Africa's population will double by 2050, amounting to approximately 2.5 billion people with electricity demand expected to triple by 2040.

By 2050, two in every five children will be born in Africa with the urban population expected to nearly triple to 1.34 billion. The West African power pool (WAPP) region will represent one-third of the continent's total population in 2070, with over 1.5 billion people.

Hydropower remains the continent's primary renewable resource in Africa at over 38 GW of installed capacity, with 971 MW added in 2020. It accounts for over 70 per cent of the renewable electricity share and about 16 per cent of the total electricity share. Hydropower's share of total electricity is predicted to increase to more than 23 per cent by 2040 following efforts to achieve universal access and a low carbon energy transition.

Sustainable energy is at the forefront of national development plans across the continent. Out of the 53 African nationally determined contributions (NDCs) under the Paris Agreement on climate change, 45 contain quantified renewable energy targets.

These efforts are aligned with the Program for Infrastructure Development in Africa (PIDA), a continent wide initiative that intends to harness Africa's vast renewable energy potential and identifies a need for high-capacity transmission networks. The North-South Transmission Corridor from Egypt to South Africa in particular presents priorities for transmission networks and large-scale hydropower generation projects.

While Africa seeks higher penetration of variable renewable energy, such as solar and wind, the need for new hydropower development as well as modernisation of the existing hydropower fleet has

Ranking by total installed hydropower capacity

Rank	Country/Territory	Installed capacity (MW)*
1	Ethiopia	4,074
2	Angola	3,836
3	South Africa	3,596
4	Egypt	2,876
5	Democratic Republic of the Congo	2,760
6	Zambia	2,400
7	Mozambique	2,216
8	Nigeria	2,111
9	Sudan	1,923
10	Morocco	1,770
11	Ghana	1,584
12	Zimbabwe	1,091
13	Uganda	1,040
14	Cote D'Ivoire	879
15	Kenya	837
16	Cameroon	822
17	Guinea	706
18	Tanzania	596
19	Malawi	371
20	Namibia	347
21	Gabon	331
22	Algeria	269
23	Mali	220
24	Congo	218
25	Madagascar	186
26	Reunion	134
27	Equatorial Guinea	128
28	Rwanda	111
29	Liberia	93
30	Senegal	81
31	Lesotho	73
32	Tunisia	66
33	Sierra Leone	64
34	Mauritius	61
35	Eswatini	60
36	Burundi	57
37	Togo	49
38	Mauritania	48
39	Burkina Faso	34
40	Benin	33
41	Central African Republic	19
42	Sao Tome And Principe	2
43	Comoros	1

*including pumped storage

Africa

Developments

become more pressing in the region. For example, the power system master plans of the Eastern Africa Power Pool (EAPP) and the Southern African Power Pool (SAPP) involve substantial hydropower capacity.

The African economy has been impacted by Covid-19 lockdown measures, but the effects have not been uniform across the region. The United Nations Economic Commission for Africa (UNECA) reports that countries such as Mozambique and Democratic Republic of Congo experienced higher electricity demand in 2020 compared to previous years, mainly thanks to recent progress in expanding energy deployment.

On the other hand, in countries where almost the entire population had access to energy, such as South Africa and Tunisia, electricity demand decreased with respect to 2019 levels. Moreover, despite the disruptions and changes caused by Covid-19, hydropower has shown resilience with its share being increased in the electricity mix in several countries.

In Angola, the 2,071 MW Lauca hydropower station became fully operational in December 2020. It is the second largest hydropower plant in Africa, after the 2,075 MW Cahora Bassa power station in Mozambique, and represents more than half of the country's hydropower capacity.

In Guinea, two units of the Souapiti hydropower project (225 MW out of 450 MW) became operational in November 2020. The project is expected to be fully operational by end 2021 and is supported by China's Belt and Road Initiative (BRI).

In Ethiopia, work continued on the 6,350 MW Great Ethiopian Renaissance Dam (GERD). The project has come under pressure from both Egypt and Sudan, with Ethiopia asked to commit to a legally binding agreement on the amount of water retained in the reservoir. Elsewhere, part of the Genale Dawa basin development, the 254 MW Genale-Dawa III multipurpose dam also connected to the electricity grid in February 2020.

In Uganda, the 600 MW Karuma hydropower project has reached 98 per cent completion and is expected to become operational in May 2021. The government's grid development plans have forecasted that total electricity demand will more than double by 2030, with hydropower accounting for almost

Generation by hydropower
139 TWh

Total installed capacity*
38 GW
*including pumped storage

Capacity added in 2020
938 MW

Pumped storage installed capacity
3 GW

Pumped storage capacity added in 2020
0 MW

Rusumo Falls, Rwanda
Credit: Andritz Hydro.

Top 5 countries by capacity added in 2020

1st	Angola	401 MW
2nd	Ethiopia	254 MW
3rd	Guinea	225 MW
4th	Cameroon	30 MW
5th	Madagascar	28 MW

70 per cent of the generation mix.

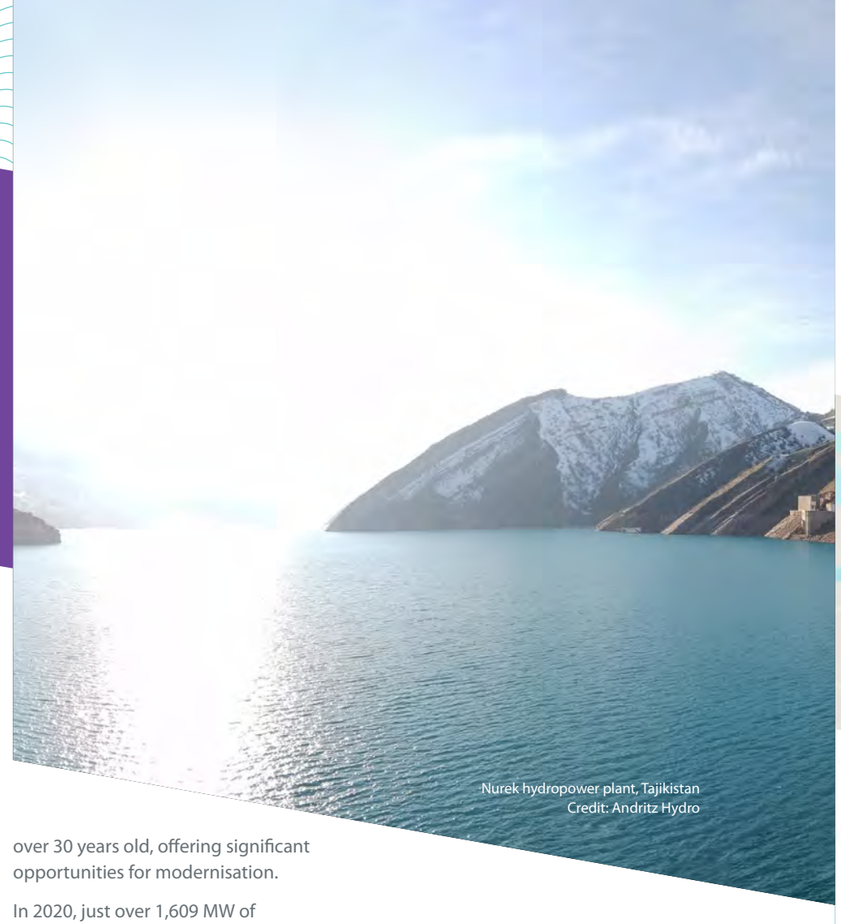
In Zambia, the 750 MW Kafue Gorge Lower hydropower project is expected to be commissioned in 2021. In addition, the 2,400 MW Batoka Gorge hydropower project, jointly owned by Zambia and Zimbabwe, will begin construction in 2021 and is expected to generate more than 10,000 GWh a year on completion.

In Nigeria, two multipurpose hydropower projects – Gurara (30 MW) and Kashimbila (40 MW) – reached a concession from Federal Government. These projects are part of the Nigerian government's priority actions and its 2030 targets to increase the grid's installed capacity to at least 32,000 MW, of which 14,000 MW will be from hydropower. The most significant hydropower project under development is the 3,050 MW Mambila hydropower project, that will commence construction in 2021 and, once completed, will be the largest power station in Nigeria.

In Morocco, the 350 MW Abdelmoumen pumped storage project has reached 40 per cent completion and is scheduled for commissioning in the first half of 2022. In addition, the 300 MW Ifahsa pumped storage project is under construction and is expected to be commissioned in 2025. These projects are part of Morocco's strategy to meet the country's renewable energy targets while managing peaks in demand.

South and Central Asia

Overview



Nurek hydropower plant, Tajikistan
Credit: Andritz Hydro

Hydropower resources are unevenly distributed across South and Central Asia due to the region's diverse topography and hydrologic conditions.

While several arid countries have limited or no hydropower resources, hydropower remains the dominant source of electricity in Georgia, the Kyrgyz Republic, Tajikistan, Afghanistan, Nepal and Bhutan. The majority of the region's overall electricity mix is supplied by natural gas, coal and oil, with hydropower contributing approximately 11 per cent of annual generation, making it the predominant renewable energy source.

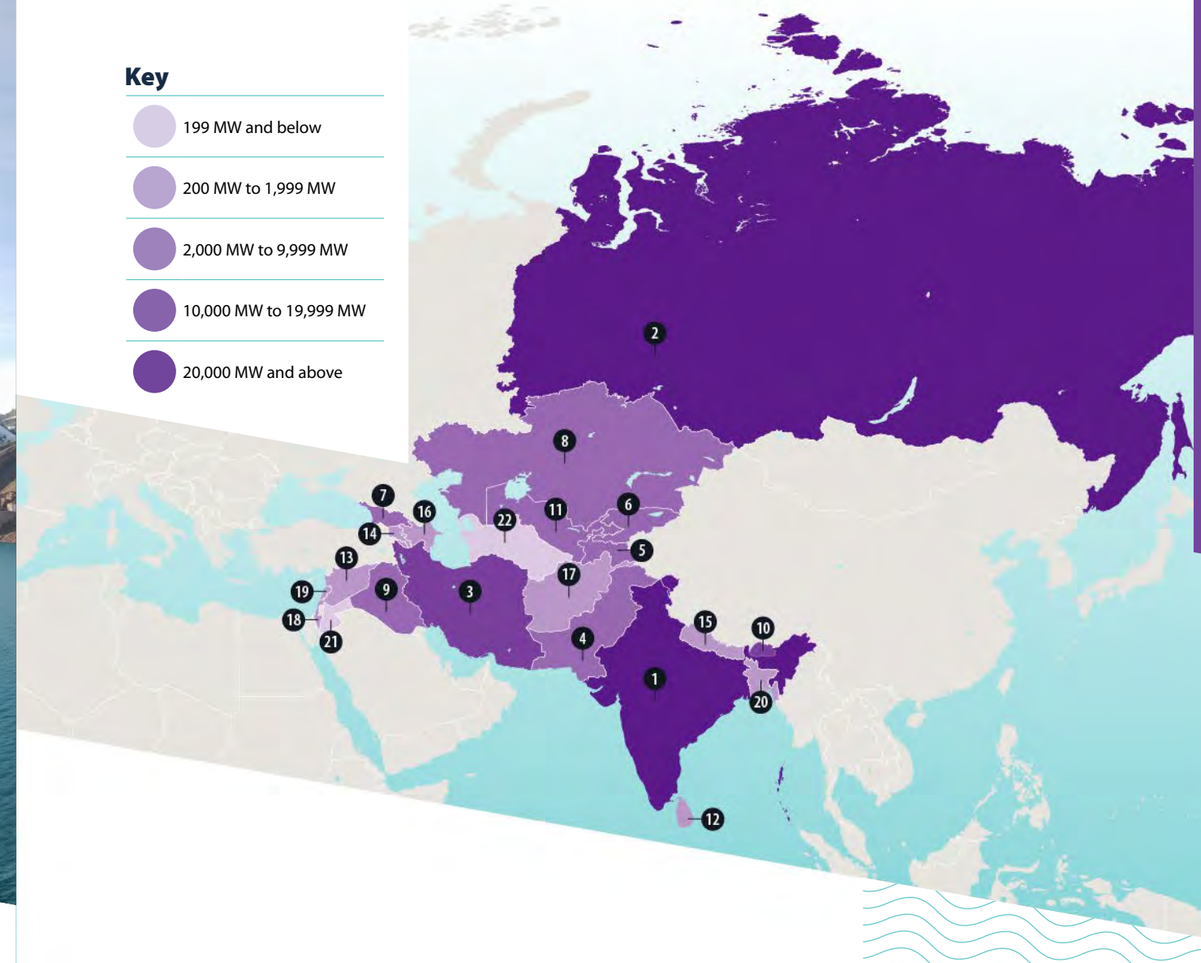
While total hydropower installed capacity exceeds 157 GW, the majority of the region's hydropower potential is still untapped. Georgia, Tajikistan, Kyrgyzstan and Uzbekistan have more than 75 per cent of potential hydropower capacity that could still be developed. In addition, most existing hydropower assets are over 30 years old, offering significant opportunities for modernisation.

In 2020, just over 1,609 MW of hydropower capacity went into operation. Most of the stations in the region that were supposed to be commissioned were however delayed or halted due to the impact of the Covid-19 pandemic. Where new capacity was added, it was predominantly commissioned in India, Russia, Israel, Georgia and Pakistan.

Recent events have demonstrated the flexibility and resilience hydropower brings to electricity grids. Responding to a Covid-19 solidarity event in India which encouraged households to switch their lights on and off, hydropower producers had to ramp down and up within seconds to support the unprecedented 31 GW shift in electricity demand.

The World Bank held a summit to encourage South Asian nations to work together on Covid-19 and unlock development opportunities focusing on resilience, economic connectivity and human capital. Subsequently, the World Bank highlighted the need for countries to invest in sustainable hydropower as part of green recovery efforts.

During 2020, India commissioned the 300 MW Kameng hydropower project while several other projects were granted approval to proceed, such as Dibang (2,880 MW), Bodhghat (500 MW), Athirappilly (163 MW) and North Koel (24 MW). Additionally, approval for construction of the 240 MW Kutehr Dam has finally been granted, and the 800 MW Parbati II project is expected to be



Ranking by total installed hydropower capacity

Rank	Country/Territory	Installed capacity (MW)*
1	India	50,549
2	Russia	49,912
3	Iran	12,169
4	Pakistan	9,929
5	Tajikistan	6,395
6	Kyrgyzstan	3,892
7	Georgia	3,449
8	Kazakhstan	2,730
9	Iraq	2,753
10	Bhutan	2,326
11	Uzbekistan	2,005

Rank	Country/Territory	Installed capacity (MW)*
12	Sri Lanka	1,809
13	Syria	1,505
14	Armenia	1,293
15	Nepal	1,278
16	Azerbaijan	1,131
17	Afghanistan	461
18	Israel	307
19	Lebanon	282
20	Bangladesh	230
21	Jordan	12
22	Turkmenistan	5

*including pumped storage

South and Central Asia

Developments

commissioned by December 2021.

Russia commissioned four hydropower plants in 2020, namely Zaramagskaya 1 (346 MW), Verkhnebalkarskaya (10 MW), Ust-Dzhegutinskaya (5.6 MW) and an upgraded Irkutsk project (adding 22.9 MW). Finally, Barsuchkovskaya (5.25 MW) was commissioned in January 2021.

As for Uzbekistan, in 2020 six hydropower plant modernisation (adding 7.45 MW) and construction projects (adding 64 MW) were commissioned by Uzbekhydroenergo, with a total capacity of 71.35 MW, capable of producing 541 GWh of electricity. The Kamchik hydropower project (26.5 MW) and Zarchob small hydropower chain on the Tupalang river (37.4 MW) were both commissioned, offering a combined annual average output of 177 GWh. It also established an ambitious national energy strategy to double hydropower electricity generation by 2030 involving launching seven large plants with 1.24 GW of hydropower capacity.

In Kazakhstan, Shardarinskaya hydropower plant was modernised in 2020, increasing its installed capacity from 100 MW to 126 MW.

In Nepal, the Upper Trishuli 3A hydroelectric project (60MW) and Kulekhani III hydroelectric project (14 MW) were commissioned. Due to the Covid-19 pandemic however, three hydropower plants were delayed: Rahughat Khola (40 MW), Upper Rahughat (48.5 MW) and Rahughat Mangale (37 MW) are now expected to be commissioned in 2022-2023. According to the Asian Development Bank (ADB), Nepal has about 88 per cent of its economically viable potential hydropower to develop and could export the electricity surplus to Bangladesh and other neighboring countries.

In Pakistan, as of early 2021 the 240 MW Keyal Khwar project had resumed works and was expected to be commissioned by December 2023. The 102 MW Gulpur hydropower plant was commissioned in 2020, located near the Poonch river, capable of generating 465 GWh. A US$300 million loan was granted by the Asian Development Bank (ADB) to finance construction of a 300 MW hydropower plant in Kunhar river near Balakot City, projected to be commissioned by 2027 and with an estimated annual generation of 1,143 GWh.

Georgia has made solid progress in the past decade in improving the security of its energy supply and transitioning to a cleaner, more sustainable energy system. The Shuakhevi hydropower project was commissioned in May 2020 with a total capacity of 178 MW.

In Bhutan, an ambitious update of the country's energy policy is expected to focus on capacity building to secure a minimum of 5,000 MW by 2030. The plan includes the construction of the 1,200 MW Punatsangchhu-1 hydroelectric plant. The policy will also support the preparation of the 1,125 MW Dorjilung hydropower project and associated transmission lines to be identified during preparation.

After 12 years of negotiations, India and Bhutan took a major step forward to construct the 600 MW Kholongchhu project, the first hydropower joint venture project in Bhutan's less developed eastern region of Trashiyangtse. Construction of Punatsangchhu-2 (1,020 MW) will be implemented by the two governments.

Central Asia has a complementary mix of energy sources and countries could realise major benefits from regional energy cooperation. Progress in development of both the CASA-1000 and TUTAP cross-regional power interconnection projects connecting Central and South Asian countries will increase electricity trading and economic benefits.

Elsewhere, Israel reached a key hydropower milestone by commissioning a pumped storage station for the 300 MW Mount Gilboa project and increased its national capacity from 7 MW to 307 MW.

Generation by hydropower
498 TWh

Total installed capacity*
154 GW
*including pumped storage

Capacity added in 2020
1,609 MW

Pumped storage installed capacity
7.75 GW

Pumped storage capacity added in 2020
300 MW

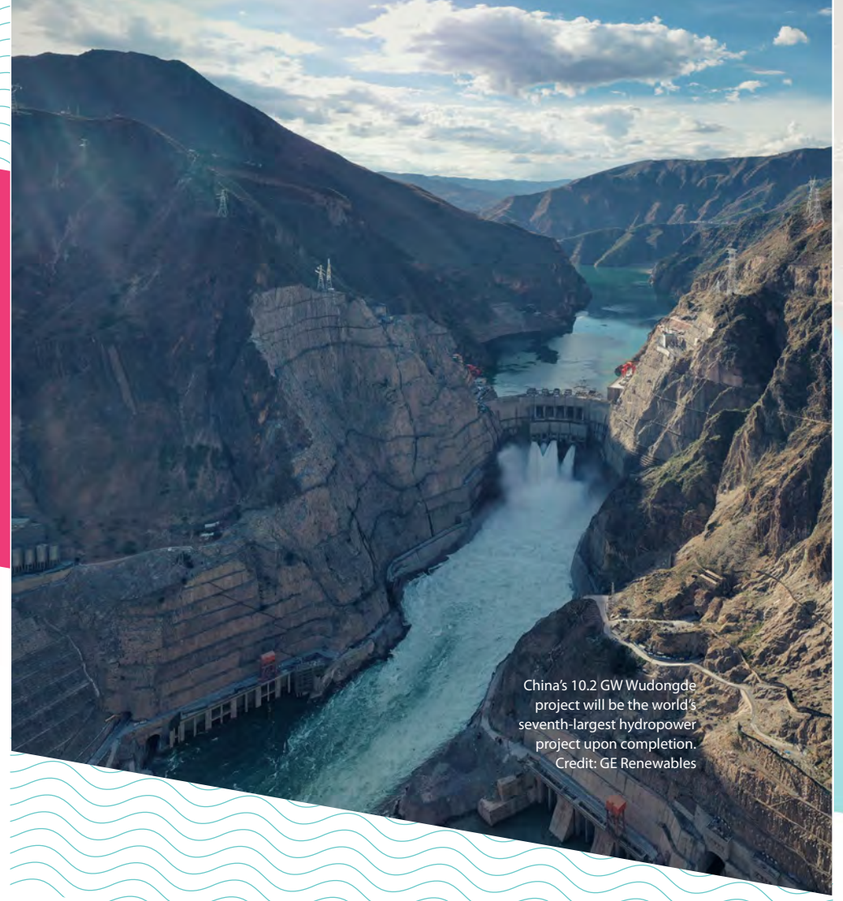

New Delihi, India

Top 5 countries by capacity added in 2020

1st	India	478 MW
2nd	Russia	380 MW
3rd	Israel	300 MW
4th	Georgia	178 MW
5th	Pakistan	102 MW

East Asia and Pacific

Overview



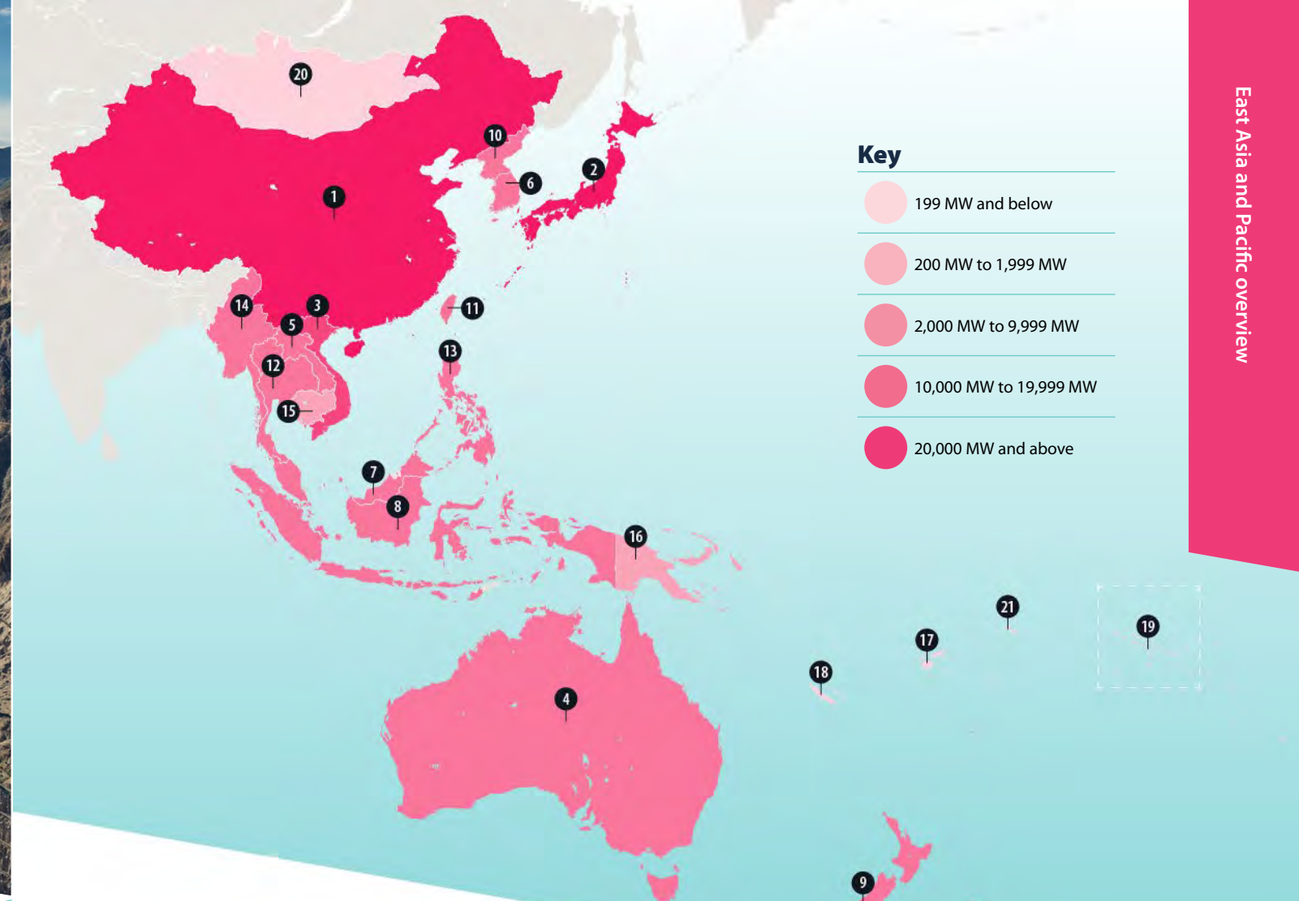
China's 10.2 GW Wudongde project will be the world's seventh-largest hydropower project upon completion. Credit: GE Renewables

With rapid urbanisation and industrialisation, the East Asia and Pacific region has been on a trajectory of rapidly rising energy demand. The Covid-19 pandemic has dampened this growth as countries implemented Covid-19 containment measures. The pandemic has highlighted the critical role for reliable power supply in delivering essential healthcare services, such as vaccine storage, while energy access remained an issue for developing economies in the region.

While fossil fuels retain the largest share of the region's generation mix, in many countries coal generation was the most affected by demand reductions over the last year. The momentum of divesting from fossil fuel generation continued to grow in 2020 as more countries announced pledges to achieve carbon neutrality and deliver green recovery packages. Japan pledged to reach a net zero emissions target by 2050 and cut emissions by 46-50 per cent by 2030. South Korea committed to terminate public overseas coal finance and achieve net zero emissions by 2050.

China announced plans to become carbon neutral by 2060 and peak coal consumption by 2025. In 2020, the country added 13.76 GW of new hydropower capacity, including 1.2 GW of pumped storage from the last four units of the Jixi project. At 1.8 GW, Jixi is China's largest pumped storage project by installed capacity. The majority of the additions were in south-western provinces such as Sichuan (4.13 GW) and Yunnan (3.4 GW). The 10.2 GW Wudongde project is scheduled to be fully operational by July 2021 and will be China's fourth-largest and the world's seventh-largest hydropower project upon completion.

Pumped storage continues to be a significant focus in China's energy transition. In the 2021 Energy Work Plan issued by the National Energy Administration, nationwide medium and long-term planning for pumped storage is emphasised. This is coupled with the consolidation of pumped storage pricing mechanism released in April 2021 that suggested all pumped storage plants in China to adopt a two-part tariff mechanism based on capacity and energy tariff after 2023.



Ranking by total installed hydropower capacity

Rank	Country/Territory	Installed capacity (MW)*
1	China	37,0160
2	Japan	50,016
3	Viet Nam	17,111
4	Australia	8,790
5	Laos	7,376
6	South Korea	6,506
7	Malaysia	6,275
8	Indonesia	6,121
9	New Zealand	5,354
10	North Korea	5,010
11	Chinese Taipei (China)	4,694

Rank	Country/Territory	Installed capacity (MW)*
12	Thailand	4,512
13	Philippines	4,385
14	Myanmar	3,331
15	Cambodia	1,329
16	Papua New Guinea	234
17	Fiji	125
18	New Caledonia	78
19	French Polynesia	47
20	Mongolia	23
21	Samoa	12

*including pumped storage

East Asia and Pacific

Developments

Malaysia has stepped up its renewable energy ambitions and now recognises "large hydropower" as part of its renewable energy definition, in line with practices adopted by other countries internationally. Malaysia also rolled out large-scale solar tenders as part of a green stimulus package. The construction of the 1,285 MW Baleh project continued to progress and is scheduled to be completed in 2026. Other projects in the pipeline in Sarawak are Limbang 2 (130 MW), Belaga (160 MW), Linau (182 MW), Trusan 2 (240 MW), Baram 3 (300 MW) and Pelagus (465 MW), and Kota 2 (12 MW).

The Philippines government has declared a moratorium on new coal power plants and, to boost private investment in renewable energy, opened up to full foreign ownership in geothermal and hydropower in its latest tender, which included 17 potential hydropower projects with a combined capacity of 80 MW.

Thailand plans a transition away from coal, reducing it to only a 5 per cent capacity share by 2030. The Electricity Generating Authority of Thailand has completed the construction of the 2.5 MW Klong Tron project. In addition, it is constructing the 14 MW Pha Chuk project which is expected to be operational by December 2021. Thailand is implementing a 16-year programme to retrofit floating solar on nine hydropower plants, aiming to achieve a total installed capacity of 2,725 MW. The first project in this programme, a 45 MW hydro-solar hybrid project at Sirindhorn dam, was near completion in 2021.

The ASEAN regional grouping of governments has put forward an ambitious joint ministerial statement of achieving 23 per cent renewable energy by 2025. The proposed ASEAN Power Grid aims to foster regional interconnection and economic growth, which has been taking shape under the Lao PDR-Thailand-Malaysia power integration project. The Lao People's Democratic Republic continued to advance its plan to export 20 GW by 2030, with a 728 MW Phou Ngoy project newly announced. Cross-border hydropower will therefore continue to play an important role in decarbonising the South East Asian power grid.

In Viet Nam, the 26 MW Pa Hu project has begun commercial operations. PC1 began operation of the three hydropower plants—which have total capacity of 54 MW 2020, including the 30 MW Mong An hydropower plant and the 18 MW Bao Lac B, and the 6 MW Song Nhiem 4 projects. Due to the pandemic, the construction of Ngan Truoi project was delayed. The 480 MW expansion of Hoa Binh Hydropower Plant has started, which after completion will reach a total capacity of 2,400 MW. Another 180 MW expansion of Yaly hydropower plant is scheduled to begin construction in the second quarter of 2021.

In Australia, the Snowy 2.0 pumped storage project reached key construction milestones including fast-tracked planning and environmental approvals granted as part of green recovery efforts, and the commissioning of the first tunnel boring machine. On the island of Tasmania, the state government announced a 200 per cent renewable energy target by 2040. The Tasmanian state government together with the Australian federal government also signed a bilateral emissions and energy reduction agreement to progress the Marinus Link and Battery of the Nation projects. The 250 MW Kidston pumped storage project in the state of Queensland has also begun construction.

In Papua New Guinea, the 180 MW Ramu 2 hydropower project, costing US$902 million, will be the country's largest energy infrastructure investment and will have a crucial role in creating a stable national grid and lowering electricity tariffs. Fortescue Metals Group also signed a hydropower generation agreement with the country to assess the feasibility of potential projects to develop 25 GW of hydropower resources.

Generation by hydropower
1,642 TWh

Total installed capacity*
501 GW
*including pumped storage

Capacity added in 2020
14,466 MW

Pumped storage installed capacity
70 GW

Pumped storage capacity added in 2020
1,200 MW

Top 5 countries by capacity added in 2020

1st	China	13,760 MW
2nd	Indonesia	236 MW
3rd	Laos	176 MW
4th	Japan	111 MW
5th	Malaysia	101 MW

Shisanling pumped storage hydropower plant, China
Credit: Voith Hydro

Installed capacity and generation 2020

Africa

Country	Total installed capacity including pumped storage (MW)	Pumped (MW)	Generation (TWh)
Algeria	269	-	0.09
Angola	3,836	-	10.08
Benin	33	-	0.06
Botswana	-	-	-
Burkina Faso	34	-	0.11
Burundi	57	-	0.22
Cameroon	822	-	5.88
Cape Verde	-	-	-
Central African Republic	19	-	0.15
Chad	-	-	-
Comoros	1	-	-
Congo	218	-	1.07
Cote D'Ivoire	879	-	2.31
Democratic Republic of the Congo	2,760	-	9.19
Djibouti	-	-	-
Egypt	2,876	-	12.09
Equatorial Guinea	128	-	0.12
Eritrea	-	-	-
Eswatini	60	-	0.16
Ethiopia	4,074	-	13.56
Gabon	331	-	1.74
Gambia	-	-	-
Ghana	1,584	-	7.21
Guinea	706	-	2.47
Guinea-bissau	-	-	-
Kenya	837	-	3.52
Lesotho	73	-	0.50
Liberia	93	-	0.53
Libya	-	-	-
Madagascar	186	-	0.81
Malawi	371	-	1.30
Maldives	-	-	-
Mali	220	-	0.95
Mauritania	48	-	0.21
Mauritius	61	-	0.10
Morocco	1,770	465	1.55
Mozambique	2,216	-	14.17
Namibia	347	-	0.95
Niger	-	-	-
Nigeria	2,111	-	6.10
Reunion	134	-	0.49
Rwanda	111	-	0.45
Sao Tome And Principe	2	-	0.01
Senegal	81	-	0.31
Seychelles	-	-	-
Sierra Leone	64	-	0.18
Somalia	-	-	-
South Africa	3,596	2,912	5.67
South Sudan	-	-	-
Sudan	1,923	-	7.75
Tanzania	596	-	2.35
Togo	49	-	0.09
Tunisia	66	-	0.06
Uganda	1,040	-	4.03
Western Sahara	-	-	-
Yemen	-	-	-
Zambia	2,400	-	13.67
Zimbabwe	1,091	-	7.26
Total	**38,174**	**3,377**	**139.54**

South and Central Asia

Country	Total installed capacity including pumped storage (MW)	Pumped (MW)	Generation (TWh)
Afghanistan	461	-	0.62
Armenia	1,293	-	2.50
Azerbaijan	1,131	-	1.03
Bahrain	-	-	-
Bangladesh	230	-	0.61
Bhutan	2,326	-	8.95
Georgia	3,449	-	8.25
India	50,549	4,786	155.00
Iran	12,169	1,040	27.70
Iraq	2,753	240	1.80
Israel	307	300	0.02
Jordan	12	-	0.03
Kazakhstan	2,730	-	9.90
Kuwait	-	-	-
Kyrgyzstan	3,892	-	14.80
Lebanon	282	-	0.97
Nepal	1,278	-	3.00
Oman	-	-	-
Pakistan	9,929	-	37.38
Qatar	-	-	-
Russia	49,912	1,385	196.00
Saudi Arabia	-	-	-
Sri Lanka	1,809	-	4.90
Syria	1,505	-	0.75
Tajikistan	6,395	-	17.00
Turkmenistan	5	-	-
United Arab Emirates	-	-	-
Uzbekistan	2,005	-	6.90
Total	**154,421**	**7,751**	**498.11**

East Asia and Pacific

Country/Territory	Total installed capacity including pumped storage (MW)	Pumped (MW)	Generation (TWh)
American Samoa	-	-	-
Australia	8,790	1,340	14.89
Brunei	-	-	-
Cambodia	1,330	-	3.49
China	370,160	31,490	1,355.20
Chinese Taipei	4,694	2,602	6.18
Cook Islands	-	-	-
Fiji	125	-	0.50
French Polynesia	47	-	0.18
Guam	-	-	-
Hong Kong	-	-	-
Indonesia	6,121	-	18.63
Japan	50,016	27,637	89.17
Kiribati	-	-	-
Laos	7,376	-	19.2
Macau	-	-	-
Malaysia	6,275	-	15.8
Marshall Islands	-	-	-
Micronesia, Federated States Of	-	-	-
Mongolia	23	-	0.09
Myanmar	3,331	-	11
Nauru	-	-	-
New Caledonia	78	-	0.22
New Zealand	5,354	-	23.98
Niue	-	-	-
North Korea	5,010	-	12.20
Papua New Guinea	234	-	0.80
Philippines	4,385	685	7.79
Samoa	12	-	0.04
Singapore	-	-	-
Solomon Islands	-	-	-
South Korea	6,506	4,700	7.10
Thailand	4,513	1,000	4.54
Timor-leste	-	-	-
Tonga	-	-	-
Tuvalu	-	-	-
Vanuatu	-	-	-
Viet Nam	17,111	-	51.98
Total	**501,490**	**69,454**	**1,643**

Europe

Country	Total installed capacity including pumped storage (MW)	Pumped (MW)	Generation (TWh)
Albania	2,390	-	5.28
Andorra	45	-	0.12
Austria	14,597	5,596	42.52
Belarus	97	-	0.43
Belgium	1,427	1,307	1.29
Bosnia and Herzegovina	2,513	420	6.10
Bulgaria	3,129	1,404	3.37
Croatia	2,141	293	3.40
Cyprus	-	-	-
Czechia	2,268	1,171	3.40
Denmark	9	-	0.02
Estonia	8	-	0.04
Faroe Islands	39	-	0.11
Finland	3,263	-	15.56
France	25,508	5,837	64.84
Germany	11,022	6,364	24.75
Gibraltar	-	-	-
Greece	3,400	703	3.43
Greenland	91	-	0.50
Hungary	56	-	0.24
Iceland	2,086	-	12.46
Ireland	529	292	1.21
Italy	22,593	7,685	47.72
Kosovo	92	-	0.26
Latvia	1,576	-	2.59
Liechtenstein	35	-	0.12
Lithuania	1,016	900	1.06
Luxembourg	1,330	1,296	1.09
Macedonia	674	-	1.24
Malta	-	-	-
Moldova	76	-	0.20
Monaco	-	-	-
Montenegro	658	-	1.80
Netherlands	38	-	0.05
Norway	32,995	1,439	141.69
Poland	2,385	1,780	2.93
Portugal	7,193	2,820	13.96
Romania	6,313	92	15.53
San Marino	-	-	-
Serbia	3,123	639	9.66
Slovakia	2,522	1,017	4.67
Slovenia	1,524	180	5.24
Spain	20,409	6,117	33.34
Sweden	16,478	99	71.60
Switzerland	16,881	3,029	40.62
Turkey	30,984	-	77.39
Ukraine	6,229	1,563	4.85
United Kingdom	4,712	2,833	7.64
Total	**254,454**	**54,876**	**674**

South America

Country	Total installed capacity including pumped storage (MW)	Pumped (MW)	Generation (TWh)
Argentina	11,340	974	30.35
Bolivia	735	-	2.94
Brazil	109,271	30	409.50
Chile	6,945	-	20.79
Colombia	11,941	-	45.82
Ecuador	5,076	-	24.79
French Guiana	119	-	0.44
Guyana	3	-	-
Paraguay	8,810	-	49.34
Peru	5,396	-	29.04
Suriname	190	-	1.36
Uruguay	1,538	-	3.95
Venezuela	15,393	-	72.00
Total	**176,757**	**1,004**	**690**

North and Central America

Country	Total installed capacity including pumped storage (MW)	Pumped (MW)	Generation (TWh)
Anguilla	-	-	-
Antigua and Barbuda	-	-	-
Aruba	-	-	-
Bahamas	-	-	-
Barbados	-	-	-
Belize	55		0.08
Bermuda	-	-	-
Canada	82,000	177	383.00
Cayman Islands	-	-	-
Costa Rica	2,331		8.29
Cuba	68		0.06
Dominica	7		0.04
Dominican Republic	616		0.12
El Salvador	575		1.99
Grenada	-	-	-
Guadeloupe	11		0.03
Guatemala	1,559		5.77
Haiti	60		0.13
Honduras	837		2.70
Jamaica	30		0.16
Martinique	-	-	-
Mexico	12,612		23.12
Montserrat	-	-	-
Nicaragua	157		0.57
Panama	1,786		7.25
Puerto Rico	100		0.05
Saint Bartholemy	-	-	-
Saint Kitts And Nevis	-	-	-
Saint Lucia	-	-	-
Saint Pierre And Miquelon	-	-	-
Saint Vincent And The Grenadines	7		0.04
Trinidad And Tobago	-	-	-
Turks And Caicos Islands	-	-	-
United States	102,000	22,855	291.00
Virgin Islands, British	-	-	-
Virgin Islands, U.S.	-	-	-
Total	**204,811**	**23,032**	**724**

World

	Total installed capacity including pumped storage (MW)	Pumped (MW)	Generation (TWh)
Total	**1,330,106**	**159,494**	**4,370**

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