2025

World Hydropower Outlook

Opportunities to advance net zero

iha
international hydropower association

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Cover photograph
Upper Reservoir of Changlongshan pumped storage project, China
Credit: CTG

Contents photograph
Aldeadávila hydropower project, Spain
Credit: Iberdrola

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Foreword
Malcolm Turnbull, IHA President

Hydropower is playing an increasingly vital role in the global energy transition. As the world's largest source of renewable electricity, it delivers not only clean energy but also the flexibility, reliability and resilience needed to support power systems that are increasingly dependent on variable sources like wind and solar. Encouragingly, this year's World Hydropower Outlook shows that new capacity is accelerating after several years of stagnation.

While we are seeing strong progress on pumped storage hydropower, particularly in China, India, Europe and Australia, it is clear that the market alone will not deliver. Continued momentum will require bold policy action, including reforms to reward hydropower's multiple benefits, and faster permitting.

Pumped storage hydropower (PSH) is on the rise globally, and rightly so. As the most proven and scalable form of long-duration energy storage, it is essential to deliver the flexibility and reliability that modern electricity systems require. As variable renewables grow, pumped storage will become increasingly critical to balancing supply and demand.

The private sector stands ready to deliver – but it cannot do so alone. Governments must ensure that market frameworks and policy support are fit for purpose. Clear investment signals are needed to expand the project pipeline and accelerate construction timelines.

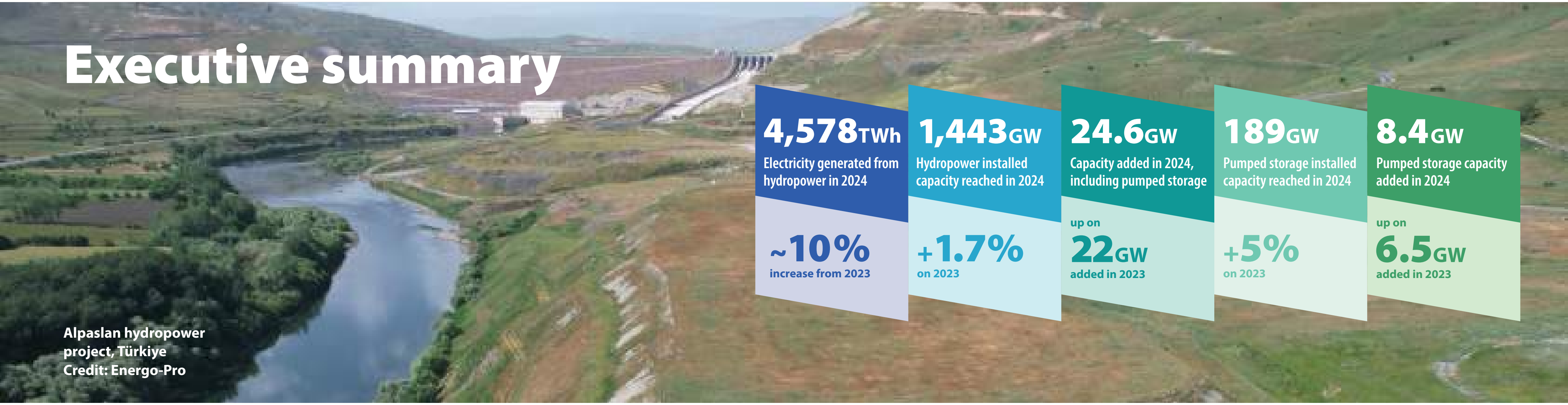
And in the face of growing climate volatility, we must build not just clean energy systems, but resilient ones. Hydropower, when developed sustainably, is uniquely placed to support communities during droughts and floods, acting as a strategic water resource while also reducing emissions.

This year, as we celebrate our 30th anniversary, IHA will continue to push for market and policy reform, foster collaboration across the diverse spectrum of stakeholders involved in hydropower, and champion sustainable practices globally. We will also deepen our regional presence to support local stakeholders, while scaling up our focus on pumped storage through crucial initiatives such as the Global Alliance for Pumped Storage and the #Pumpedforpower campaign.

The upcoming International Forum on Pumped Storage Hydropower in Paris this September will be a pivotal moment – bringing together governments, industry leaders and innovators to chart a clear course for the scale-up of long-duration energy storage. Water, wind and sun gets the job done. The only resource we lack is time.

Malcolm Turnbull
IHA President

Executive summary



Alpaslan hydropower project, Türkiye
Credit: Energo-Pro

Hydropower development in 2024 continued on an upward trajectory, with positive signals emerging, particularly for pumped storage. A total of 24.6GW of hydropower capacity was added in 2024 – a strong performance despite ongoing challenges.

Global hydropower generation increased by approximately 10% in 2024, rebounding from 4,180TWh in 2023 to 4,578TWh, despite significant drought conditions in Latin America and southern Africa. This growth illustrates the sector's resilience, but also highlights increasing climate-driven variability, which is expected to shape year-to-year performance.

The 2024 total included 8.4GW of PSH – long considered the "water battery" of the energy sector. This brought global PSH capacity to 189GW, marking a 5% year-on-year increase and signalling an accelerating trend: annual PSH additions have nearly doubled in just two years. In 2024, conventional* hydropower added 16.2GW, slightly below the five-year average of 20GW per year, but still demonstrating steady progress – particularly in East Asia, South and Central Asia, and Africa.

The Global Energy Storage and Grids Pledge, signed by 58 countries at COP29, further reinforced PSH's critical role. With pumped storage already accounting for more than 90% of the world's energy storage, the pledge to deploy 1,500GW of storage by 2030 highlights the urgency, and opportunity, for further hydropower growth.

While this report highlights the growing role of pumped storage in balancing energy systems with rising shares of variable renewables, it also reaffirms that all forms of hydropower remain essential to achieving global climate and development goals. While mature markets are leaning heavily toward PSH to enhance flexibility and grid stability, many developing regions are investing in large-scale conventional projects to meet basic energy access, foster economic development and reduce reliance on fossil fuels.

As this momentum continues, it is essential that all future hydropower is developed sustainably, guided by international good practice and robust sustainability frameworks such as the Hydropower Sustainability Standard – so that its benefits are delivered responsibly, equitably and in harmony with communities and ecosystems. This year, IHA put effort into renewing our view of the pipeline of projects in development, particularly PSH. As of 2024, the global hydropower development pipeline totals around 1,075GW – including approximately 600GW of PSH and 475GW of conventional projects – reflecting both the rising momentum behind electricity

*IHA defines conventional hydropower as run-of-river and reservoir not equipped with pumping capacity storage and the enduring importance of conventional hydropower in building low-carbon energy systems. The rise in PSH capacity under development is particularly striking. There is nearly three times as much PSH capacity being developed than when we last reported on the pipeline in 2023.

China continues to dominate global hydropower development, with 14.4GW of new capacity added in 2024, including 7.75GW of PSH. With more than 91GW of PSH under construction, the country is set to exceed its 120GW PSH target for 2030. With a further 136GW of PSH capacity moving forward, China is likely to accelerate deployment beyond 2030.

Elsewhere across **East Asia and Oceania**, governments are embedding hydropower and PSH into long-term plans to improve grid stability, energy security and renewable integration. Australia, Vietnam, the Philippines, Laos and China are advancing new projects and refining regulatory frameworks, while Malaysia and Indonesia are exploring hybrid hydro-solar models.

Africa doubled its 2023 total, adding more than 4.1GW of conventional capacity. Hydropower already delivers 20% of total electricity generation, and there is huge scope for further development, with only a small fraction of the over 600GW of continent's potential currently harnessed. A new wave of projects, many led by private developers, is beginning to emerge, positioning hydropower as a core pillar of Africa's clean energy transition.

Flagship projects reached key milestones, including Tanzania's Julius Nyere project beginning operations, the Grand Ethiopian Renaissance Dam adding 800MW with its third and fourth units, and Uganda's 600MW Karuma and Cameroon's 420MW Nachtigal plants being fully commissioned. However, financing for hydropower projects in Africa remains a challenge.

In **Europe**, driven by ambitious energy and climate policies, renewable generation is progressively growing. In 2024, hydropower, wind and solar were, at times, the primary contributors to the EU power system. Hydropower generation reached a decade-high of 680TWh, driven by strong precipitation. Ongoing geopolitical shifts and growing curtailment of variable power plants are increasing the need for flexible generation and electricity storage. A clear business case for pumped storage is emerging, supported by a European project pipeline of 52.9GW in development. Of this, 3GW is under construction and 6.7GW has already received regulatory approval.

In **North and Central America**, the focus is on modernising legacy infrastructure and pursuing new projects, reinforcing hydropower as a mature contributor to the region's renewable energy landscape. Canada, the US and Central America all saw increases in investment.

Despite a modest total capacity addition of 306MW in 2024, hydropower provides approximately 45% of **South America's** electricity demand. Around 30% of the region's hydropower potential is being utilised. As renewable energy deployment accelerates, so too does the challenge of maintaining grid stability amid variable generation and increasing, but fluctuating, demand. However, hydropower continues to face reputational challenges in the region. The industry is responding with a strong focus on demonstrating sustainability. In the past year, Brazil's 198MW Mascarenhas plant was certified Gold under the Hydropower Sustainability Standard, while Colombia's 2.45GW Ituango and 19.9MW Chorreritas projects were certified Silver. This follows Brazil's 3.75GW Jirau plant achieving Gold certification the previous year.

In **South and Central Asia**, India remains an important driver of development, with 132 hydropower projects at various stages. Progress in the region is increasingly underpinned by cross-border cooperation, with trade agreements and joint infrastructure initiatives gaining momentum, including between countries previously involved in decades-long conflicts. Looking ahead, in a region facing growing climate extremes and political uncertainty, sustainable hydropower offers a powerful opportunity to strengthen water security, enhance climate resilience, and provide a stable foundation for long-term development.

Overall, 2024 reaffirmed hydropower's essential role in the global clean energy transition. As countries strive to meet climate and energy targets, hydropower stands out not only as a source of renewable electricity generation, but for its flexibility, storage capacity and broader contributions to water management, agriculture and climate resilience. Realising its full potential, however, will require concerted efforts to streamline permitting, enhance investment environments and expand the sector's skilled workforce. With growing political alignment and technological momentum, the outlook for hydropower is increasingly bright.

This momentum comes as IHA marks its 30th anniversary in 2025 – a milestone that highlights both the progress the sector has made and the challenges ahead. The next 30 years will be decisive in addressing the world's climate and energy challenges. Explore the campaign at **hydropower.org/iha30**.

Methodology

The data presented in this report have been continuously tracked and updated to account for new information in IHA's 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:

- Official statistics from governments, regulation agencies, transmission network operators and asset owners
- Scientific articles and reports
- Daily news reports involving hydropower plant development, official declarations of contracts and equipment deals
- Direct consultation with operators and industry sources.

Different sources report on capacity and generation using their own methodologies. For example, some countries may not include off-grid facilities (hydropower plants not connected to the main electricity grid) in their official statistics, while others do. Where possible IHA has accounted for these differences – e.g. including off-grid facilities – but some inconsistencies may remain.

When generation data from primary sources were not available, estimates were prepared based on previous year figure, averaged capacity factors and regional meteorological data. For a small number of countries, capacity data from previous years have been revised with updated information. As a result, some countries may show year on-year differences compared to previous years' reports. These updated capacity numbers, however, do not represent new capacity added or retired in 2024.

Publicly available information on projects has been supplemented by IHA's own research.

Baihetan hydropower station, China
Credit: CTG

Advertisement

Global overview

Pocinho hydropower project, Portugal
Credit: EDP

Pipeline analysis

Amfilochia pumped storage hydropower project
Credit: Terna Energy

Hydropower in 2024: Status and future trends

Hydropower remains the world's largest source of renewable electricity, supplying 14.3% of global power and supporting grid stability in more than 150 countries. In 2024, the sector experienced renewed momentum, particularly in PSH. This section of the World Hydropower Outlook assesses the current state of the sector, recent growth, and the forward pipeline for both conventional and PSH. It also examines regional trends and the challenges and opportunities that lie ahead.

Recent growth and installed capacity

Total global conventional hydropower installed capacity grew by approximately 1% in 2024, with 16.2GW added, bringing total global capacity to 1,254GW. This is similar to 2023 but remains below the five-year rolling average of 20GW per year, which has held steady since 2019.

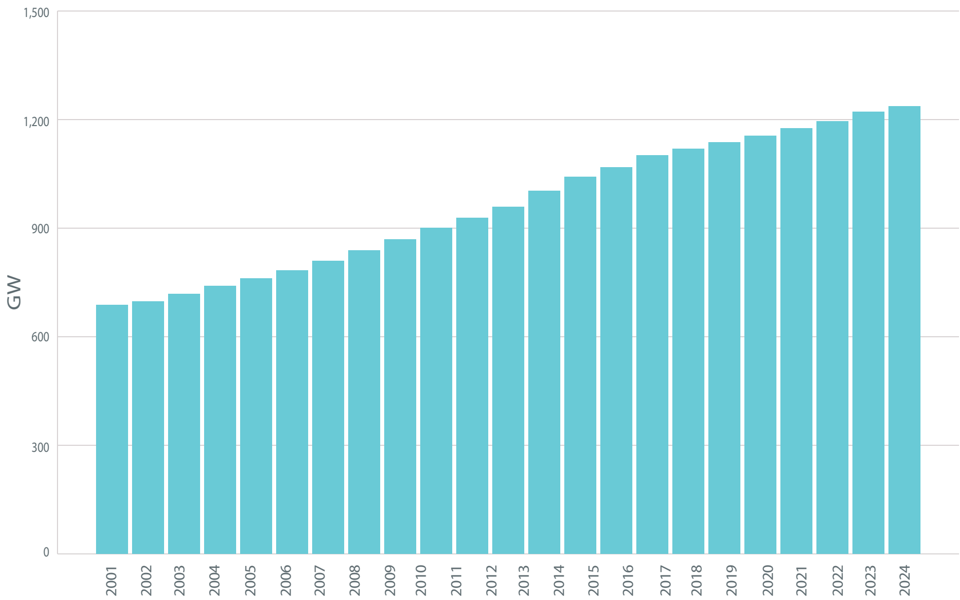
Meanwhile, PSH saw a 5% increase of the total global installed turbine capacity, with 8.4GW added in 2024, bringing the total to 189GW. Annual PSH additions have nearly doubled over the past two years, raising the five-year average to 6GW per year, up from 2–4GW across the previous two decades. This marks a notable shift for a technology with a much smaller installed base, where even modest additions translate into a significant percentage increase in total capacity.

Global hydropower generation rose by an estimated 10% in 2024 to approximately 4,578TWh, up from 4,180TWh in 2023, despite drought conditions in Latin America and southern Africa. However, year-on-year generation variability is expected to increase as climate change impacts intensify. See pages 26–28 for a more detailed exploration of these trends.

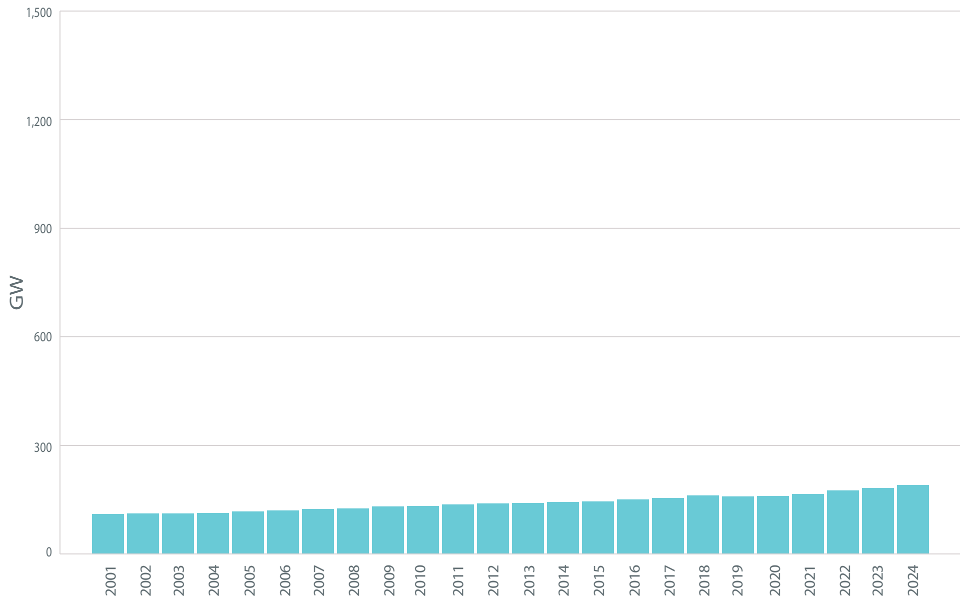
Current Pipeline Status

The global hydropower pipeline includes approximately 600GW of pumped storage capacity in development and just over 475GW of conventional projects. The global deployment of conventional hydropower and PSH will remain broadly aligned in the near term but, beyond 2030, pumped storage is expected to lead in terms of new capacity. This prediction is supported by the larger quantity of capacity in the PSH pipeline and the fact that the PSH

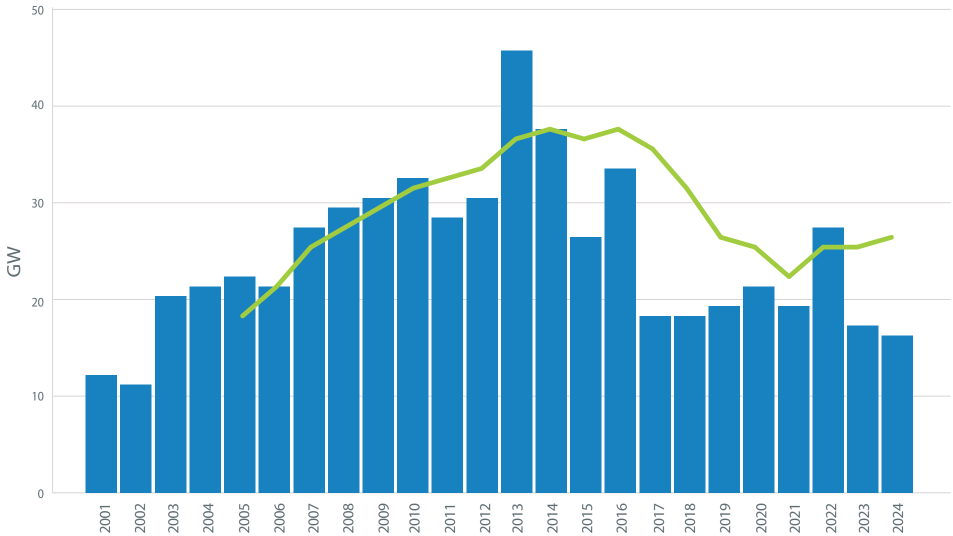
Conventional hydropower cumulative capacity



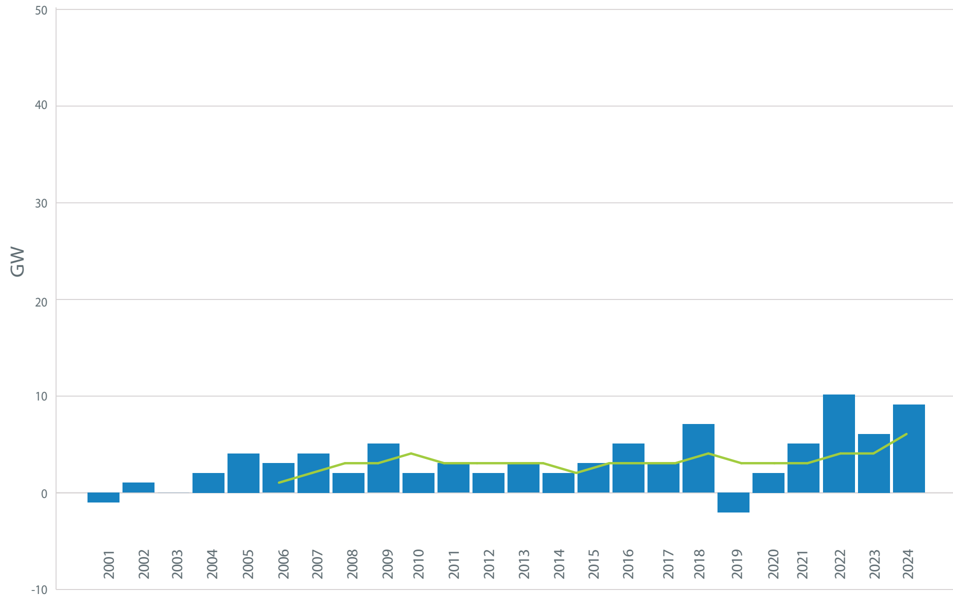
Pumped storage hydropower cumulative capacity



Conventional hydropower annual additions and five-year rolling average



Pumped storage hydropower annual additions and five-year rolling average



pipeline has nearly tripled in the last few years. PSH currently exceeds conventional hydropower by 88GW at the 'approved' stage and by 30GW at the 'pending approval' stage, with 'announced' volumes broadly comparable.

Conventional Hydropower

Around 105GW is currently under construction, with another 69GW approved but not yet started. Based on typical project timelines, most of the under-construction capacity is expected to be commissioned by 2030. This indicates that the build rate should remain around 20GW per year, bringing total capacity to approximately 1,350GW by 2030 – an increase of approximately 8%.

However, this falls short of the trajectory needed to meet the COP28 'tripling renewables' target. In addition, IHA projects a shortfall of 60–70GW in 2030 against the target for hydropower set out by the International Renewable Energy Agency in its tripling up scenario, unless project approvals and construction are accelerated. This also applies to delivery after 2030, where the prospect is of a decline in the rate of new commissioning. At present there are just under 69GW of projects approved but not yet in construction, which could be delivered in the period 2030-35, depending on financing progress. If this is delivered evenly over the first half of the 2030s, then this would represent a decline in delivery, to about 15GW per year of newly commissioned projects. Additional capacity must therefore progress swiftly through the pipeline to ensure delivery is maintained into the 2030s.

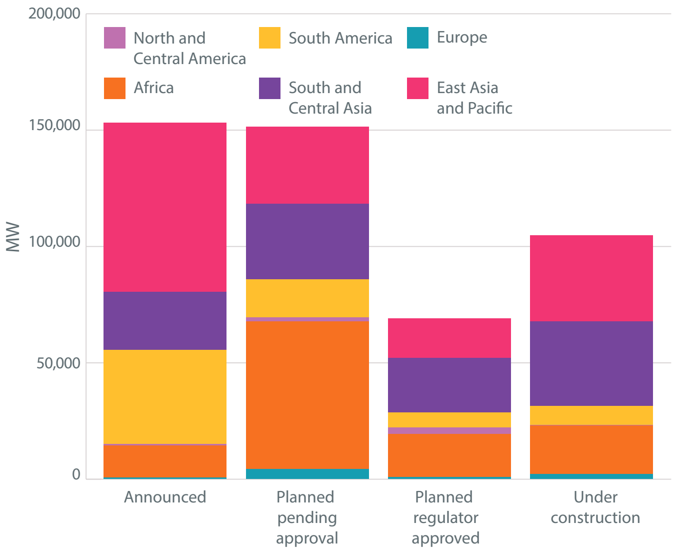
Pumped Storage Hydropower

More than 105GW of PSH is under construction globally, with over 90GW in China alone. While China has set a national target to commission 120GW of pumped storage by 2030, twice the size of its current fleet, system operators China State Grid and Southern State Grid forecast a combined delivery of 129GW within their operating areas. Based on this, IHA estimates that around 70GW of China's under-construction capacity could be commissioned by 2030.

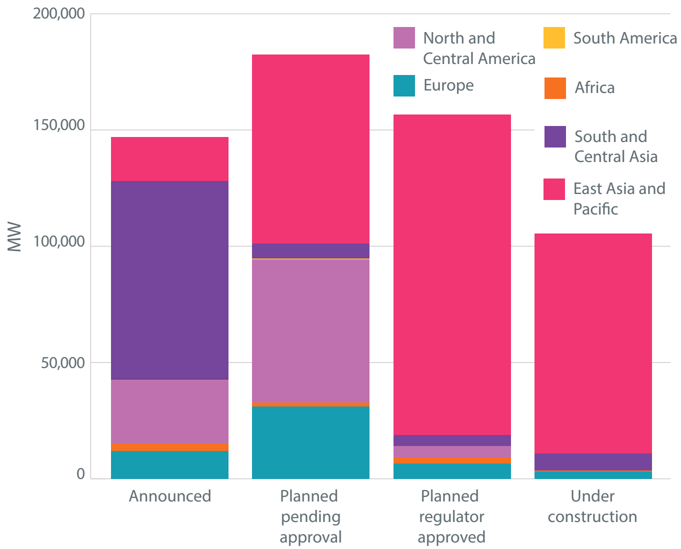
India represents a significant share of the remaining PSH pipeline, with a national target of 26GW by 2032. It is likely that some of India's approved projects will be completed before 2030, in addition to the 4.5GW already being built. A number of approved projects in Europe and North America may also be completed by 2030.

In total, an estimated 90GW of PSH could be added by 2030, bringing the global capacity to around 280GW. From the existing installed base of 189GW, this would represent a nearly 50% increase. At 18GW per year, the projected build rate is also five to ten times greater than the 2–4GW added annually over the past two decades.

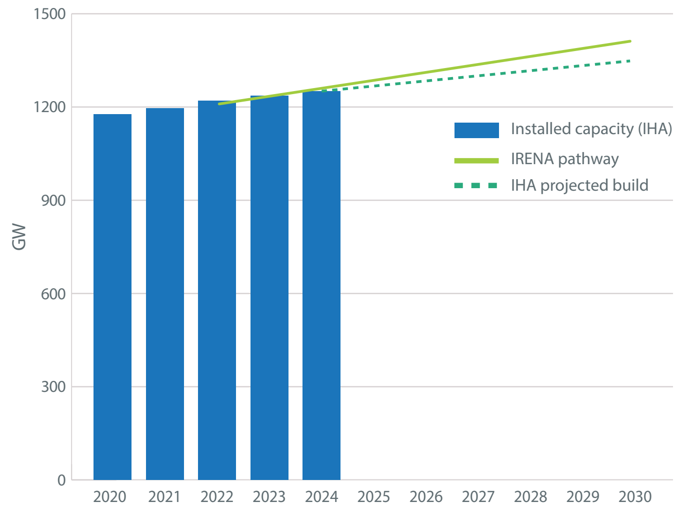
Conventional capacity pipeline



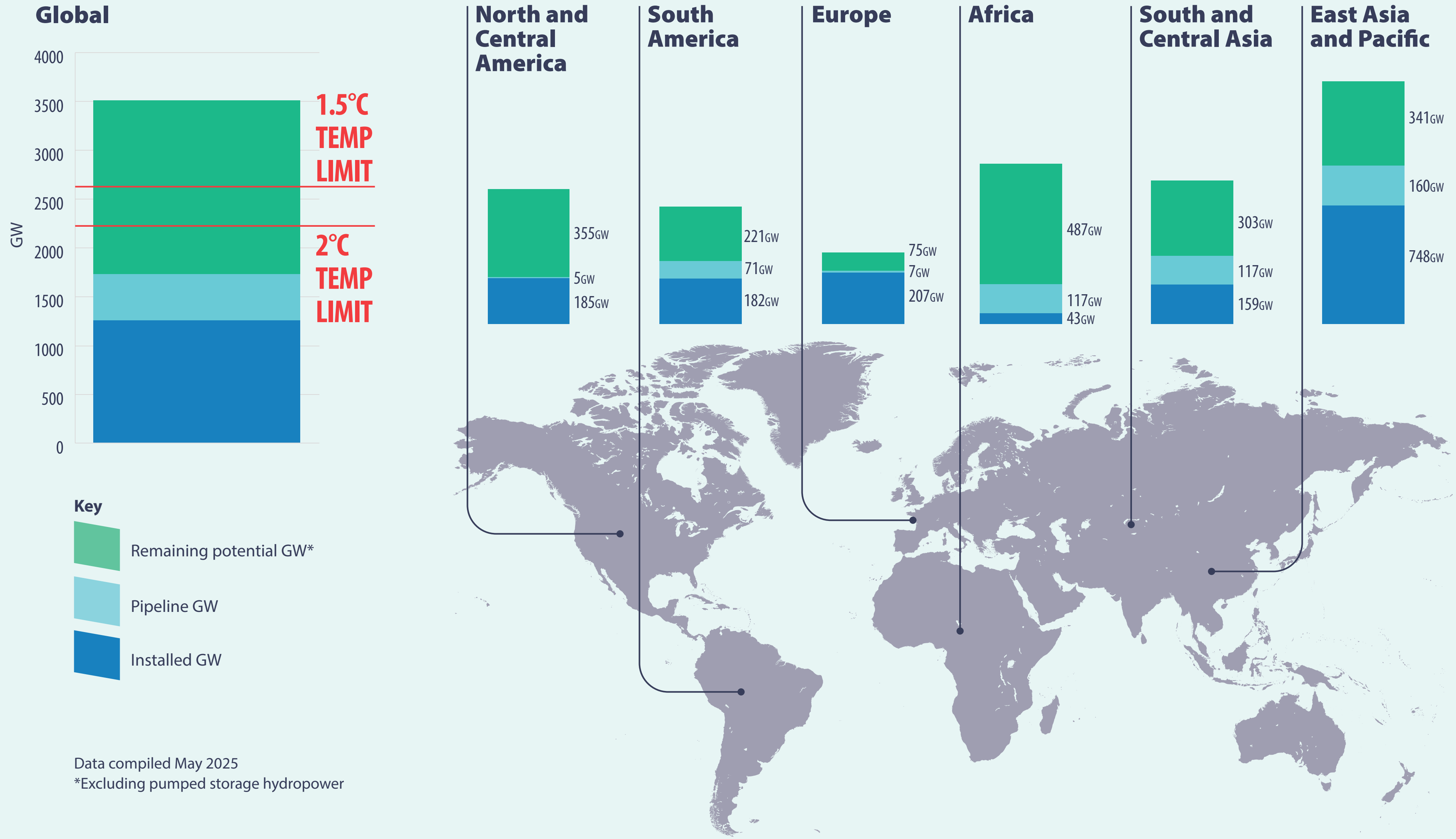
Pumped storage hydropower capacity pipeline



Projected conventional hydropower build versus IRENA 'Tripling Up' pathway



Installed, pipeline and potential for conventional hydropower capacity



Data compiled May 2025
*Excluding pumped storage hydropower

Natel Energy engineers, California, US
Credit: Natel Energy

Beyond 2030, the pace of development is likely to increase further. In China, 136GW of approved PSH capacity is expected to come online by 2035. Additional projects are also being planned. In other regions, a further 180GW of PSH capacity is awaiting approval, and the early-stage pipeline is considerably larger than that of conventional hydropower. This could support a further acceleration in the global build rate, potentially rising to 30–40GW per year. That is 50–100% higher than the 2025–2030 pace.

Geographic trends

Geographic differences in hydropower development are also striking. While East Asia includes 60GW of announced conventional hydropower projects in China, the region is largely dominated by China's pumped storage ambitions. The Asian continent holds the largest volume of regulator-approved projects in the global PSH pipeline, with East Asia and Pacific having 43% of global projects awaiting construction and South and Central Asia having 18%.

Africa and South America feature prominently in the conventional pipeline but are almost absent from the PSH data. By contrast, development in Europe and in North and Central America is almost entirely focused on pumped storage. Central and South Asia have pipelines comprising both types of hydropower, though the PSH projects are heavily concentrated at the announced stage. This reflects the influence of the Indian market, where a favourable policy environment is expected to accelerate project progress through the development cycle.

However, the current pipeline of conventional hydropower that is announced or pending approval –

totalling over 300GW – looks precarious given typical project attrition. Addressing barriers to permitting and funding, as well as ensuring that projects meet international standards of good practice, will be essential to support the important and necessary continued growth beyond 2030.

Many suitable sites remain available worldwide for both conventional and PSH technologies. While mature hydropower markets have been able to rely on existing assets to provide system flexibility, a relative surge in PSH investment and deployment is expected due to the massive expansion of variable renewable energy, and in some contexts nuclear, and the corresponding need for long-duration electricity storage. Recent policy developments in Brazil suggest that interest in pumped storage is growing, and similar initiatives may emerge in regions where activity has so far been limited.

Unlocking Africa's stalled potential

Africa holds one of the most significant untapped hydropower opportunities, with 18.5GW of approved conventional capacity stalled due to financing challenges, and 63.4GW on standby for approval. This equates to 42% of the global capacity of projects awaiting approval. If built, this could generate 250–300TWh annually – more than a third of the continent's current electricity consumption.

Unlocking this pipeline will be essential to achieving regional energy goals, including universal access to electricity and ensuring that Africa plays a full role in the global clean energy transition. However, nearly 50GW of this approved or pending capacity is concentrated in the Grand Inga scheme. To realise this opportunity equitably for all Africans, concerted regional action will be needed on transmission infrastructure and market integration.

Long-term outlook and strategic considerations

Looking ahead, annual deployment of PSH is projected to exceed conventional hydropower by 50% to 100% beyond 2030. However, there is currently no long-term global target for pumped storage. IRENA long-term pathways for 2050 include a figure of 325GW of PSH for 2050, but our analysis indicates this figure will be exceeded before 2035, perhaps as early as 2032.

The broader global pledge to triple renewable energy capacity by 1.5TW by 2030 – endorsed by over 60 countries and 100 organisations at COP29 – underscores PSH's critical role, with around 20% of the target capacity expected to come from this long-duration storage technology.

While short-term development remains split between conventional and PSH, the longer-term trajectory clearly favours PSH. Realising this potential across both technologies will require targeted policy support, streamlined permitting, and increased access to finance. Addressing regional disparities, unlocking stalled projects –particularly in Africa – and accelerating approvals and financing will be key to meeting global energy targets and ensuring a balanced and resilient clean energy future.

Kainji hydropower project, Nigeria Credit: Mainstream Energy Solutions Limited

Hydropower's global impact in numbers (2024)

1,443GW
Installed hydropower capacity (conventional + PSH)

4,578TWh
Electricity generation

2.3 million
Direct jobs

1,078GW
Capacity in development

14%
Total electricity generation

Over 90%
Potential energy converted to electrical energy

100+ years
Facility lifetime

10x
the total electricity consumption of France

2.2 billion
Tonnes of CO_2 avoided as compared to gas combined cycle generation

The role of hydropower in an era of low energy prices

Frades 2 pumped storage hydropower project, Portugal
Credit: XFLEX HYDRO

The power sector's central role in the net zero transition

The transition to a sustainable net zero economy is one of the defining global challenges of our time. Achieving this transition will require greater flexibility in renewable-based systems – both to limit further market volatility and to maintain public support for long-term climate goals. This points to a stronger role for hydropower technologies. Yet this very volatility also makes investment more challenging, particularly for capital-intensive, low-operating-cost technologies such as hydropower.

Examining power markets at the forefront of this transition offers valuable insight into how these challenges could be addressed.

Europe as a proving ground for renewable integration

Europe's electricity system is shaped by competitive markets, a highly integrated grid, and clear policy direction from initiatives such as the Green Deal and RePowerEU. These conditions make the region a useful testing ground for understanding how large-scale integration of variable renewables affects the commercial viability of existing hydropower assets.

Transport, residential and industrial sectors across Europe remain heavily reliant on fossil fuels for direct energy use. Decarbonising these sectors will require a widespread shift towards electrification, replacing fossil-based systems with electric-powered alternatives. For example, ENTSO-E, the regional transmission network operator, projects that final electricity demand in the EU will reach around 4,000TWh by 2050 – a 50% increase from 2023 levels (2,696TWh).

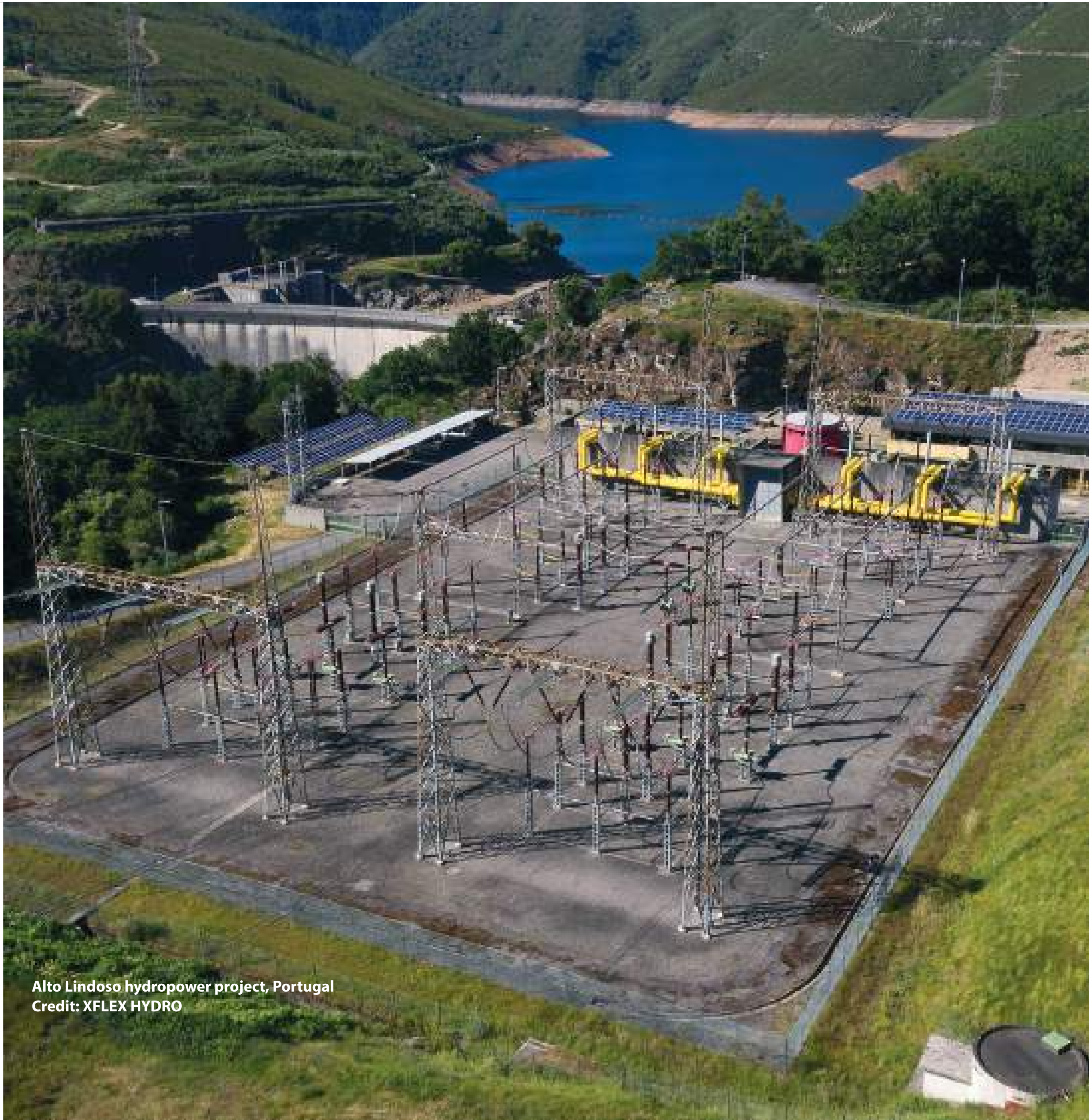
Under current EU targets, at least 69% of electricity generation must come from renewable sources by 2030 – requiring an additional 592GW of solar PV and 510GW of wind power capacity. While hydropower is a more established technology, it too will play a crucial role in providing the inertia, flexibility and dispatchability needed to integrate this growth in variable renewables and reduce reliance on gas and coal during peak demand periods.

Market impacts of variable renewables

The increased penetration of variable renewables – wind and solar power – means that there are more periods of high output and low demand, where demand cannot absorb the entire generation from these non-dispatchable technologies. As a result, energy is curtailed. Excess supply pushes prices down and zero or negative pricing can occur.

The global energy landscape is already showing signs of this trend. For instance, in the United States there were approximately 1,180 hours of negative pricing in California in 2024, a 123% increase from 2023. In the EU, the number of negatively priced hours rose from 154 in 2018 to 821 in 2023. In just the first eight months of 2024, the figure had already reached 1,031, according to data from Eurelectric, a European electricity industry association. The Australian Energy Council reported that on 1 September 2024, 40% of the day's electricity prices were negative, resulting in 28% of renewable energy generated being curtailed, with 26% being reportedly curtailed on 15 September 2024.

This trend is expected to continue in the coming years. Recent forecasts for France and Portugal, developed in the framework of the XFLEX HYDRO project, predict a significant rise in the share of hours with zero electricity prices. In France, zero pricing will occur in 30-40% of hours by 2040 and rise to over 45% by 2050. In Portugal approximately 50% of hours will be subject to negative pricing by 2040, growing to approximately 60% of the time by 2050. Research by the US National Renewable Energy Laboratory (NREL) suggests that in an energy landscape which exceeds 50% PV integration, very low energy prices would occur up to 36% of hours in a year.



Alto Lindoso hydropower project, Portugal
Credit: XFLEX HYDRO

Ongoing reliance on fossil fuels and pricing volatility

Despite growing renewable capacity, European power markets remain heavily dependent on gas and coal plants to meet peak demand. In 2021, these plants set electricity prices for more than 70% of the time in several major EU countries, as the most expensive source in any given hour typically determines the market price. This leaves consumers exposed to fluctuations in fossil fuel and CO_2 prices on international markets.

Over the next few decades, due to the increasing penetration of non-dispatchable technologies and continued reliance on coal and gas plants, electricity prices are likely to become more volatile. Prices may fluctuate more frequently between periods of production surplus – resulting in very low prices – and periods of peak demand, which will require supply from high-cost, marginal technologies such as coal and gas.

Hydropower's role in delivering low-carbon flexibility

Low-carbon flexibility is not only essential for grid stability and security of supply, but also for reducing electricity price shocks and volatility. Hydropower's unique ability to deliver dispatchable power across a wide range of timescales – from seconds to months – makes it a leading source of low-carbon flexibility. To maintain and expand this contribution, the hydropower fleet will need to be upgraded, and, where feasible, expanded.

Making modernisation add up

Across the globe, a significant portion of hydropower assets are ageing, with nearly 40% of plants at least 40 years old. Rehabilitation will be essential to prevent the retirement of existing units. In addition, modernisation, for example, by adding capacity through unit replacement, digitalising operations to optimise use, or by better hybridisation with batteries, wind and solar power, will help meet long-term climate and energy targets.

Growing variability in demand and production – both daily and intraday – will increasingly require hydropower units to operate with greater flexibility. This includes more frequent start–stop cycles, faster ramping and extended operation beyond original design conditions.

Modernisation challenges and the policy response

Modernising turbines, improving dam designs, increasing storage capacity and implementing monitoring tools will help ensure that hydropower remains relevant and capable of delivering the flexible services needed in a more dynamic power system.

These upgrades will also enable operators to respond more efficiently to market volatility, positioning hydropower as a low-carbon source of both stability and value in evolving electricity markets.

However, a recent study under the ReHydro project found that two key obstacles are limiting investment in modernisation: uncertainty around how electricity market will reward the role of hydropower, and the complexity of the relicensing process, which often overlaps with the need for major upgrades to ageing infrastructure. Together, these factors make it difficult for operators to commit the necessary capital.

Many governments are now including modernisation


Credit: Hydro Tasmania

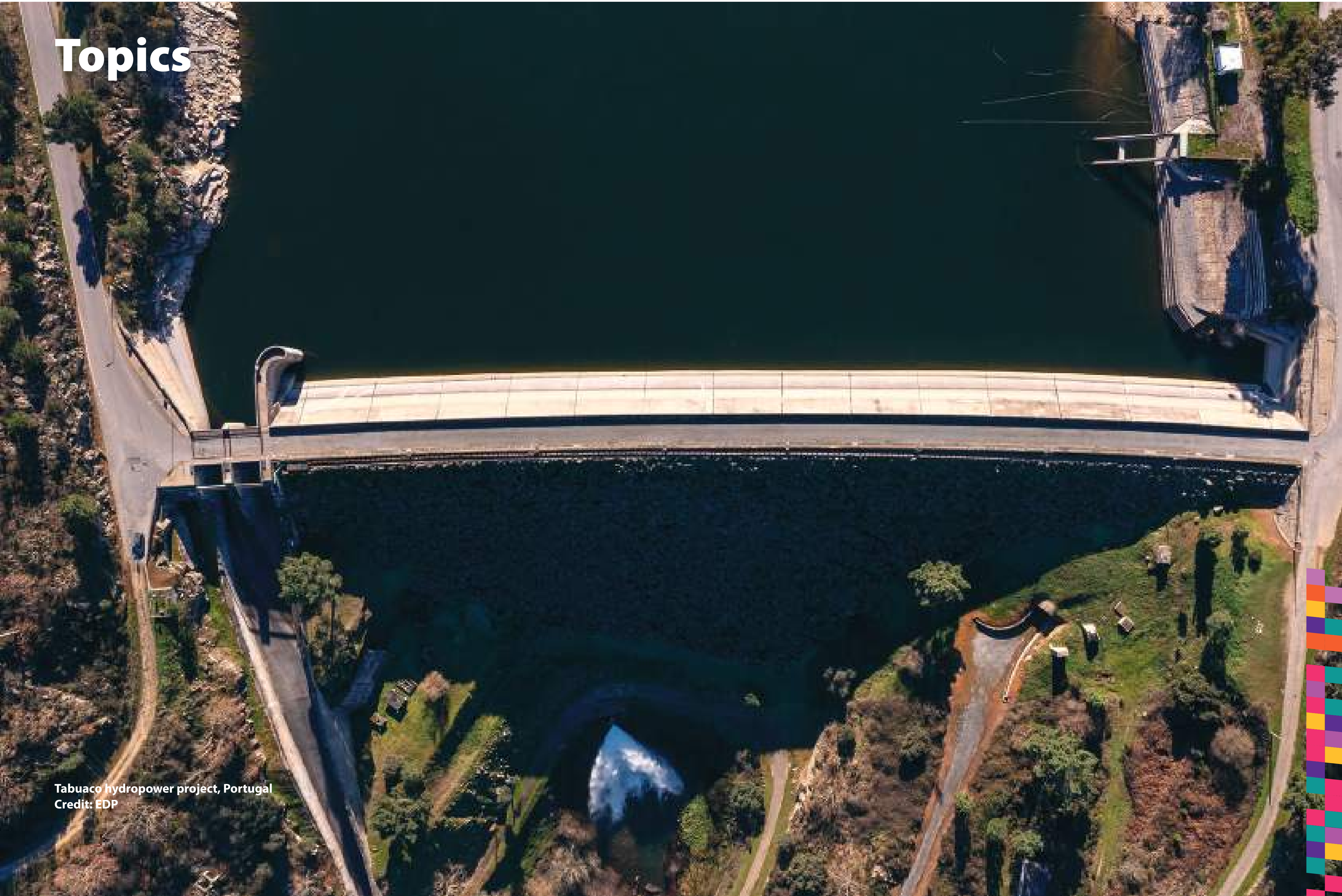
in their power system planning to support integration of variable renewables. Countries across Central Asia – including Russia, Kyrgyzstan, Tajikistan and others – have launched or planned extensive modernisation programmes over the past decade and into the next. These efforts have resulted in notable increases in capacity from new turbine installations.

Modernisation and rehabilitation are critical in ensuring that existing renewable energy and water infrastructure are prioritised, while also planning for future energy and water security. Policy that recognises and supports investment in these assets offers a cost-effective way to advance the energy transition and enable additional capacity.

As the world transitions to a net zero economy, the power sector must evolve to deliver greater system flexibility, ensure energy security, and maintain affordability. Hydropower stands out as a critical enabler of this transition, offering reliable, low-carbon flexibility amid growing market volatility. However, realising its full potential will require coordinated policy action, targeted investment, and modernisation of ageing infrastructure. The European power market provides a valuable case study – illustrating both the challenges and opportunities of integrating variable renewables at scale. Lessons from Europe's experience can help inform global efforts to build resilient, sustainable electricity systems fit for the future.

Francis turbine transport, Malpaso hydropower project, Mexico
Credit: ANDRITZ Hydro

Topics



Tabuaco hydropower project, Portugal
Credit: EDP

Pumped storage hydropower: investing in system resilience

Pinnapuram pumped storage hydropower project, Andhra Prades, India
Credit: Greenko

As variable renewables reshape power systems around the world, electricity storage is emerging as perhaps the most important factor in grid flexibility, reliability and decarbonisation.

Since the conclusion of the International Forum on Pumped Storage in 2021 and the publication of its outputs, governments worldwide have increasingly recognised the importance of long-duration electricity storage. PSH is now widely seen as essential to support variable renewable energy and to safeguard energy security during the global shift to wind and solar.

Yet projects have struggled to get built, mainly because difficulties persist over how best to value storage, particularly when comparing short- and long-duration technologies. Understanding the economics of electricity storage, particularly the role of duration and the system-wide value of flexibility, is essential to guide investment and policy decisions.

Energy versus power flexibility – valuing duration

Grid flexibility is often described in terms of how quickly power output can increase or decrease. However, speed alone is not sufficient. In renewables-based systems, flexibility also depends on duration, the ability to sustain output over multiple hours or days. Power flexibility addresses moment-to-moment imbalances. Energy flexibility ensures supply security for hours, through multi-day variability, seasonal changes, and extreme weather. As renewable penetration increases, both types of flexibility will become essential.

The value of storage changes depending on how long electricity can be discharged. While short-duration systems are suited to managing daily peaks and price volatility, longer-duration flexibility is required when multiple days of low renewable output coincide with high demand.

PSH facilities – or water batteries – are designed for energy flexibility, but can also support short-term power flexibility. Pumped storage supports short-term frequency, inertia services, and daily balancing and arbitrage. Uniquely, it also delivers multi-hour and multi-day resilience.

During extended periods of low wind or solar generation, PSH can maintain supply adequacy and reduce reliance on fossil fuel backup. This capability becomes increasingly important as renewable penetration grows and thermal capacity declines.

Duration also acts as a hedge against future system uncertainty. As climate variability increases and weather becomes more extreme, systems will need to withstand longer and more frequent periods of renewable intermittency. Long-duration assets help protect against these risks by providing security over operational and seasonal timeframes.

Economic trade-offs and the discount rate

Storage investments often involve a trade-off between short-term returns and long-term system value. Short-duration storage, such as chemical batteries, may appear more cost-effective upfront, especially when financed over relatively short time horizons. Long-duration assets like PSH require higher capital expenditure and longer lead times but deliver benefits over many decades with the ability to operate for more than 100 years with relatively low lifetime costs.

The discount rate applied to investment decisions significantly affects the outcome. A low discount rate, such as three to five percent, better reflects the long-term value of resilient, low-carbon infrastructure. Under these conditions, pumped storage is competitive, particularly when its civil works lifespan, often exceeding 100 years, is taken into account. At higher discount rates, however, investors tend to favour faster returns, making shorter-duration options appear more attractive.

Even when long-duration storage offers greater system resilience, commercial modelling may favour solutions with faster payback periods and higher cycling frequency. As a result, the true value of long-duration flexibility is often underrepresented in procurement and investment decisions. Aligning investment frameworks with decarbonisation goals requires a shift in how value is measured. System planning should account for whole-life costs, avoided emissions, and resilience benefits, not just near-term revenue.

Market signals and revenue models

Electricity storage projects typically recover costs via energy market revenues, system services and capacity mechanisms. Yet many market designs prioritise short-duration cycling and frequent dispatch over long-duration flexibility and overall system adequacy.

While water batteries often operate in daily short-term cycles, their greatest contribution lies in supporting rare but critical periods – days or weeks of low renewable output, when sustained flexibility is vital. Yet existing electricity markets are not structured to reward this role.

Payments for long-duration reserve capacity are rare, leaving developers to rely on arbitrage margins, which often do not reflect the full value of reliability, to generate revenue.

This mismatch creates a funding gap. Without specific instruments or long-term contracts, investors in long-duration electricity storage face uncertain returns, despite the asset's high system value. Bridging this gap will require deliberate policy interventions that reward resilience and duration, not just frequency of operation.

De-risking investments in pumped storage

To support the momentum for pumped storage, and address market and construction risks, IHA convened a cross-industry working group to explore how best to de-risk greenfield pumped storage projects. The group's findings, published in July 2024, offer recommendations across three thematic areas: markets and revenue, project development, and risk allocation.

A central finding was that high capital costs make construction risk a critical factor. Reducing this risk requires sufficient early-stage investment and robust project preparation. Developers should prioritise actions such as conducting detailed market and grid studies, defining performance parameters using advanced modelling, and applying best-practice environmental and permitting standards.

Where risks are passed to contractors, delivery costs tend to rise. The report emphasises that risks should be mitigated early and allocated to the parties best placed to manage them. Early contractor involvement, combined with procurement strategies based on technical competence, was identified as an effective approach.

Download the full publication here

The group noted that revenue frameworks such as capacity payments, flexibility tenders or long-term availability contracts are essential tools that governments can use to support pumped storage projects.

While the private sector is ready and able to deliver, achieving the scale required to support the energy transition – as reflected in the global pipeline – will require private-sector delivery enabled by strong public-sector support. This includes clear policy frameworks, long-term revenue visibility, and mechanisms for risk-sharing in early-stage development. Where such enabling conditions are lacking, particularly around market design and government-backed investment signals, project progress is being stalled.

Policy priorities for pumped storage

As grids change, storage will be essential to the reliability and resilience of renewable power systems, but markets alone will not deliver the volume or type of capacity needed. Pricing reforms are needed to properly reflect the full value of pumped storage's deeper flexibility and long-term energy shifting.

To encourage greater government engagement in pumped storage, IHA launched the Global Alliance for Pumped Storage (GAPS) at COP29 in November 2024. GAPS was established to address the urgent global need for energy storage and to accelerate the deployment of pumped storage through an intergovernmental leadership platform of more than 50 governments and non-governmental organisations.

In January 2025, IHA published a policy toolkit to help governments identify the critical levers for macro-level policy support. Aimed at policymakers new to pumped storage, the toolkit offers guidance to develop robust national strategies and investment roadmaps.

As part of the policy toolkit, IHA analysed national efforts to advance pumped storage, highlighting where governments are introducing enabling policies, for example, direct subsidies for pre-feasibility and early-stage investment in low-carbon infrastructure, as well as formal definitions of energy storage and 'closed-loop' pumped storage within electricity regulations.

Governments will need to step in with clear frameworks that reflect the strategic value of long-duration electricity storage. These may include targeted support through public-private finance mechanisms, long-term capacity contracts or market reforms that reflect the strategic value of duration and flexibility. Without such measures, infrastructure development will remain limited or biased toward short-duration technologies that cannot fully support system resilience.

IHA also supported the COP29 Presidency's Global Energy Storage and Grids Pledge, which sets a global target of 1,500GW of energy storage capacity by 2030 – the first global pledge to increase energy storage. Setting national pumped storage targets sends a clear signal to investors and industry that governments recognise these assets as critical infrastructure.

The policy toolkit recommends that governments:

1. **Assess the required levels of long-duration storage and system flexibility**
2. **Identify and safeguard suitable sites for development**
3. **Implement fit-for-purpose permitting and approval procedures**
4. **Introduce mechanisms that provide long-term revenue visibility**
5. **Design electricity markets to reward energy storage assets**
6. **Procure and compensate ancillary services through dedicated mechanisms**

Download the full publication here

China Three Gorges and the scale-up of pumped storage

Drawing on its deep expertise in large-scale hydropower, China Three Gorges Corporation (CTG) is now scaling up pumped storage as a national infrastructure priority. The company has already completed the 2.1GW Changlongshan Pumped Storage Power Station and is constructing 11 additional projects with a combined capacity of over 16GW.

The Changlongshan project was approved in October 2015, broke ground later that year, and reached full operation in June 2022. As the largest pumped storage facility in East China, it has set three world records: the highest generating head among completed PSH plants, reversible units with the largest single-unit capacity at high rotational speed, and the highest head-diameter value for a high-pressure steel bifurcated pipe. The project reflects CTG's commitment to ecological protection and green development, while also improving the power structure and operating conditions of the East China grid. It forms a key part of efforts to build a clean, low-carbon, secure and efficient energy system.

The Tiantai Pumped Storage Power Station in Zhejiang Province, East China, was approved in December 2021, with main construction beginning in May 2022. The project features a rated head of 724 metres – the highest among pumped storage facilities currently under construction in China. Each unit has a capacity of 425MW, making them the largest of their kind in the country.

During construction, several technical and manufacturing innovations have been introduced. For the first time in China, the stay ring and extension section of the spiral case were assembled and welded in the assembly chamber and installed as a single unit – significantly reducing construction time.

Once completed, the Tiantai station will provide peak and frequency regulation to the Zhejiang power grid. It will also enhance the integration of renewable energy, optimise the regional power structure, contribute to local economic development, and support China's carbon neutrality goals.

Upper Reservoir of Changlongshan pumped storage hydropower project, China
Credit: CTG

Tiantai pumped storage hydropower project under construction, China
Credit: CTG

Climate

Wudongde hydropower project
Credit: CTG

Hydropower in a changing climate: challenges and opportunities

Climate change is making water supply increasingly unpredictable, prompting renewed scrutiny of hydropower investment, particularly in the face of rising drought risk and growing concerns about reliability. Yet hydropower remains among the most effective ways to manage water stress and provide socio-economic benefits during dry periods. Most hydropower plants act as strategic reservoirs, storing water during high precipitation and releasing it during low flows to support agriculture, industry and households. Regions with well-developed hydropower infrastructure tend to be more resilient to droughts and floods. As climate volatility grows, demand for robust water infrastructure will also rise. Where water infrastructure can produce clean energy, it reinforces hydropower's role in supporting both adaptation and decarbonisation.

The challenge of climate change and rising competition for water

Climate change is fundamentally reshaping the world's water landscape. As freshwater reserves dwindle and river flows become more erratic, competition for limited water resources is intensifying – particularly between agriculture, industry and energy. Only 0.5% of Earth's water is both usable and accessible, and the United Nations estimates that by 2040, around 40% of the global population could face acute water scarcity.

The consequences are especially severe for regions such as the Middle East, Africa and South Asia, where declining water availability is already reducing crop yields, raising food prices and threatening economic stability. These pressures are amplified by rising temperatures, which accelerate evaporation, extend dry periods and further increase water demand across all sectors.

As water scarcity deepens, the impact on hydropower is twofold. First, shifting river discharge patterns – driven by climate change – can disrupt reliable energy generation. Second, growing demand from cities, farms and factories places additional strain on water supplies, underlining the need for integrated management strategies that balance competing needs.

Globally, annual water use is estimated at 4,000 to 4,600 billion cubic meters, with agriculture accounting for roughly half, industry for one-fifth, and domestic needs for about 15%. Meeting future demand will require smarter, more efficient management to safeguard food security, maintain energy supplies and promote economic resilience.

Water use in energy production

Energy production, especially thermal power, is a major water consumer. For example, thermoelectric power generation in the US accounts for 41% of freshwater use, mostly for cooling. The shift to low-carbon energy sources is changing how water is used across the sector. Despite reduced water needs in fossil fuel-based power generation, global water consumption for energy is projected to rise slightly – by around 5 billion cubic meters by 2030 (IEA, 2023). Phasing out coal, oil and gas will lower water withdrawals. Renewables such as solar and wind require minimal water, and hydropower typically returns water to source. As a result, renewables should ease overall water stress, and hydropower remains central to the water–energy nexus, providing low-carbon electricity and supporting basin-wide water efficiency.

Managing hydropower in a changing climate

Climate change disrupts hydrological planning by affecting both total water volume and the timing of flows. Rising temperatures bring intensified rainfall and longer dry spells: dry regions are expected to become drier, wet regions wetter. For example, in the northeastern US, annual precipitation may rise, but higher evaporation reduces water availability, complicating management and reliability. Extreme weather events and shifting hydrological patterns also heighten disaster risk. Water-related disasters now account for approximately 70% of all disaster-related deaths during the past 50 years.

Events such as glacier retreat and snowpack loss are disrupting seasonal storage and natural river regulation. Rapid summer melt combined with heavy rain can trigger flooding. The expansion of glacial lakes, especially in the Himalayas, is increasing the risk of glacial lake outburst floods (GLOFs), threatening infrastructure and downstream communities.

Regional impacts of climate change on hydropower

Hydropower output may peak earlier in the year as a result of earlier snowmelt and increased rainfall, while drier summers and autumns are likely to reduce generation. In some regions, greater precipitation may enhance hydropower potential, but in others, declining river flows will limit production. Scandinavia and Central Asia may see a 5% –15% rise in hydropower from their current fleet, while Southern Europe, North Africa and the Middle East could experience declines of up to 40% by the century's end. These declines are driven by longer dry periods, reduced flows and greater evaporation, with countries such as Spain, Italy and Türkiye most affected. While some areas may see short-term gains, others face lasting reductions, highlighting the need for adaptive hydropower strategies and a diversified renewables mix.

Hydropower systems must adapt to these regional variations. Focusing on system flexibility – providing balancing and reserve services to complement wind and solar – can deliver greater value from less water. This is critical as water becomes more volatile. China, for example, is seeing increasingly erratic rainfall patterns. In contrast, South America's heavy reliance on

Zahesi hydropower project, Archil Guchmanidze, Georgia
Credit: Energo-Pro

Alqueva pumped storage hydropower project, Portugal
Credit: EDP

glacial melt makes it particularly vulnerable to long-term reductions in water availability. As much as 92% of South America's hydropower capacity may be affected, with generation projected to fall by 8%, increasing the risk of electricity shortages.

Storage solutions to meet rising water and energy demand

Hydropower reservoirs are highly effective for water storage, regulating supply as demand grows. But natural storage is declining due to glacier retreat, snowpack loss and wetland degradation. Sedimentation also reduces reservoir capacity, making sediment management and new infrastructure essential for water security. Where new water infrastructure is needed, integrating energy generation makes sense. Multipurpose reservoirs combine hydropower with irrigation, water supply and flood control. Investment, however, has not kept pace with rising needs: global food production must rise by 70% by 2050, requiring much more irrigation and storage. This storage gap threatens both food and energy resilience. In water-stressed regions such as Central Asia, PSH could help balance energy needs and support wider water management.

Hydropower's future in a changing climate

Hydropower's unique role in flexible energy generation and water storage places it at the centre of climate adaptation strategies. As the impacts of climate change accelerate, hydropower's importance for energy and water security will continue to rise. Achieving this potential requires a clear focus on long-term planning, investment in resilient infrastructure, and a willingness to adapt policies and management practices as conditions evolve.

By unlocking hydropower's full value, countries can better safeguard communities, strengthen economic stability, and advance a more sustainable future in the face of mounting climate and water challenges.

Understanding and managing reservoir emissions

Hydropower remains one of the lowest-emission sources of electricity over its full lifecycle, especially when compared to fossil fuels and even many renewables. While the construction phase is relatively carbon-intensive, these emissions are offset over time through low-emission operations. One area that can contribute more significantly to a plant's environmental footprint, however, is reservoir emissions – greenhouse gases released from organic matter in the water and surrounding environment. The hydropower sector continues to invest in understanding and managing these emissions to further reduce its climate impact.

How do reservoirs emit greenhouse gases?

Greenhouse gases released from reservoirs are primarily carbon dioxide and methane, with smaller amounts of nitrous oxide also produced. These gases result from the decomposition of organic matter imported from the catchment, generated within the reservoir, or released when vegetation and soils are flooded. The type of gas produced depends on environmental conditions:

- **Methane (CH_4):** Formed when organic matter decomposes under anaerobic (oxygen-deprived) conditions, particularly in reservoir sediments. Methane is a potent but relatively short-lived greenhouse gas.
- **Carbon dioxide (CO_2):** Produced under both aerobic and anaerobic conditions during organic matter decomposition.
- **Nitrous oxide (N_2O):** Generated through microbial processes at the sediment–water interface or within the water column.

The creation of a reservoir alters the natural carbon cycle of a river basin. Flooded land releases greenhouse gases as vegetation and soil decompose, while reservoirs can also accumulate organic material transported from upstream. These processes add to the reservoir's potential as a source of emissions.

Several factors influence reservoir emissions, including carbon and nutrient loading from the catchment, temperature, oxygen concentration, reservoir age, depth and shape, water level fluctuations, and human-sourced inputs such as agricultural runoff, land use change, or wastewater. Emissions are typically higher in warmer climates, making the issue more significant in lower latitudes. Younger reservoirs also tend to have higher emissions, particularly in the first few years after impoundment (the creation of the reservoir), due to decomposition of recently flooded biomass and soils.

In general, emissions decrease with age, following this initial period of heightened activity.

How do hydropower's emissions compare to other energy sources?

Reservoirs primarily emit greenhouse gases which originate from the decomposition of organic matter. This carbon is part of the biosphere and continuously cycles through the environment, making it biogenic. This contrasts with fossil carbon, which has been locked away for millions of years and is released through the burning of coal, oil or gas. Fossil carbon belongs to the so-called 'slow domain' and contributes to long-term carbon dioxide accumulation, driving the greenhouse effect. By contrast, reservoirs operate in the 'fast domain', cycling biogenic carbon that does not necessarily add to long-term atmospheric carbon levels. This distinction is important: reservoir emissions involve carbon already active in the biosphere, unlike fossil fuel emissions, which introduce long-sequestered carbon into the atmosphere.

Tabuaço hydropower project, Portugal
Credit: EDP

Even when reservoir emissions are included, hydropower remains an attractive option from a climate perspective. According to the Intergovernmental Panel on Climate Change, hydropower has a median lifecycle emission of 24g CO_2-equivalent per kilowatt-hour. For comparison, the median emissions from other renewable sources are:

Wind power:	11–12g CO_2-eq/kWh
Geothermal energy:	38g CO_2-eq/kWh
Solar power:	48g CO_2-eq/kWh

However, hydropower emissions can vary widely, from negative values, where reservoirs act as carbon sinks, to higher emissions in exceptional cases.

Reducing reservoir emissions

Hydropower operators have several options for reducing emissions from reservoirs. One key approach is adjusting reservoir water levels to reduce the extent of shallow areas to limit the conditions that favour methane due to organic matter decomposition. This helps limit the conditions that favour methane formation, thereby lowering overall emissions. Another effective measure is the use of aeration devices to increase dissolved oxygen in the water column, reducing methane production by disrupting anoxic conditions.

During construction of new facilities or in major refurbishment projects, operators can install a secondary intake above the methane-rich zone or implement a multi-level intake system. These systems draw in oxygen-rich surface water rather than deeper, low-oxygen layers, improving circulation and helping to reduce methane emissions while maintaining generation efficiency.

An emerging approach involves capturing methane emissions and converting them into usable energy. Studies suggest that methane released from reservoirs can be recovered and used as a fuel source. This approach reduces emissions while providing an additional energy source, supporting the sustainability of hydropower operations.

Deuxième Camp nord pond, La Romaine hydropower project, Canada
Credit: Hydro-Québec

Estimating reservoir emissions with the G-res tool

IHA has played a central role in advancing the understanding and assessment of reservoir emissions for nearly two decades and was instrumental in the publication of the UNESCO/IHA GHG Measurement Guidelines for Freshwater Reservoirs in 2010, a framework still widely used today.

Building on this work, IHA launched the G-res tool in 2017 – a web-based platform designed to estimate and report the net greenhouse gas emissions of reservoirs. The tool was developed in collaboration with the University of Québec at Montreal (UQAM), the Norwegian Foundation for Scientific and Industrial Research (SINTEF) and the Natural Resources Institute of Finland (Luke), with financial assistance from the World Bank. It provides a widely recognised means of estimating emissions in lieu of direct measurement, offering a lower-cost alternative to field campaigns.

IHA continues to prioritise reservoir emissions as a critical area for research and mitigation, recognising it as one of the few aspects where hydropower has a measurable climate impact. The G-res tool provides a practical, science-based method for estimating emissions, helping developers, operators and policymakers understand and reduce their climate footprint.

Further information on using the G-res tool to estimate reservoir emissions is available at grestool.org

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3 Applications & Success Stories

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- Ensuring optimal water usage
- Maintain consistent turbine operation

Results

- Enhanced flexibility through optimized water usage
- Reduced OpEx through automation

+37% revenue

INVESTMENT DECISION SIMULATION

CADRE

Challenges

- Assessing the impact of integrating an additional turbine to derive ROI and a go / no-go decision
- Fine-tune the optimal turbine specification

Results

- Calculated the increase in plant revenue resulting from an additional turbine

simulated profit delivered in 3 days

ENVIRONMENTAL & OPERATIONAL COMPLIANCE

DALANE ENERGI

Challenges

- Multiple connected reservoirs & planning horizons
- Multiple gates used for flow control
- Different catchment areas & inflow conditions

Results

- Automatic adherence to all project's environmental restrictions

67 constraints integrated

The growing role of the Hydropower Sustainability Standard

Assessment team conducting an official site visit of l'Office National de l'Électricité et de l'Eau Potable (ONEE)'s Ifhasa project, Morocco
Credit: Hydropower Sustainability Alliance

Certification: trends and looking ahead

The Hydropower Sustainability Standard (HSS) is a globally recognised framework that supports accountability and performance in hydropower development. As of April 2025, 13 hydropower projects across all major continents have been certified under the HSS, with an additional 25 in the assessment or certification pipeline. This upward trend highlights growing sector-wide commitment to sustainable practices.

A key benefit identified by certified projects is improved access to finance. Roughly half of certified developers cited financing as a motivation for pursuing assessment. For example:

- **Contact Energy** (New Zealand) certified its Clyde and Roxburgh projects to qualify for Climate Bonds Initiative's Green Hydro certification.
- **Pamir Energy** (Tajikistan), **Energo-Pro** (Colombia), **Bizbell** (Nepal) and **Western Power Co.** (Zambia) have also reported improved access to capital and insurance as direct benefits of certification.

These examples demonstrate the growing recognition that HSS certification is not only a mark of sustainability but also a strategic financial asset.

Financing hydropower: the role of the Hydropower Sustainability Standard

The Hydropower Sustainability Standard is increasingly seen as a key enabler of climate-aligned finance in the hydropower sector. Its 12 performance topics are closely aligned with the safeguards of major international lenders, including the International Finance Corporation (IFC) and the World Bank, making it an accessible and compatible tool for developers seeking finance from these institutions.

Leading financial institutions – such as Swiss Re, HSBC and Standard Chartered – have already incorporated the HSS into their environmental, social and governance (ESG) frameworks and funding criteria. This integration reflects a broader shift in the financial sector toward sustainable investment practices, where demonstrable sustainability performance is a prerequisite for funding.

Additionally, the HSS features in the technical criteria of the RE100 campaign, an initiative led by the Climate Group and CDP. The campaign that includes some of the world's most influential corporations committed to sourcing 100% renewable electricity. The RE100 criteria guide companies in their renewable procurement decisions, and projects certified under the HSS are especially attractive to these companies, offering verifiable assurance that their electricity purchases are both renewable and sustainably sourced. Projects certified under the HSS offer these companies credible assurance that their electricity purchases are not only renewable, but also sustainably sourced.

This ecosystem – where developers, financiers, and energy buyers all recognise and reward sustainability certification – creates a virtuous circle cycle that channels capital toward high-performing, low-risk hydropower projects. In doing so, it places the HSS at the heart of a sustainable hydropower finance model.

Building capacity: knowledge and skills in hydropower sustainability

The Hydropower Sustainability Alliance continues to strengthen capacity across the hydropower sector. As demand for sustainable hydropower grows, so does the need for professionals and institutions to embed sustainability considerations throughout the entire project lifecycle.

To help meet this need, the HSA has expanded its Training Academy, offering a series of online and self-paced courses. Current topics include biodiversity in hydropower, environmental and social management, and resettlement, with more modules in development.

Building sustainability into hydropower requires more than meeting a standard at a single point in time. It calls for ongoing learning and informed action across the value chain, ensuring that all actors – from developers to financiers to operators – have the knowledge and tools to deliver lasting, responsible outcomes.

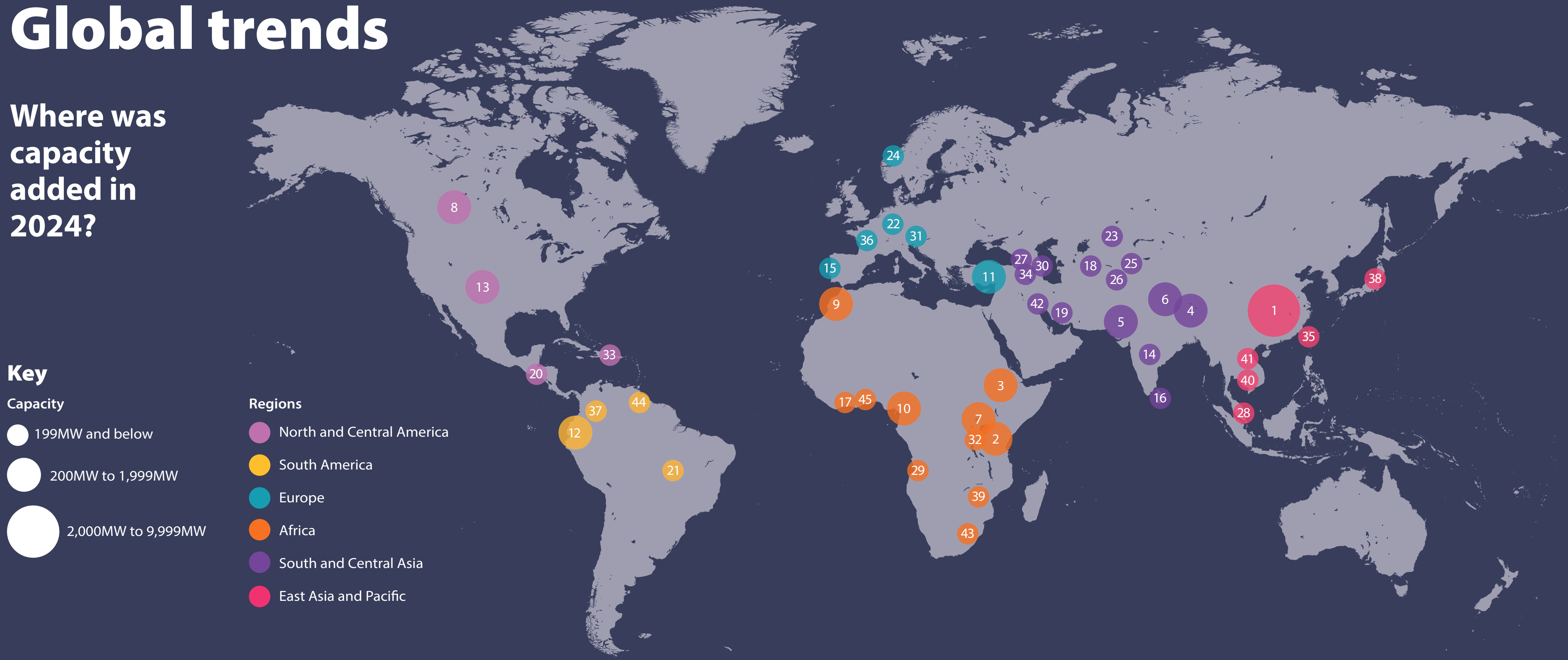
Hydropower Sustainability Alliance

Find out more: hs-alliance.org

Indonesia-Switzerland Hydropower Conference Credit: Hydropower Sustainability Alliance

Global trends

Where was capacity added in 2024?



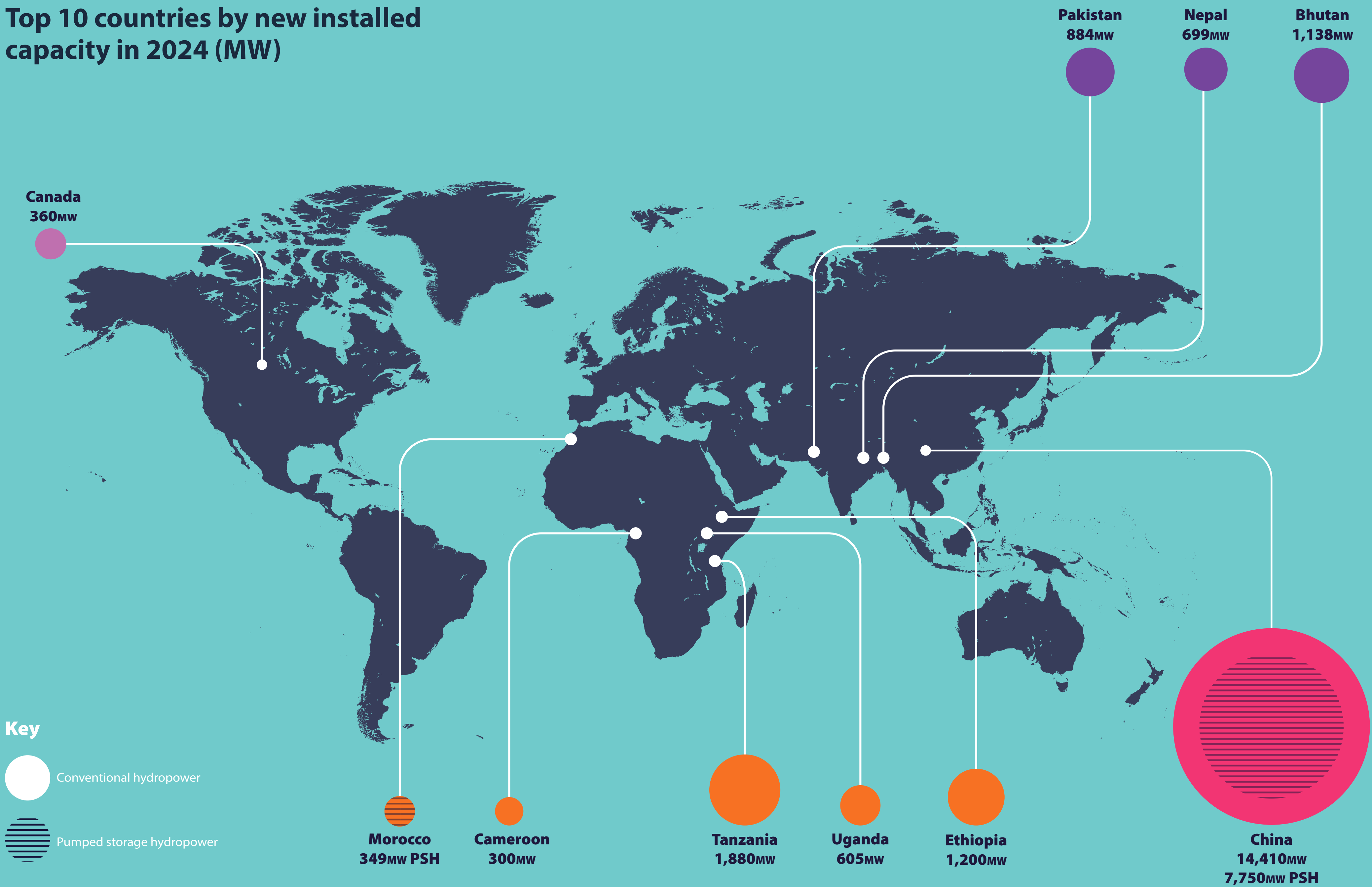
	Country/region	Conventional (MW)	Pumped storage (MW)	Combined (MW)
1	China	6,660	7,750	14,410
2	Tanzania	1,880		1,880
3	Ethiopia	1,200		1,200
4	Bhutan	1,138		1,138
5	Pakistan	884		884
6	Nepal	700		700
7	Uganda	605		605
8	Canada	360		360
9	Morocco		349	349
10	Cameroon	300		300
11	Türkiye	241		241
12	Ecuador	226		226

	Country/region	Conventional (MW)	Pumped storage (MW)	Combined (MW)
13	United States	120	96	216
14	India	172		172
15	Portugal	160		160
16	Sri Lanka	127		127
17	Côte d'Ivoire	113		113
18	Uzbekistan	111		111
19	Iran	102		102
20	El Salvador	67		67
21	Brazil	66		66
22	Germany	63		63
23	Kazakhstan	59		59
24	Norway	53		53

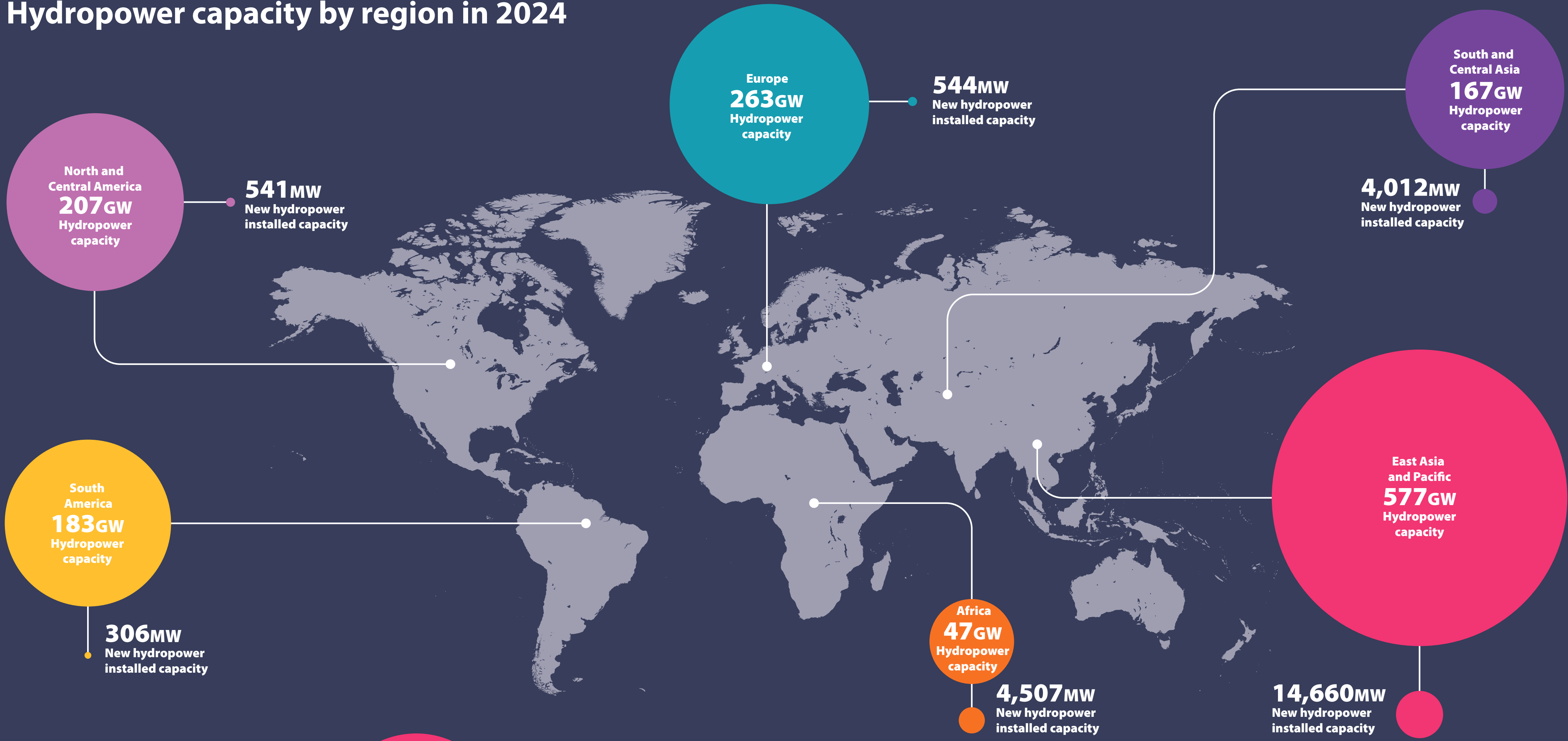
	Country/region	Conventional (MW)	Pumped storage (MW)	Combined (MW)
25	Kyrgyzstan	49		49
26	Tajikistan	104		104
27	Georgia	47		47
28	Malaysia	40		40
29	Angola	34		34
30	Azerbaijan	28		28
31	Austria		27	27
32	Burundi	20		20
33	Dominican Republic	18		18
34	Armenia	17		17
35	Taiwan, China	16		16
36	France		14	14

	Country/region	Conventional (MW)	Pumped storage (MW)	Combined (MW)
37	Colombia	12		12
38	Japan	6		6
39	Zimbabwe	5		5
40	Cambodia	5		5
41	Laos	4		4
42	Iraq	2		2
43	Lesotho	1		1
44	Guyana	1		1
45	Ghana	1		1

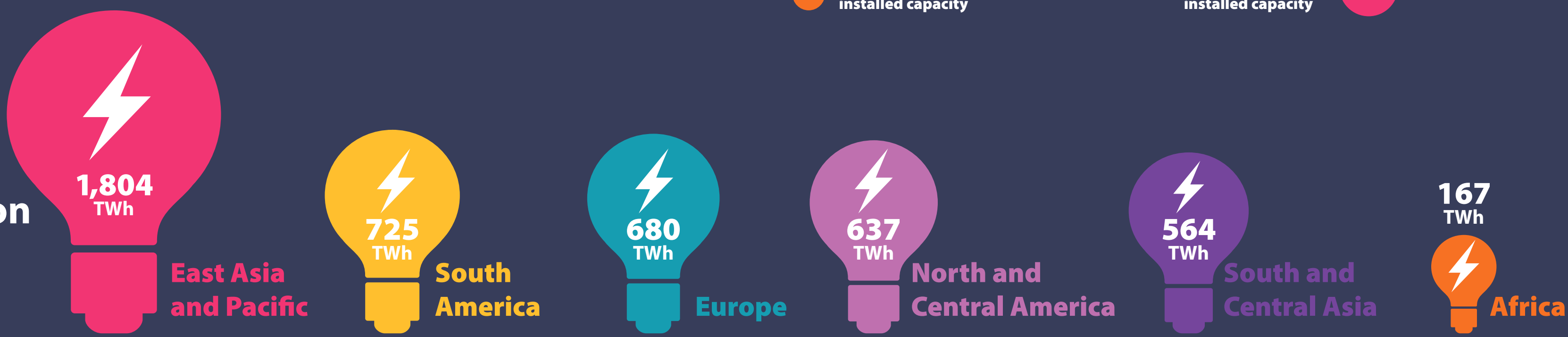
Top 10 countries by new installed capacity in 2024 (MW)



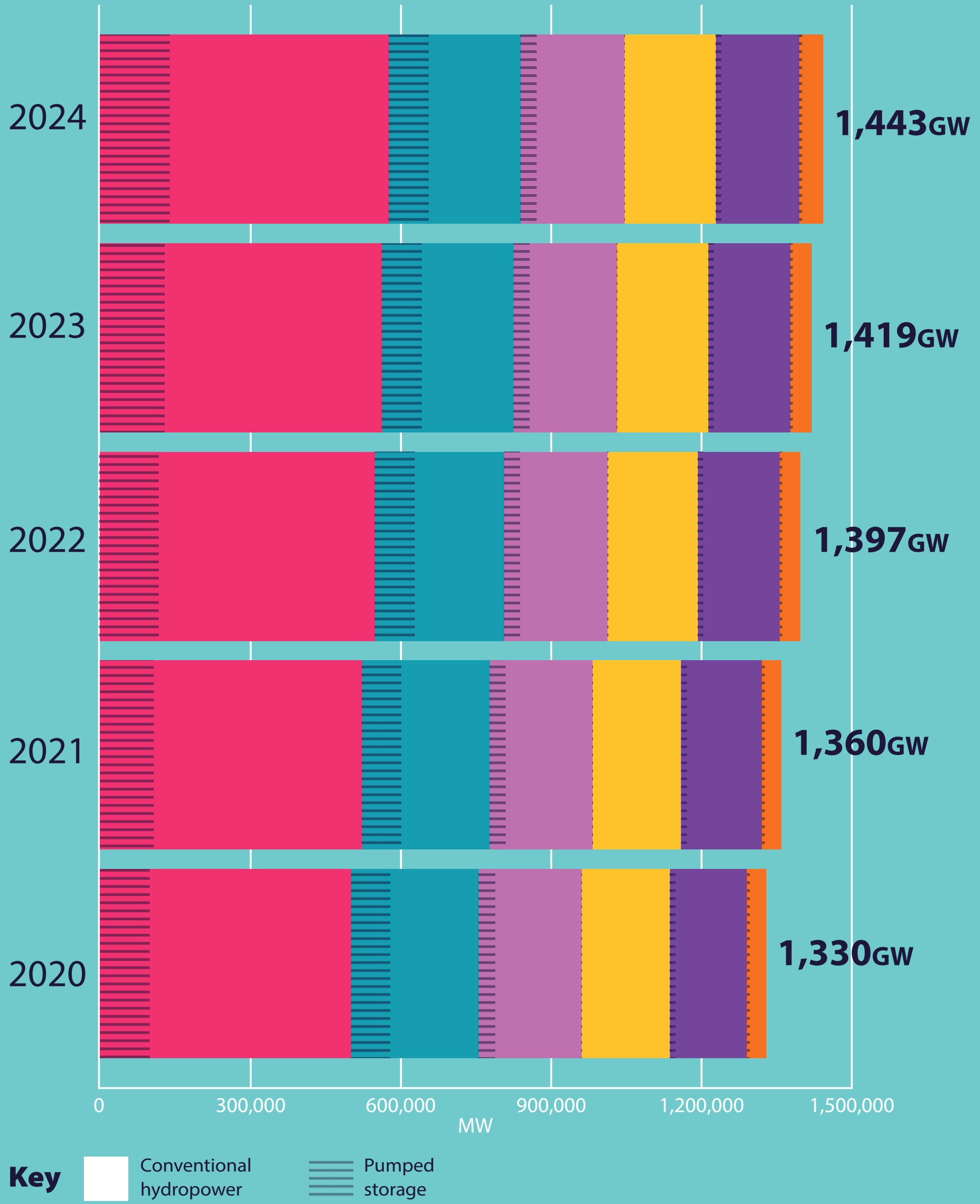
Hydropower capacity by region in 2024



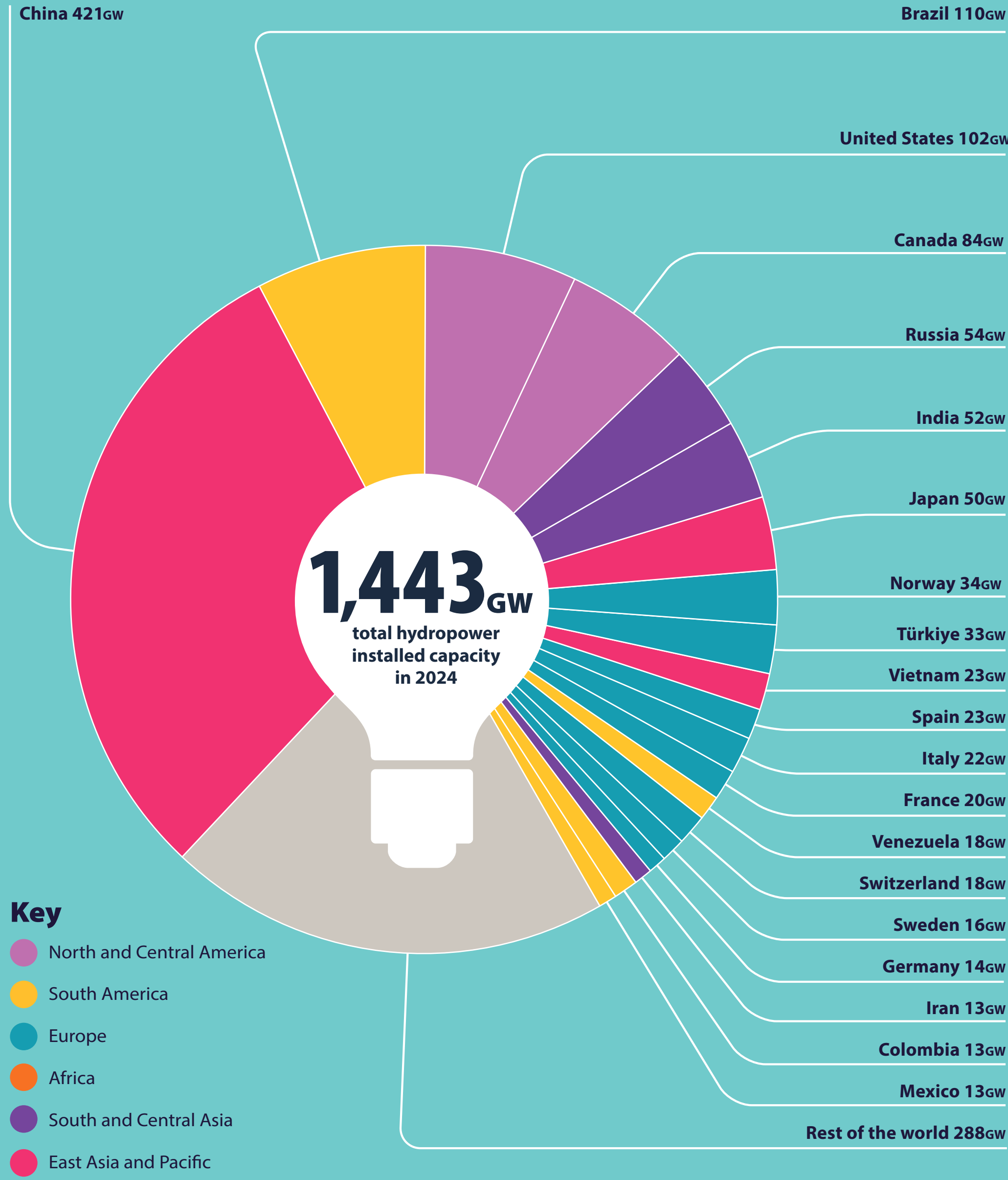
Hydropower generation by region in 2024



Hydropower installed capacity growth 2020–2024



Overall hydropower installed capacity 2024

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North and Central America

Generation by hydropower in 2024

637 TWh

Capacity added in 2024*

541 MW

Pumped storage capacity added in 2024

96 MW

Total installed capacity*

207 GW

Total pumped storage installed capacity

22 GW

*Includes pumped storage

Daniel-Johnson dam (Manic-5),
Côte-Nord region, Canada
Credit: Hydro-Québec

Regional overview and outlook

Hydropower development in North and Central America is characterised by a dynamic blend of modernisation and strategic collaboration, reinforcing hydropower as a mature contributor to the region's renewable energy landscape.

Most of the energy generation capacity in many North and Central American countries and subnational jurisdictions continues to come from hydropower and, although much of the region's core infrastructure was constructed decades ago, there is still significant new development.

In Canada, for example, British Columbia's Site C project achieved a major milestone with the commissioning of two of six new generating units. Site C will have a capacity of 1,100MW, increasing the province's production capacity by 8%, when the site is fully operational in the autumn of 2025. In addition, a landmark agreement between Québec and Newfoundland & Labrador has been announced, with the provinces joining forces to invest in and develop future hydropower initiatives, signalling a commitment to cooperative energy advancement.

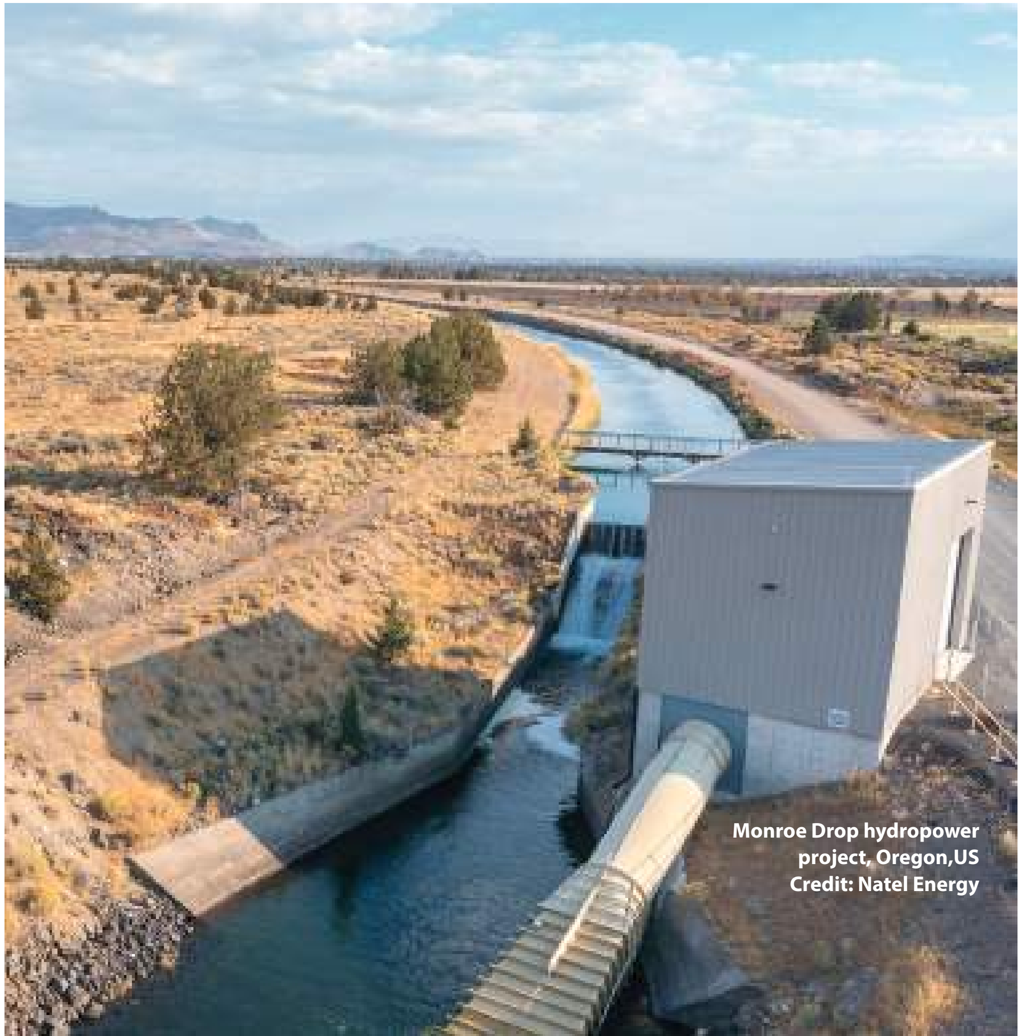
Meanwhile, in the United States, the Bipartisan Infrastructure Law (BIL) continues to benefit hydropower. Federal funding from BIL and other sources has been ringfenced for new development in small communities, maintenance and refurbishment of existing facilities, and in-country hydropower research. Other developments include the commissioning of the Taylor River Hydro Project in Colorado, a 500kW hydro plant generating an anticipated 3.8GWh annually.

Central America also saw significant hydropower investment as countries reduce their reliance on imported fossil fuels. For example, Panama's Changuinola II project, which has an anticipated installed capacity of up to 228MW, is scheduled for completion in 2029, aligning with Panama's 2020–2034 national electricity system expansion plan.

Meanwhile, the modernisation of Costa Rica's 97MW La Garita Hydroelectric Plant has been completed with the upgraded facility entering full commercial operation in early 2025.

The Dominican Republic is also pursuing several hydropower projects aimed at expanding its renewable energy capacity and enhancing grid reliability. The country has set a goal of generating 25% of its power from renewables by 2025.

Hydropower development in North and Central America is marked by facility modernisation, new construction, and strategic collaboration, reinforcing its role as a cornerstone of the region's renewable energy strategy.



**Monroe Drop hydropower project, Oregon,US
Credit: Natel Energy**

Policy and market overview

Hydropower is a well-established component of the energy mix in North and Central America, yet this maturity has led some policymakers to overlook its potential for further development. As government attention increasingly shifts toward expanding solar and wind resources, hydropower is not always prioritised in energy strategies, despite its reliability and ability to provide baseload power.

This policy neglect is particularly problematic given the ageing hydropower fleet in the region. In the United States, for instance, licences for nearly 40% of the non-federal hydropower fleet – representing approximately 15,700MW of capacity – are set to expire between 2020 and 2035.

Without reforms to streamline the licensing process, many operators may find the costs and complexities of relicensing prohibitive, potentially leading them to surrender their licences. This could result in a significant loss of renewable generation capacity at a time when energy transition goals are increasingly ambitious.

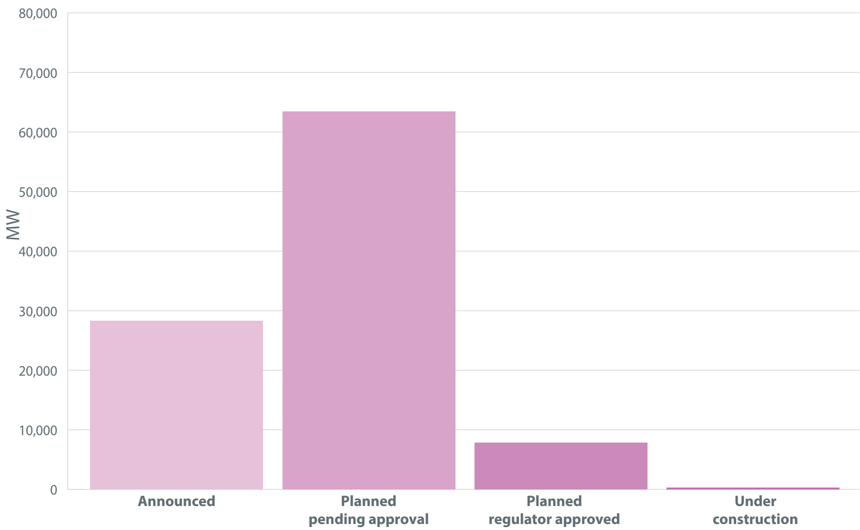
Some operators have initiated ambitious rehabilitation and modernisation projects to address these challenges. These efforts can increase output and improve efficiency with minimal-to-no new infrastructure, making such projects attractive from both an economic and environmental perspective.

However, the regulatory environment remains a significant barrier, as lengthy approval processes can delay or discourage investment.

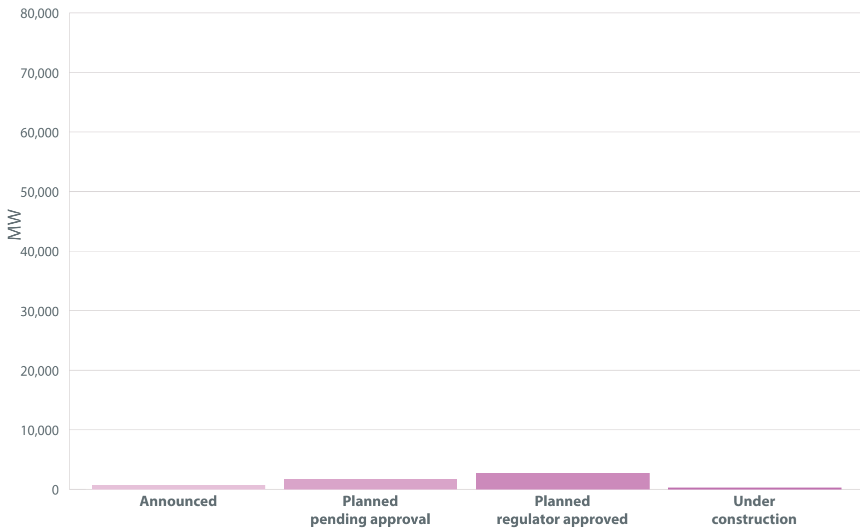
Additionally, climate-related issues such as prolonged droughts are casting a shadow over the future of hydropower, especially in Mexico and some Central American countries. Recent severe heatwaves, combined with drought, have placed considerable strain on power systems, leading to decreased hydropower generation and a greater reliance on fossil fuels to meet energy demand.

This situation underscores the need for adaptive policies that recognise both the challenges and opportunities associated with hydropower.

To reinforce hydropower's role as a resilient, low-carbon energy source for North and Central America, it is imperative that regulatory hurdles are addressed, modernisation is supported, and hydropower is seamlessly integrated with other renewables.



North and Central America PSH pipeline



North and Central America Conventional pipeline

Latest developments by country

Canada

Hydropower continues to produce almost 60% of Canada's total annual electricity generation and represents more than half of its total installed capacity. In several provinces where hydropower is abundant, further expansion is seen as key to satisfying increasing energy needs.

For example, the premiers of Québec and Newfoundland & Labrador recently announced an historic agreement to collaborate on future electricity development through joint ventures. The deal includes increased hydropower generation capacity at the existing Churchill Falls facility, the development of a new generation station on the Churchill Falls site, and a new facility at Gull Island. These projects will add a total of 3,900MW new hydropower generation capacity.

In addition, Newfoundland & Labrador Hydro's 2024 Resource Adequacy Plan reveals that a new 154MW hydroelectric unit for its Bay d'Espoir facility is a frontrunner among several supply options.

In British Columbia, a major milestone was achieved at the Site C project with the successful testing and commissioning of the first two of its six generating units.

As the third major dam and generating station on the Peace River in northeast BC, Site C is poised to significantly boost the province's hydroelectric capacity. Once fully operational, it will add 1,100MW of capacity and generate approximately 5.1TWh annually – enough to satisfy approximately 8% of BC's total electricity needs.

Pumped storage development also took a significant step forward in Nova Scotia, where there are proposals to repurpose a disused mine into a closed-loop pumped hydro energy storage system. A feasibility study will be conducted for the facility which will be complemented by photovoltaic panels.

Ontario also announced investment to advance a PSH project, including the completion of a detailed cost estimate and environmental assessments to determine the feasibility of the project.

The province's Minister of Energy also initiated the Northern Hydro Program (NHP). The initiative, which is being developed by the Independent Electric System Operator (IESO), aims to recontract existing hydroelectric generation facilities in northern Ontario with an installed capacity greater than 10MW. Eligible facilities will have contracts with the IESO or the Ontario Electricity Financial Corporation (OEFC) that have expired or are set to expire on or before April 30, 2043. The program will also consider factors beyond facilities' ability to generate electricity, including:

- The social and regional benefits hydropower provides – including water management, which can help with flood control, irrigation and the support of local ecosystems.
- The capital investments needed to keep large hydroelectric facilities running safely and efficiently over time.

More than two dozen hydropower facilities are expected to qualify for contracting again under the NHP, highlighting the extent of the program's impact across northern Ontario.

Several major refurbishment projects have also continued or were announced in BC, Ontario and Québec.

United States

Hydropower attracted strong federal investment in the US in 2024. For example, in February the United States Department of Energy (DOE) awarded a total of US$76 million to four proposed hydropower projects – three in Alaska and one in Washington State.

This funding will have a particular impact in Alaska, where small, remote communities find it extremely challenging to raise the capital required to construct the hydropower infrastructure needed to improve system reliability and assist the transition from diesel generation to renewables.

As a further vote of confidence in hydropower, the DOE's Water Power Technologies Office (WPTO) announced in June investments worth more than US$1.7 million in 16 hydropower and 12 marine power research and development projects at the department's laboratories.

It also announced US$1 million in funding from the Bipartisan Infrastructure Law to support the Hydropower Foundation's hydropower workforce development programmes.

Meanwhile, the DOE's Grid Deployment Office (GDO) announced the selection of 293 hydroelectric projects across 33

Sampling of fish at the mouth of the Rivière Romaine, Canada
Credit: Hydro-Québec

states to receive more than US$430 million in Maintaining and Enhancing Hydroelectricity Incentive payments.

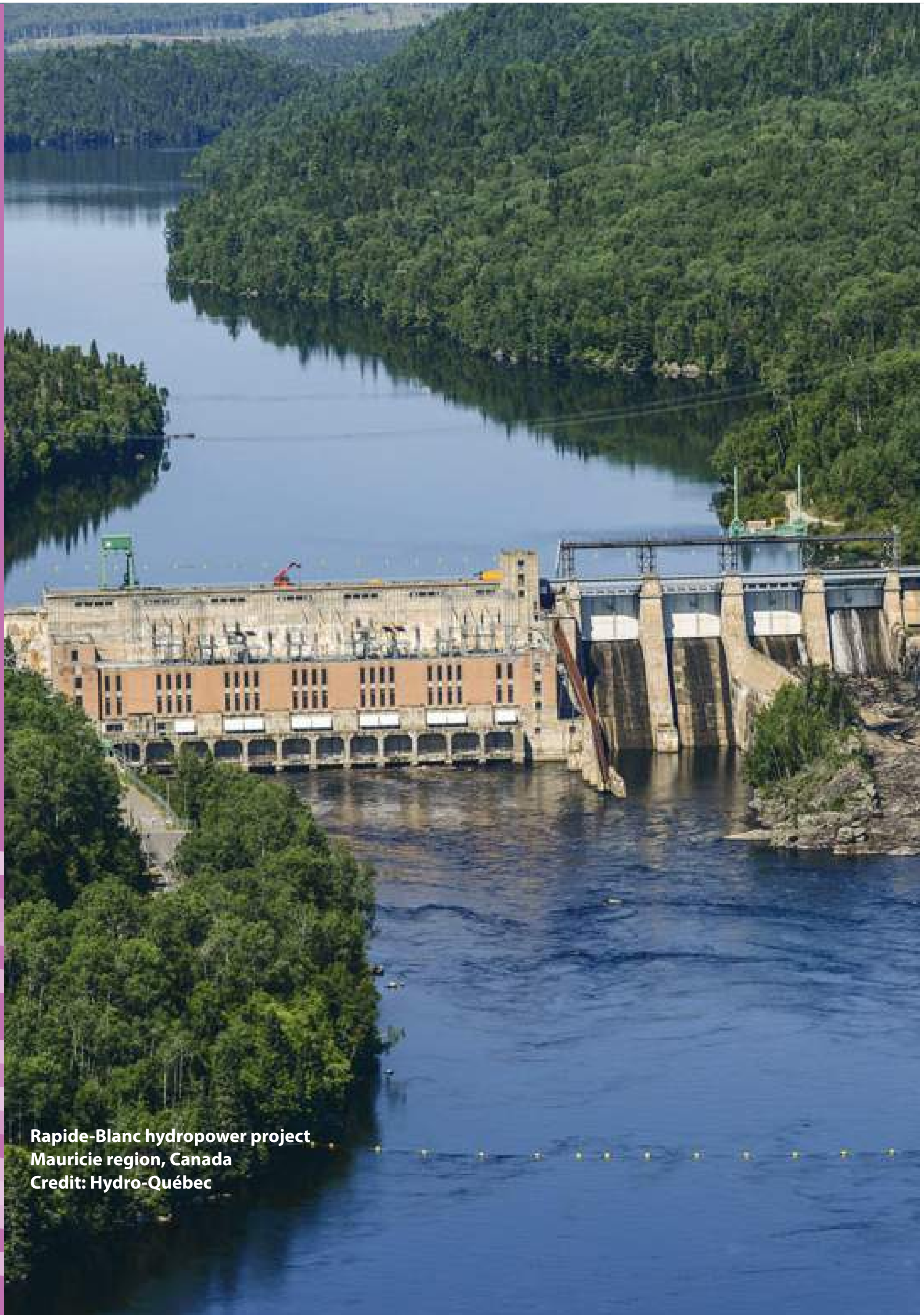
The funding, which comes from Section 247 of the BIL, can be used to fund grid resilience, dam safety improvements and/or environmental impact reduction.

However, the incentives for hydropower and other renewable energy projects under the BIL are at risk. The new government which came into place in early 2025 took measures to restrict or eliminate key incentives put into place by the previous administration – a situation to watch as the United States hydropower sector is working hard to establish a tax credit to support critical upgrades to existing hydropower projects.

The Department of Energy's national laboratory system has also been busy conducting research and publishing reports relevant to the hydropower industry:

- The National Renewable Energy Laboratory (NREL) developed a detailed labour and construction cost-estimation tool for closed-loop PSH plants.
- NREL also published a report highlighting the significant untapped potential for hydropower in the US. It asserted that the development of medium-sized hydropower and pumped storage would advance the nation's clean energy transition.
- Oak Ridge National Laboratory published an updated dataset revealing that 2,564 non-powered dams in the contiguous United States could theoretically generate a total of 4.1GW.
- The Pacific Northwest National Laboratory published a study that examined how climate change could impact hydropower generation in the US. It found that generation could increase by 5% by 2039 and 10% by 2059 throughout the United States due to increases in seasonal precipitation, albeit with regional disparities.

In power plant news, Duke Energy completed the upgrade of its four-unit, 1,680MW Bad Creek PSH facility. The refurbishment added 320MW of energy storage, significantly increasing reliability for consumers.



Rapide-Blanc hydropower project
Mauricie region, Canada
Credit: Hydro-Québec

Mexico

Efforts to modernise existing hydropower plants continued in Mexico, including capacity additions where feasible.

Costa Rica

Plans were announced to build the 53MW Fourth Cliff hydropower plant, which could be operational by 2031. While still in the pre-feasibility stage, the plant would complement the country's already impressive fleet and help mitigate energy challenges associated with climate variability and cyclical phenomena such as El Niño, which can affect rainfall and hydropower generation.

Panama

Construction continued on Bocas del Toro hydropower project (224MW, previously named Changuinola II). Other projects under construction are Burica (63MW) and Chuspa (10MW).

Dominican Republic

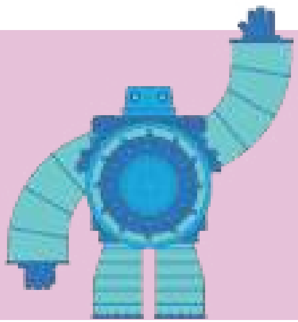
Construction continued on Bocas del Toro hydropower project (224MW, previously named Changuinola II). Other projects under construction are Burica (63MW) and Chuspa (10MW).

El Salvador

The 3 de Febrero hydropower project (previously known as El Chaparral) completed its first full year of operation, adding 64MW to the energy mix and acting as a giant battery to integrate other renewables.

Interesting fact

In November 2024, hydropower helped Panama achieve 100% renewable electricity generation. The country not only satisfied its own domestic needs, it also exported 226.47MW of surplus power to its neighbours.



North and Central America

Top 4 Countries/region by capacity added in 2024

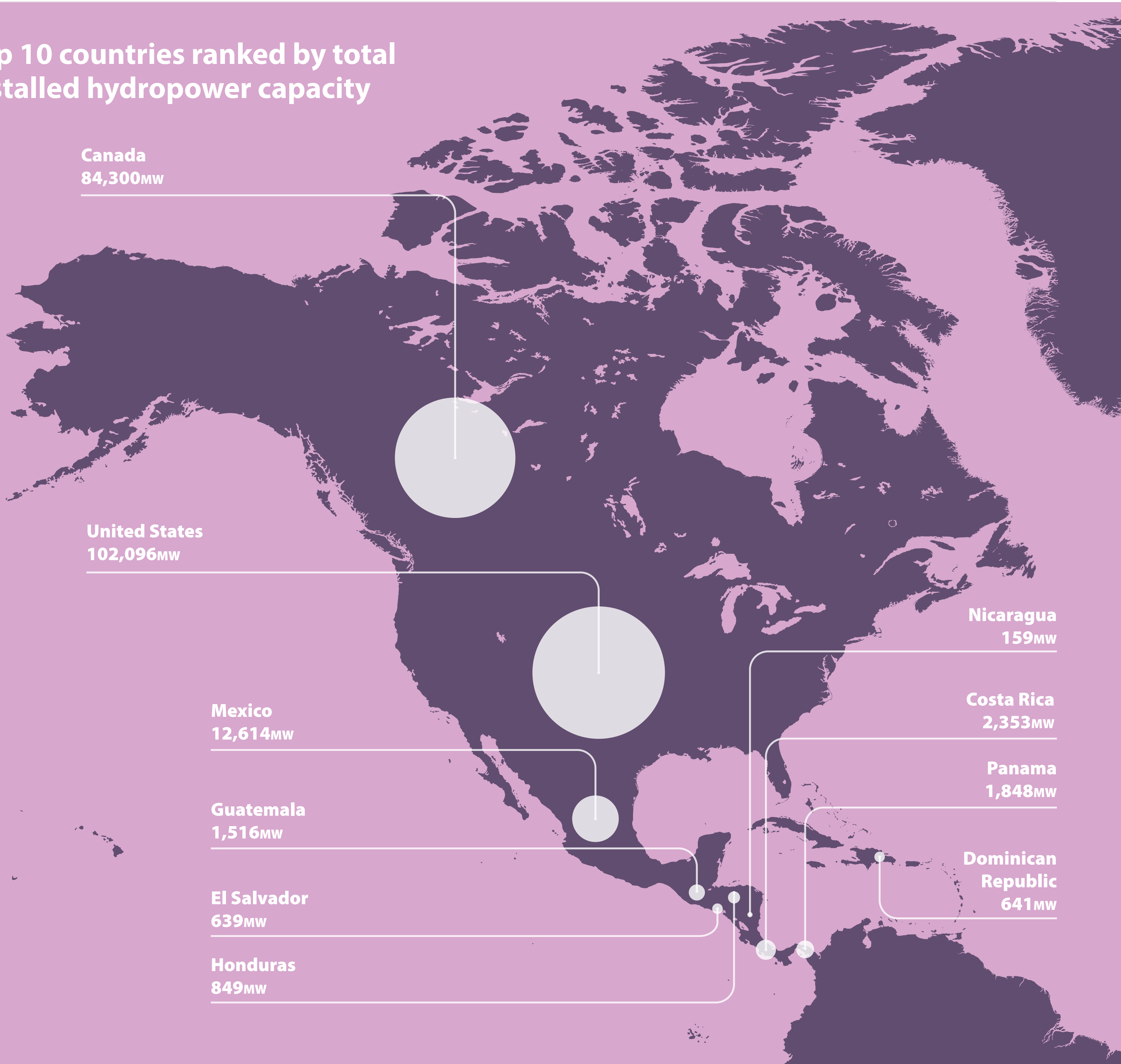
1 Canada 360MW

2 United States 96MW

3 El Salvador 67MW

4 Dominican Republic 18MW

Top 10 countries ranked by total installed hydropower capacity



North and Central America

Countries to watch

Key
- Low unexploited potential/minimal policy activity/limited project pipeline
- Moderate unexploited potential/some policy activity/intermediate project pipeline
- High unexploited potential/strong policy activity/large project pipeline

COUNTRY	UNEXPLOITED POTENTIAL	POLICY ACTIVITY	DEVELOPMENT PIPELINE
Canada	Canada has a well-established hydropower fleet, but significant potential remains.	Its federal government and several provinces are promoting new hydropower development.	Several projects are underway to increase capacity at existing plants and build new ones.
United States	Approximately 80 PSH sites have been identified, most of which are closed loop.	The US Federal Energy Regulatory Commission (FERC) has introduced expedited licensing processes for closed-loop PSH projects, reducing permitting times from several years to months.	67 new projects are in various stages of planning across 21 states, representing more than 50GW of new storage capacity. Three projects are fully permitted and awaiting final investment decisions.
Costa Rica	Costa Rica has a well-established hydropower fleet, but potential remains.	New hydropower development is underway. The Renewable Energy Laws and Regulations Report 2025 highlights updated incentives for private renewable energy projects, streamlined permitting processes for small hydropower and storage, and favourable feed-in tariffs for run-of-river plants.	One new project announced.
Dominican Republic	The Dominican Republic has identified new greenfield and brownfield PSH sites.	The country's state-owned hydroelectric utility has called for tenders to better define the potential of PSH.	The development pipeline is unclear.

South America

Generation by hydropower in 2024
725 TWh

Capacity added in 2024*
306 MW

Pumped storage capacity added in 2024
0 MW

Total installed capacity*
183 GW

Total pumped storage installed capacity
994 MW

*Includes pumped storage

Cachoeira Caldeirão hydropower project, Brazil
Credit: Engie

Regional overview and outlook

Hydropower is vital for South America's energy mix, and thanks to natural resources such as the Andes mountains and the Amazon basin, potential for generation is vast. A mere 30% of the region's hydropower potential is currently being exploited, but even that satisfies approximately 45% of the continent's electricity demand.

The industry is rising to the challenge as sustainability becomes increasingly important in such an ecologically-sensitive environment. In January 2025, for example, Brazil's Mascarenhas hydropower plant received gold certification under the Hydropower Sustainability Standard. The 198MW run-of-river plant owned by ENRG became only the second project in South America to achieve gold status, a fitting way to celebrate 50 years in service. Meanwhile, Colombia's 19.9MW Chorreritas project earned Hydropower Sustainability Standard silver certification, making it only the 10th project in the world to achieve silver or higher. Likewise, the 2,400MW Ituango Hydroelectric Project in Colombia – South America's largest ongoing hydropower scheme – has only recently begun phased commissioning amid significant technical and social challenges, yet its full capacity will be critical for the country's energy security once all turbines are online.

By 2024, solar and wind power accounted for 36.8GW of installed capacity in the continent's grid, out of a total capacity of around 400GW. Renewables may be increasing, but so is potential grid instability as operators attempt to match inconsistent renewable generation with demand.

In response, South America is pioneering hybrid systems combining hydropower and other renewables to maximise sustainability and efficiency. The deployment of PV arrays on hydro reservoir surfaces is a leading example of this approach.

Brazil, for example, began construction of the country's largest floating solar plant in late 2024. The 54MW facility at the Lajeado hydro reservoir in Tocantins features thousands of solar panels on the dam's reservoir, leveraging existing transmission while the cooling effect of the water will boost solar output.

Conversely, prospects for rising energy demand are materialising through billion-dollar investments across the region in data centres, extensive mining operations, mega-port logistics hubs and heavy industry. Moreover, the 2024 inauguration of Peru's Chancay Port – now South America's largest – has quickly become one of the most energy-intensive and industry-stimulating developments in recent years. Global tech companies are considering Colombia for new regional data centres, and Equinix is leading plans to develop an integrated financial data centre spanning Chile, Colombia and Peru. These trends underscore the urgent need for both reliable baseload generation and flexible, sustainable capacity.

Hydropower remains the backbone of South America's energy system, and as the region embraces innovation and sustainability – through certified projects and hybrid systems such as floating solar – its vast Andean-Amazon potential continues to shape a resilient, renewable future.

Passo Fundo hydropower project, Rio Grande do Sul, Brazil
Credit: Engie

South America

Policy and market overview

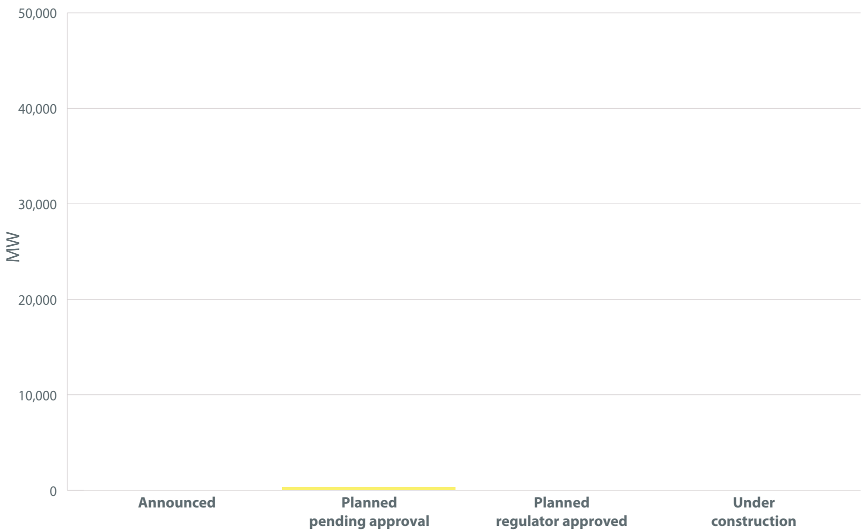
Although several high-profile projects are reaching completion, the overall rate of hydropower development in South America has plateaued. Regulatory reforms in the sector are often lagging the needs of the industry. Uncertainty around concession renewals, particularly in Brazil, has created challenges for operators, worsened by political volatility and frequent policy shifts in countries such as Argentina and Colombia. This instability has led to investor/state disputes and project delays.

In 2024-2025, Colombia's government clashed with hydropower companies over alleged opaque pricing and excessive profits, contributing to a 25% drop in investment confidence. In response, authorities are pushing for stricter oversight and tariff reforms.

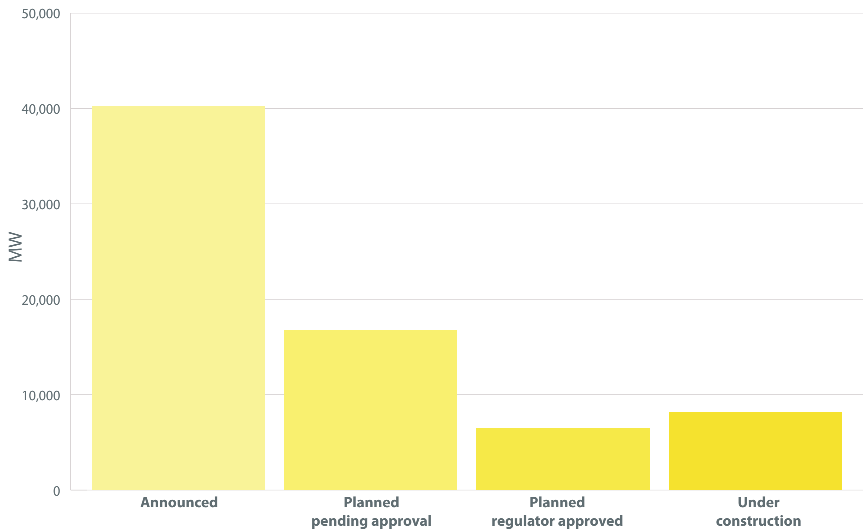
Sustainable hydropower in South America faces persistent barriers – chiefly slow, multi-layered approval processes and fragmented water-rights regimes. In Argentina, dual federal-and-provincial concessions and lengthy disputes prompted a 2024 provincial water law and audits to ease delays. In Peru, bureaucratic inertia and local opposition have repeatedly slowed hydropower developments. In Chile, the 2022 Water Code reform replaced perpetual water rights with 30-year conditional concessions – curbing speculation in the secondary market by making unused entitlements forfeitable.

Similarly, social and environmental review processes can extend timelines. Colombia, where hydropower still provides about 65% of electricity, has begun issuing decrees to streamline bureaucratic steps and strengthen social consent for new dams.

Meanwhile, Chinese investors are recalibrating their approach. Under China's Going Out strategy and Belt & Road Initiative, investment initially focused in some markets on constructing large dams. Today, there is greater emphasis on acquiring



South America PSH pipeline



South America Conventional pipeline

operational assets such as hydropower plants and transmission companies to secure stable returns and avoid political risk. Firms such as State Grid Corporation of China have expanded into Chilean, Brazilian and Peruvian grids. However, fluctuations in Chinese capital flows, driven by domestic challenges, could impact future funding.

Despite efforts, hydropower faces competition from quicker, lower-risk solar and wind projects. Large projects such as Brazil's São Luiz do Tapajós dam have stalled due to financing and environmental hurdles or specific issues around indigenous rights.

Climate change poses major risks. Severe droughts intensified by El Niño in 2024 and 2025 critically impaired hydropower generation, leading to power cuts and higher electricity costs. Governments are now urgently seeking to diversify energy sources and improve water management.

Latest developments by country

Argentina

The Argentinian hydropower sector is undergoing major growth, with several large-scale projects nearing completion and new developments planned. Projects include the 1,310MW Santa Cruz hydroelectric plant, which is slated for completion by 2026. The 950MW Condor Cliff Dam, developed by Represas Patagonia, is set for commissioning by 2027, while the 871MW Chihuido project, still in permitting, is expected online by 2029. The national government also announced plans for the ambitious 3,500MW Cospues plant, aiming for 2033 operations. Meanwhile, the Río Grande PSH, the continent's largest reversible facility, is operating at 50% capacity, with ongoing renovations due for completion in late 2025.

Argentina's national hydroelectric capacity was revised down by 746MW in 2024, following a reclassification of the Yacyretá plant to reflect only the Argentine share. Across the country, hydropower generation declined 15.02% compared to 2023, with a further 34.3% drop in January 2025 due to extremely low river inflows. At the same time, large mining endeavours – such as copper and lithium extraction at the Caucharí-Olaroz plant in Jujuy – together with emerging green hydrogen production and the reactivation of petrochemical complexes, will each demand tens or even hundreds of megawatts, have further strained the national energy supply.

Bolivia

Bolivia's hydropower sector is growing significantly, with major projects including Rio Madera, Ivirizu and Miguillas moving forward. The 3,000MW Rio Madera hydropower project, developed by Eletrobras Participações and Empresa Nacional de Electricidad Bolivia has completed initial site selection and should start on a feasibility study and environmental licensing soon. Commissioning could be as early as 2031. Located on the Madera River in Pando, the project is expected to generate 20TWh of electricity annually. Meanwhile, the Ivirizu complex, which will generate 1.16TWh and the first stage of the 203MW Miguillas hydroelectric plant, developed by ENDE, are both expected to be finalised in 2025.

Brazil

A severe dry spell in late 2024 reduced Brazil's hydropower output to three-year lows, with hydropower falling to a 50% share of the energy mix during September. Anticipation of low water flows in the future has been a factor in limiting development of new sites. The country added a record 10.85GW of total generating capacity during 2024, but hydropower's contribution to this was small: only 56MW from eleven new projects. The nation's installed hydropower capacity now stands at 110GW, with 1.3GW more licensed or under construction.

There are currently 32 advanced-stage projects totalling 442MW and 60 licensed projects awaiting construction, representing 945MW. In March 2025, Aneel approved a regulatory change at the Jirau project so that the water level is at 90 metres year-round. This will increase output by an average of 250MW. Meanwhile, Norte Energia, operator of Belo Monte (11,233MW), boosted ESG initiatives, focusing on reforestation, gender diversity, R&D in electric mobility, and indigenous bioeconomy ventures. Meanwhile, large-scale investments in mining and heavy industry – particularly mineral processing, petrochemicals and high-tech manufacturing – alongside growing foreign direct investment in data centres (2025 saw Equinix join Google, AWS and other major operators) are driving urban electricity demand ever higher.

Brazil is also promoting capacity expansion at existing hydropower plants, as the high volume of solar and wind generation is requiring additional dispatchable capacity to provide reliability to the grid. However, current regulations do not give adequate signals to owners to add flexibility when investing in this expansion, which is a missed opportunity that should be addressed by the regulators.

Brazil is now discussing the implementation of new regulatory framework to allow pumped storage hydropower to be developed in the country, taking advantage of the country's existing supply chain and providing a sustainable solution for the National Grid's growing needs.

Chile

Chile's installed generating capacity has grown spectacularly in recent years, driven by variable renewables; hydropower, however, has played a relatively small role in this expansion. In 2024, four projects added a total of 157.7MW to Chile's hydropower capacity: Los Cóndores (150MW), Pasada Piedras Negras (3MW), La Confianza (2.6MW), and Nueva Ampliación PMGD Las Flores (2.1MW). Four more projects, with a combined investment of US$677 million, are also under construction: Las Nieves (6MW), Dos Valles (4.5MW), Los Lagos (48MW) and Central Ñuble de Pasada (136MW). A 52MW Los Lagos run-of-river project has also recently received approval.

Colombia

Construction of Ituango, Colombia's 2,400MW run-of-river project, is progressing. It is the country's largest and among the continent's ten biggest hydropower projects. By late 2024, Ituango had partially entered service with 1,200MW installed, and is expected to reach full capacity by 2027. Elsewhere, hydropower development has lagged, with just two projects completed in 2024 – TZ II (10.5MW) and Alejandría (2MW). Both are currently undergoing testing. Two major projects, Porvenir II (352MW) and Miel II (120MW), have been approved, however, signalling future growth for Colombia's hydropower sector.

Ecuador

Ecuador's hydropower system remains under pressure due to droughts, which have triggered electricity blackouts. With 72% of the country's power generation dependent on water, the government is turning to solar projects to add resilience. The government is also passing laws to help boost private investment in hydropower from 10% to 47%. Other measures include a 12-month zero import tariff for energy generators. Meanwhile, construction has yet to begin on the Zamora hydropower project (3,565MW), the first 68MW turbine in the 254.4MW Toachi-Pilatón project has been completed, and feasibility studies are underway for major projects in the Santiago basin (over 3,000MW) and further Zamora schemes.

Guyana

Guyana has revived its flagship 165MW Amaila Falls hydropower project after years of delays and failed attempts. Initially awarded to China Railway Group

Santo Antônio do Jari hydropower project, Brazil
Credit: Engie

under a BOOT model, talks collapsed in 2022 over costs. As of 2024, the government is re-tendering the project, with four international firms prequalified. Amaila is central to Guyana's low-carbon strategy, with expectations it will supply more than 50% of the nation's electricity, reducing dependence on oil. A public–private partnership is expected. Key hurdles including financing challenges, indigenous consultation, and environmental concerns remain ahead of the targeted 2029 commissioning date.

Paraguay

Itaipú Binacional, operators of one of the world's largest hydropower plants, supplied Paraguay with 20.4TWh of electricity between January and December 2024 – a record for cumulative energy production. During 2024, hydropower supply to Paraguay rose by 4.5% compared to 2023. Sector investment has been focused on optimising existing assets rather than launching new large-scale projects. For example, the 200MW Acaray plant is undergoing major modernisation under a contract awarded to AFRY (working in consortium with Latinoconsult and supported by Inter-American Development Bank funding (IADB)). The goal is to improve capacity and extend the plant's operational life.

Peru

San Gabán III (209.3MW) is located in Carabaya province, Puno, and is designed to generate approximately 1.25TWh annually. It will bolster supply to Peru's southern grid and support the mining sector. The project is initiated in 2017 and was commissioned in April 2025. Environmental management plans have been implemented to mitigate impacts on nearby protected areas and to benefit local communities through electrification and employment opportunities. In addition, construction of four small hydropower projects is more than 25% complete – CH Santa Lorenza (19MW), CH Anashironi (20MW), Centauro I (12.5MW), and Centauro II (12MW) – with operation scheduled between 2025 and 2027. Collectively, large-scale projects with a combined value exceeding US$7 billion – encompassing major mining developments, port logistics (notably the Chancay terminal) and heavy-industry installations – will increase the country's energy demand in the coming years.

Uruguay

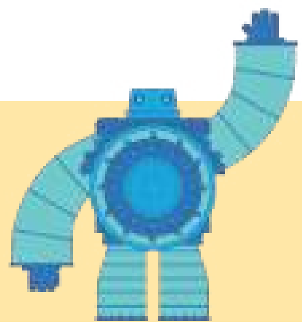
In 2024, Uruguay's total electricity production climbed to a record 14.4TWh. Hydropower accounted for over 50% of that output, more than doubling its year-on-year generation and cementing its role as the country's leading renewable source. Work also began on the modernisation of the Rincón de Baygorria hydroelectric plant during 2024, with plans to increase installed capacity to 120MW. The project is managed by Andritz in consortium with SACEEM. Uruguay's 2024-2043 Generation Expansion Plan forecasts annual electricity demand reaching 17.8TWh by 2043, highlighting the need for new solar and wind projects as hydropower's relative contribution continues to decline.

Venezuela

In recent years, Venezuela's hydropower sector has struggled with declining capacity due to economic challenges and structural neglect of key infrastructure, such as the Guri Dam (10,200MW) and the Caroní River cascade. In response, recent efforts have been focused on restoring existing facilities. During 2024, for example, the General José Antonio Páez hydroelectric complex in Barinas was reactivated, adding 120MW to the grid. Modernisation investments are also increasing, often backed by development banks. In December 2024, the Latin American Development Bank (CAF) authorised a US$380 million loan to help improve the efficiency and extend the operational life of the country's Simón Bolívar plant. The project will cost US$610.43 million in

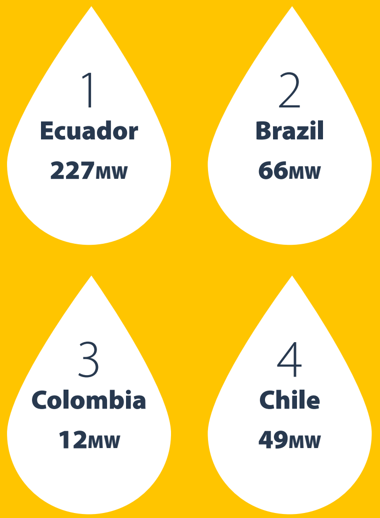
Interesting fact

Pumped storage remains largely untapped in Latin America, but a 2024 IADB report highlights its potential to boost renewable integration as ageing hydro plants modernise. The two-stage study identifies 179 possible sites across 11 countries and lays out plans for a pilot project in Pisagua, Tarapacá, Chile, providing 640MW with 12 hours of storage. The pilot uses two $4.5Mm^3$ reservoirs, four 160MW Francis turbines, and two 220kV lines. The US$570 million project would be constructed over 48 months at a cost of US$32/MWh and a 12.8% IRR. A proposed 1,200MW solar PV plant would add 300MW of capacity.

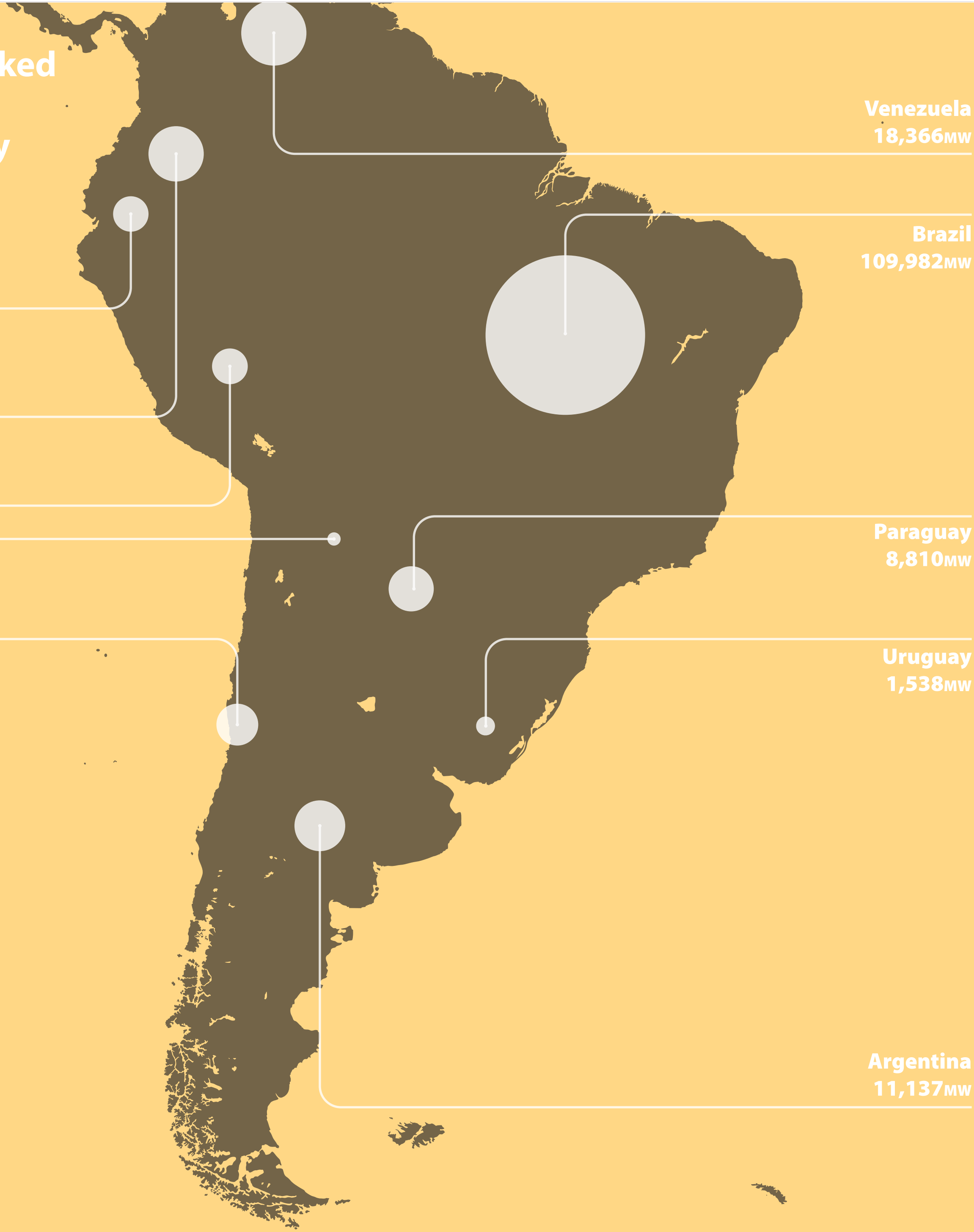


South America

Top 4 Countries/region by capacity added in 2024



Top 10 countries ranked by total installed hydropower capacity



South America

Countries to watch

Key
- Low unexploited potential/minimal policy activity/limited project pipeline
- Moderate unexploited potential/some policy activity/intermediate project pipeline
- High unexploited potential/strong policy activity/large project pipeline

COUNTRY	UNEXPLOITED POTENTIAL	POLICY ACTIVITY	DEVELOPMENT PIPELINE
Ecuador	Ecuador has tapped only 7% of its hydro power potential.	Government initiatives have been designed to help Ecuador meet its long-term goal of sourcing 80% of its electricity from renewable sources. Further policy efforts are under way to encourage greater private sector participation.	Key projects include two new run-of-river plants, which will add approximately 150MW, and the ambitious Zamora G8 project (3,600MW), now in final feasibility. The Toachi-Pilatón complex (254MW) is also nearing completion.
Argentina	Argentina has harnessed only 20% of its hydropower potential. The Inter-American Development Bank has identified 23 potential PSH projects with average installed capacities of 414.5MW.	Recent policy initiatives have focused on modernising ageing assets rather than launching new mega-dams. Argentina recently began recognising pumped hydro in the wholesale market, with plants remunerated for both energy generated, and energy consumed for pumping.	Contract renewals have stalled the Néstor Kirchner and Jorge Cepernic dams (1,310MW). The Aña Cuá Expansion (270MW) has halted due to funding and binational tensions. Chihuido I (637MW) awaits financial closure. In PSH, Argentina's focus has been on fully reactivating Río Grande's capacity, with the 750MW facility operating at 50% capacity.
Chile	The country has significant potential for small and micro run-of-river projects and pumped storage. Chile has realised approximately 53% of its estimated 16GW hydropower potential. The IADB has identified 16 potential sites for PSH development.	Permitting has been streamlined for energy storage and integrated hybrid projects. Chile's government announced a circa US$2 billion investment in energy storage by 2026. Energy storage assets can now earn revenue from capacity and ancillary services in Chile, improving the bankability of PSH.	Four hydropower projects are under construction totalling 194.5MW, with a combined investment of US$677 million. The Los Lagos Run-of-River project (52MW) has also received approval. Chile's two biggest PSH projects – Paposo (800MW) and Espejo de Tarapacá (300MW) – have both stalled. Paposo due to environmental concerns and Espejo de Tarapacá due to funding.
Peru	Peru has harnessed 8% of its hydropower potential of 69.45GW.	Recent policy initiatives seek to accelerate concessions, shorten environmental review timelines, and accelerate consent processes. An additional initiative seeks to simplify access to competitive financing and shorten perfectibility and construction-licensing periods for small hydro projects.	The Ministry of Mines and Energy has confirmed that six projects totalling 664MW will enter commercial operation between 2025 and 2027. These include the San Gabán III, Santa Lorenza and Anashironi hydroelectric plants, as well as the Centauro I and Centauro III facilities.
Brazil	The IADB has identified 28 sites for potential PSH development with an average installed capacity of 387MWh. EPE's research on pumped storage in Brazil, which incorporates social and environmental factors, has identified 15 possible locations for PSH development.	Policy objectives are set by ANEEL, clarifying questions about adaptation to grid access, licensing regulation and remuneration. Brazil's Mines and Energy Ministry highlighted pumped storage "reversible" plants in its 2050 energy policy plan as a preferred alternative to new mega-dams. PS is currently unable to access auctions for storage.	While the signs look promising, there are no notable projects in the development pipeline yet.

Europe

Generation by hydropower in 2024
680 TWh

Capacity added in 2024*
544 MW

Pumped storage capacity added in 2024
187 MW

Total installed capacity*
263 GW

Total pumped storage installed capacity
56 MW

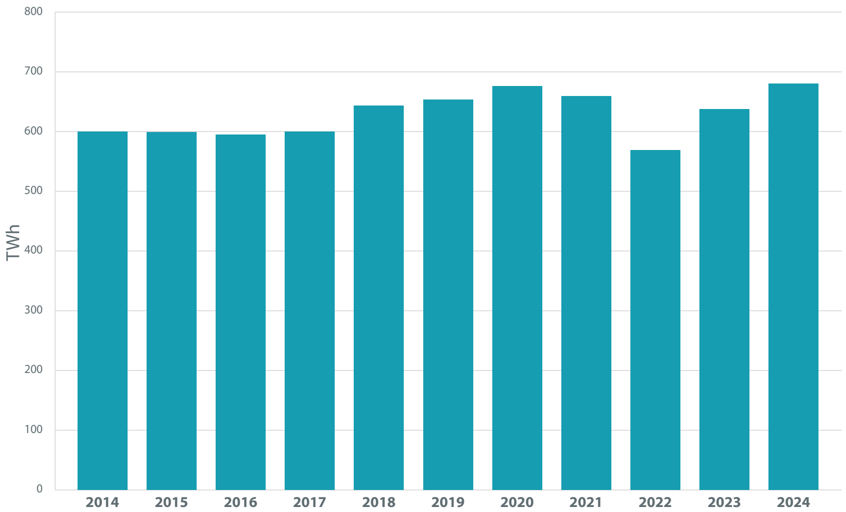
*Includes pumped storage

Cruachan pumped storage hydropower project, Scotland
Credit: Stantec

Regional overview and outlook

Europe achieved a breakthrough year of renewable energy generation in 2024, with frequent monthly peaks during which hydropower, wind and solar were the primary contributors to the EU power system.

While the rapid deployment of wind and solar contributed significantly to this achievement, hydropower also played a crucial role. Exceptional precipitation pushed hydropower generation to a decade-high of 680TWh.



Europe hydropower generation 2014 to 2024 (TWh)

Ongoing geopolitical changes are prompting European countries and institutions to accelerate decarbonisation plans, prioritising energy security and affordability. In 2024, electricity prices dropped below 2021 levels but remained two to three times higher than before the Ukrainian conflict. This reflects the continued reliance on expensive LNG imports, which still affect many nations.

The growing share of variable renewables and the dependence on gas plants used during peak demand are driving market volatility. This is increasing the need for flexible, low-carbon energy sources, especially hydropower. A clear business case for PSH is emerging, supported by a European project pipeline of 52.9GW in development. Of this, 3GW is under construction and 6.7GW has already received regulatory approval.

Policy developments are also strengthening investment confidence. Several governments are considering the introduction of revenue stabilisation mechanisms to improve the financial viability of long duration electricity storage, such as the United Kingdom's Cap & Floor mechanism and capacity markets for storage in Italy and Spain.

The EU's 2024 market design reform was another key regulatory milestone. It requires member states to assess flexibility needs over five to ten years, sets performance targets and authorises states to introduce support schemes promoting low-carbon flexibility deployment where market conditions fall short.

Modernising Europe's ageing hydropower infrastructure remains a strategic priority. Upgrading existing plants offers a timely opportunity to improve electricity generation, reduce environmental impact, and enhance system-wide flexibility, supporting the broader transition to a resilient, low-carbon energy system.

Carrapatelo hydropower project, Portugal
Credit: EDP

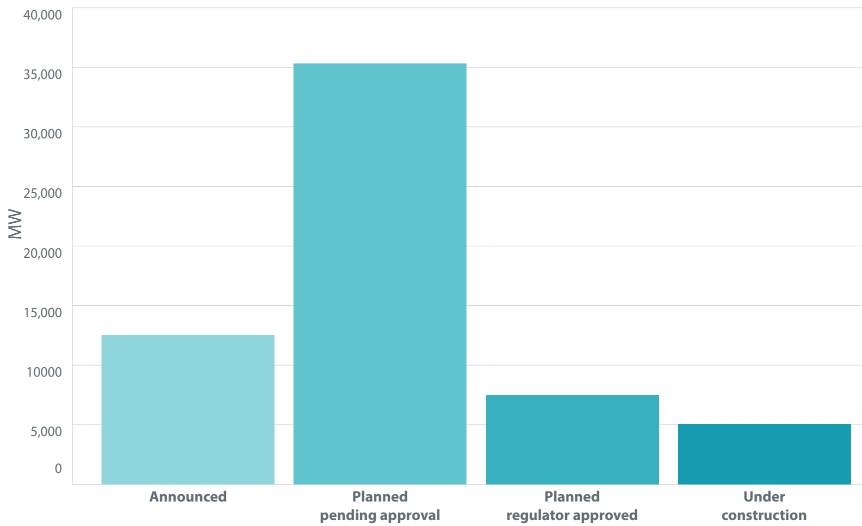
Policy and market overview

Europe's current energy landscape is defined by the urgent need to accelerate the energy transition and reduce reliance on imported fossil fuels. This shift is driven by both climate goals and energy security concerns, prompting a rapid expansion of low-carbon and renewable energy sources. A key challenge, however, is ensuring that power systems have sufficient flexibility to maintain grid stability. Hydropower, including PSH, plays a vital role in satisfying these requirements. Unlike variable renewables, hydropower offers reliable, controllable, and dispatchable electricity, while PSH uniquely provides large-scale electricity storage capabilities that are essential for balancing supply and demand and optimise the integration of variable renewable energy sources.

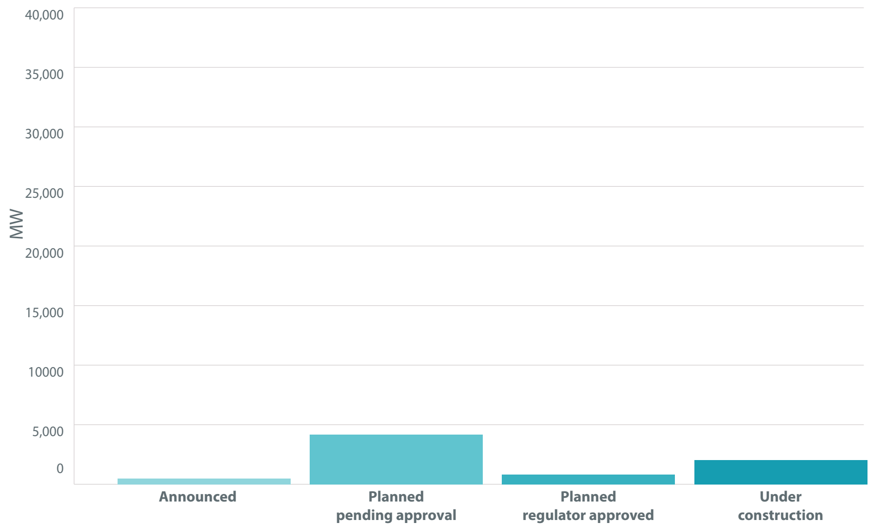
Despite its critical value, hydropower development across Europe continues to face significant obstacles. Policy misalignments and market uncertainty remain major barriers to investment. The volatility of electricity markets complicates long-term revenue forecasting, making it difficult for investors to justify large, capital-intensive projects. Complex, lengthy and burdensome permitting processes also add substantial delays, hindering the timely delivery of new capacity.

Another key issue is the lack of appropriate market recognition and compensation for the full range of services hydropower provides, including frequency regulation, grid support, and storage. For PSH, financial viability is further undermined in jurisdictions where power used for pumping is subject to grid fees or double taxation instead of being recognised as important grid service.

Modernisation of Europe's ageing hydropower fleet is also hampered by regulatory and economic uncertainty. Upgrade projects often face a lack of clarity regarding market access, future pricing structures, or licence renewals, increasing their risk and complexity. Addressing these challenges through coordinated policy frameworks and tailored support mechanisms is essential to unlock hydropower's full potential in a decarbonised and secure European energy system.



Europe PSH pipeline



Europe Conventional pipeline

Latest developments by country

Austria

Austria remains one of Europe's most active countries in PSH expansion and hydropower fleet modernisation, with more than 1.4GW currently under construction. The Kaprun 2029 project, for example, launched by Verbund, involves the modernisation of the Kaprun Main Stage power plant. This includes the reconstruction of the pressure tunnel and key electromechanical equipment. The tunnel boring work began in February 2025. The group has also announced the intention to develop a new PSH plant, Schaufelberg, with an installed capacity of 480MW.

Czechia

Six potential sites for new PSH projects were identified by the Czech Republic's Ministry of the Environment and Ministry of Agriculture in June 2024. The country is exploring PSH opportunities as it looks to increase storage capacity and the resilience of its power system. The six sites are connected to existing dams, according to the government, therefore construction is unlikely to have significant negative environmental or social impact.

Estonia

Development of the Paldiski project, Estonia's first PSH plant, moved a step closer to ground-breaking phase in 2024 as Energiasalv issued a tender for the design and construction of the 500MW underground facility. Construction works were originally expected to begin in Q2 2025 but now depend on the conclusion of the tender process.

Finland

A new and innovative underground PSH project in Pyhäjärvi was announced in May 2024. The project is unique because it reuses decommissioned mine infrastructure, combining underground pumped hydro and battery storage systems. It is designed to deliver 530MWh of energy storage with a peak capacity of 75MW. It will be developed alongside a battery energy storage system of comparable capacity.

Germany

Construction work to recommission the 160MW pumped storage plant at Happurg is underway, just months after plans were announced by Uniper in mid-2024. The project, with a total expected investment of €250 million, is set to enhance grid flexibility and reliability in southern Germany. The plant is scheduled to be fully operational by 2028.

Iceland

Tendering of the 95MW Hvammur greenfield HEP is under way and commissioning is expected in 2030. The project will generate 740GWh annually. Tendering of the expansion of the Sigalda project is also ongoing, where one 65MW turbine will be added to increase flexibility, with commissioning expected by end-2028. At the same time stops will be utilised to refurbish the existing 3 x 50MW station and dam. The pipeline of projects is healthy both for greenfield and brownfield expansion developments.

Italy

Activity in Italy's pumped storage market is intensifying as the country prepares to integrate large volumes of variable renewable energy into a relatively fragmented power system. Several pumped storage projects are currently being developed with the goal of securing contracts in the soon-to-be-launched capacity market (MACSE). For example, in April 2024, Repower confirmed that its 600MW

Daivões hydropower project, Portugal
Credit: Iberdrola

Campolattaro PSH project was awaiting final permitting approval. Just months later, in July, Edison and WeBuild announced plans to jointly develop the Pescopagano and Villarosa PSH projects, with a combined capacity of 500MW.

Latvia

Modernisation of Latvia's hydropower plants on the Daugava River is set to progress following a €230 million loan issued by the Nordic Investment Bank to Latvenergo. Part of this investment will be used to increase plant efficiency, with the goal of ramping up hydropower production across the country.

Lithuania

Expansion of the Kruonis pumped storage plant in Lithuania is set to proceed following approval of a €105 million loan from the European Investment Bank. The funding will support construction of a fifth generating unit, which will add 110MW of capacity to the facility. Once complete, the new unit is expected to enhance grid stability, contribute to energy infrastructure modernisation and further support Lithuania's transition to renewable energy.

Norway

A new Norwegian pumped storage project is set to enter the construction phase following the announcement of a €113 million investment by Hydro in 2024. Full commissioning is expected to begin by 2029. The facility is designed to generate 84GWh of electricity annually by pumping water from the Fivlemyrane reservoir, 1,018m above sea level, to the Illvatn reservoir, which is approximately 350m higher. Storage capacity at Illvatn will be increased by the construction of a new drainage tunnel, allowing for a lower minimum regulated water level.

Portugal

Commissioning of the Alto Tâmega hydropower plant marks the final stage in the development of Portugal's large-scale Tâmega Complex. The 160MW plant is located at the base of the Alto Tâmega Dam, a 105-metre-high double-curved vault structure built with 220,000 cubic metres of concrete and spanning 335 metres across its crown. The fully operational Alto Tâmega complex has 1,158MW of installed capacity, including the 880MW Gouvães pumped storage facility and the 118MW Daivões plant.

Serbia

Plans to accelerate Serbia's decarbonisation and strengthen energy security are due to move forward following the government's announcement in March 2024 of a €400 million investment package. Backed by the European Union and the European Investment Bank, the funding will support modernisation of four existing hydropower plants and the development of the 2.4GW Bistrica pumped storage project.

Spain

Spain is considering the introduction of a capacity market under its National Energy and Climate Plan, to ensure long-term grid reliability and support the integration of variable renewables. While the mechanism will be open to a range of technologies, several pumped storage projects are already moving forward in parallel, supported by targeted grants and regulatory approvals.

In March 2024, Iberdrola's Alcántara pumped storage project received a €44.9 million grant from the Institute for Energy Diversification and Saving. The project will deliver 440MW of capacity and 15GWh of storage, with construction expected to begin in 2025 and commercial operation in mid-2030. Iberdrola's Valdecañas project (275MW / 210GWh) secured administrative approval in July and has already commissioned its first pumping unit. The project uses existing infrastructure and includes a 15MW / 7.5MWh chemical battery to enhance flexibility.

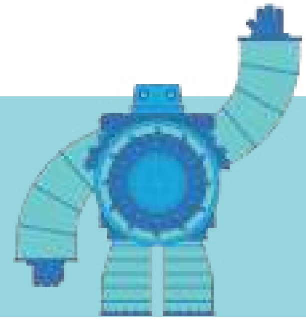
A new partnership between Capital Energy and Verbund Green Power will assess two additional pumped storage plants with a combined capacity of 830MW. Development of the 200MW Salto de Chira project in the Canary Islands is also progressing, supported by a €300 million loan from the European Investment Bank. The facility will include 3.5GWh of storage and be connected to a desalination plant.

Sweden

Sweden could significantly boost hydropower capacity and flexibility by upgrading existing plants, according to a recent study by AFRY supported by the Swedish Association of Engineers. The analysis estimates that up to 4GW of additional capacity could be added, which is equal to the output of approximately 3.5 nuclear reactors. This hydropower expansion could also unlock the integration of a further 1.2GW of wind power into the grid.

United Kingdom

The UK Government is among those pioneering political support for long duration electricity storage across Europe. In October 2024, it instructed sector regulator Ofgem to open the first round of applications for the Cap & Floor scheme, a revenue support mechanism designed to back new long-duration electricity storage projects. The scheme, which opened in April 2025, marks a major step forward for the UK's PSH market. Several utilities and developers are now advancing project identification and development. Coire Glas reached a milestone in December 2024 with the completion of a £100 million exploratory works programme, including the drilling of a 1.2km tunnel in the Scottish Highlands. The 1.3GW project is expected to provide 30GWh of storage – enough to power three million homes for 24 hours. Progress is also underway on the 600MW Cruachan 2 project, with suppliers and a consulting firm appointed for the construction of the underground facility near Drax's existing plant in Scotland.



Interesting fact

The Valdecañas and Alcántara pumped storage projects represent a major enhancement to energy storage capacity on the Iberian Peninsula. With a combined capacity of 225GWh, equivalent to the output of approximately 5.5 million 40kWh electric vehicle batteries, they are expected to reduce CO_2 emissions by an estimated 555kt annually. The projects are projected to support around 4,300 jobs, both directly and indirectly. In addition to their role in supporting decarbonisation, the plants are expected to improve system flexibility, contribute to energy security and help stabilise electricity prices.

Europe

Top 5 Countries/region by capacity added in 2024

1 Türkiye 241MW

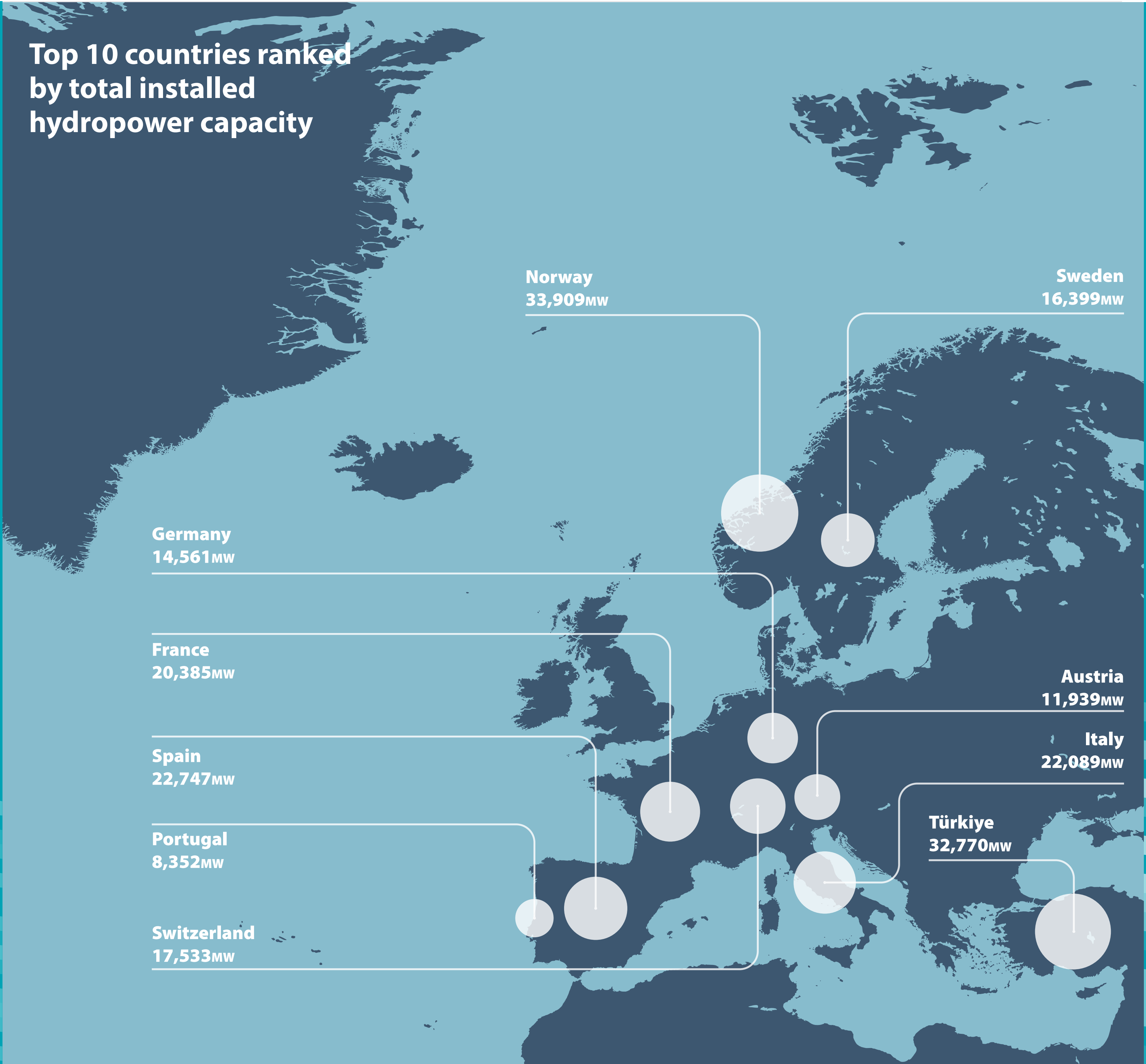
2 Portugal 160MW

3 Austria 118MW

4 Germany 63MW

5 Norway 53MW

Top 10 countries ranked by total installed hydropower capacity



Europe

Countries to watch

Key
- Low unexploited potential/minimal policy activity/limited project pipeline
- Moderate unexploited potential/some policy activity/intermediate project pipeline
- High unexploited potential/strong policy activity/large project pipeline

COUNTRY	UNEXPLOITED POTENTIAL	POLICY ACTIVITY	DEVELOPMENT PIPELINE
Türkiye	Opportunities remain in Türkiye to develop new conventional hydropower projects and expand existing facilities	The government has made hydropower a central pillar of its energy policy during the past two decades, providing substantial support for the development of new facilities.	A robust pipeline of conventional hydropower projects is progressing in the country, with nearly 600MW currently under construction.
Switzerland	While potential for new hydropower construction is limited in Switzerland, opportunities remain to expand storage capacity across the existing reservoir fleet.	A law introduced in 2023 streamlines approval processes for hydropower projects, supporting the national goal to add 2TWh of storage capacity by expanding existing infrastructure.	Owners of existing facilities are obliged to assess which of their assets should be upgraded before developing plans for modernisation.
Austria	There is substantial potential to expand Austria's existing PSH fleet.	The country's National Energy and Climate Plan emphasises renewable expansion and storage integration, identifying PSH as central to achieving long-term energy goals.	Austria has a strong pipeline of pumped storage projects, with approximately 1.3GW under construction and more than 2.8GW in early development stages.
United Kingdom	Scotland and Wales have significant potential for expansion of the PSH fleet, with numerous projects recently announced.	The introduction of the Cap & Floor scheme, designed to support long-duration electricity storage, is helping to revitalise the PSH market by providing clearer investment signals and indicating strong political commitment.	More than 13GW of pumped storage projects have been announced in the UK and are currently at various stages of development.
Spain	There is significant potential to expand Spain's pumped storage fleet, particularly through brownfield developments connecting existing reservoirs.	Spain's updated National Energy and Climate Plan has set an ambitious energy storage target of 22.5GW by 2030, up from 20GW, with pumped storage hydropower included among the key technologies.	Approximately 7GW of PSH projects have been identified in Spain, although only 300MW are currently under construction.
Italy	There is noticeable potential to expand Italy's PSH fleet, particularly through brownfield developments linking existing reservoirs.	Italy has introduced a new capacity mechanism (MACSE) to support the development of large-scale electricity storage solutions. National transmission operator Terna has been tasked with proposing changes to the rules governing pumped storage plant participation in the scheme.	The country has a PSH pipeline with a combined potential installed capacity of nearly 4GW.
Greece	Greece has significant potential to develop pumped storage through greenfield and brownfield projects, as well as by converting existing non-hydro infrastructure.	The country's National Energy and Climate Plan sets a target of 3GW of energy storage capacity by 2030.	Greece has more than 3GW of PSH projects in development, with approximately one third of this pipeline already under construction.

Africa

Generation by hydropower in 2024
167 TWh

Capacity added in 2024*
4,507 MW

Pumped storage capacity added in 2024
349 MW

Total installed capacity*
47 GW

Total pumped storage installed capacity
3,726 MW

*Includes pumped storage

Boston Hydro Project, South Africa
Credit: Serengeti Energy

Africa

Regional overview and outlook

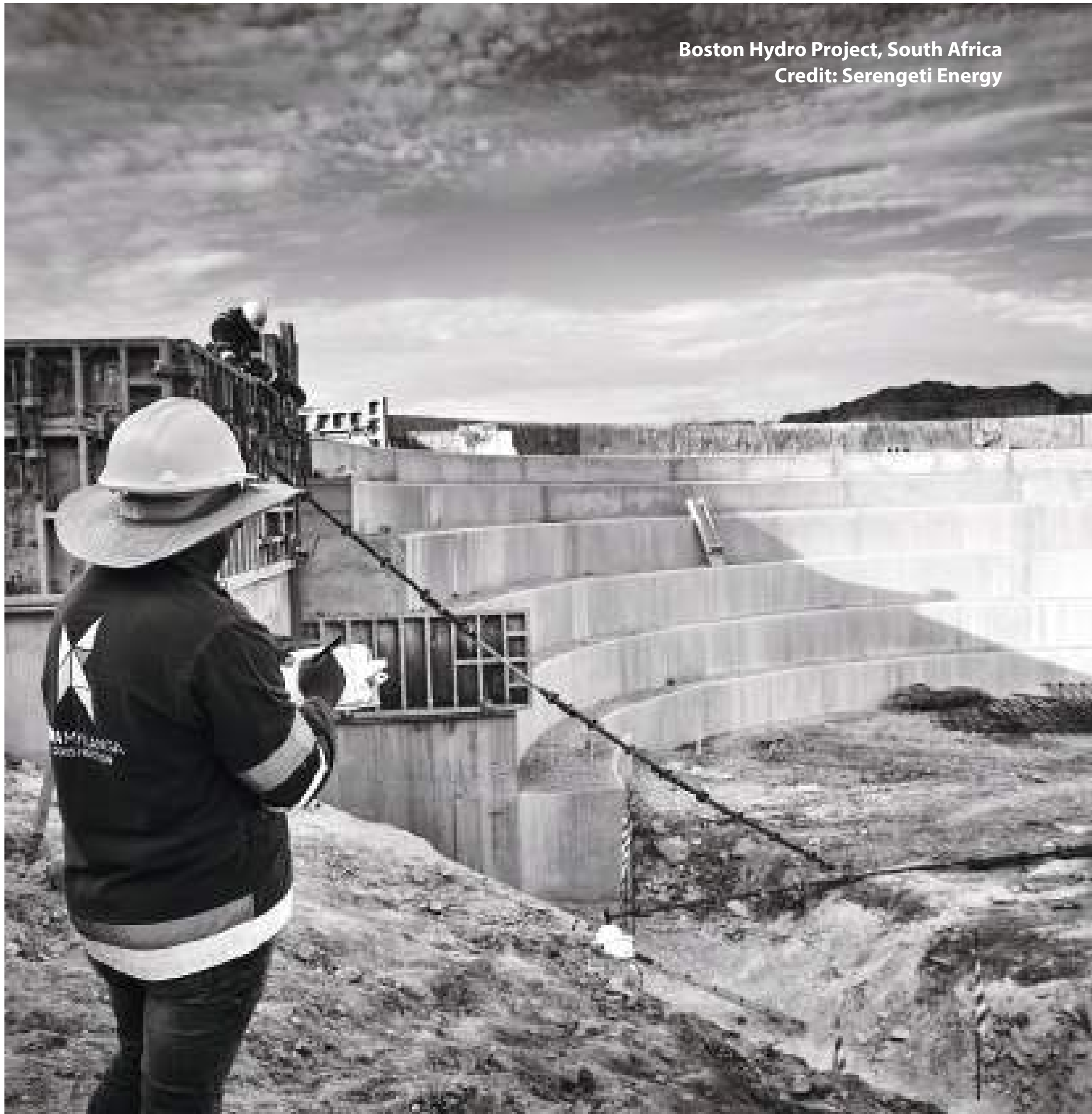
Hydropower's role in Africa's development is growing, but it starts from a low base. Approximately 10% of the continent's technical potential has been harnessed to date, yet the sector already delivers around 20% of electricity generation from a total installed capacity of 43.5GW of conventional hydropower. A new wave of projects, many led by private developers, is beginning to emerge, offering hope that hydropower will form the core of Africa's clean energy transition.

Several major projects reached key milestones in 2024. In Tanzania, the Julius Nyerere project began operations, with six of nine new 235MW units commissioned during the year. The Grand Ethiopian Renaissance Dam added 800MW with its third and fourth units, while Uganda's 600MW Karuma and Cameroon's 420MW Nachtigal plants were fully commissioned. Other large-scale schemes continue to face challenges, including the estimated near 50GW Grand Inga project in the Democratic Republic of Congo. The project faces significant hurdles, including financial constraints, governance concerns, and opposition from local communities. Despite this, the World Bank recently signalled renewed interest, starting with an initial 3–11GW tranche under the label of Inga III.

Smaller hydropower projects are proving more accessible to private investors than large developments, with notable progress seen in Burundi, Côte d'Ivoire and Eswatini. The International Finance Corporation and development partners are supporting new models for private-sector participation, including a programme to pre-develop concessions that would be auctioned to private delivery partners. This approach aims to streamline delivery by reducing the need for redesigns and renegotiations, potentially unlocking a new wave of privately financed projects across the continent.

Modernising existing assets is also a strategic priority. The African Development Bank has launched the Africa Hydropower Modernisation Programme, backed by an initial budget US$9.72 million. It will support the modernisation of 12 privately led projects in eight countries. IHA's assessment for the AfDB identified 4.6GW in high need of modernisation and a further 10.1GW in medium need, with upgrades expected not only to secure the production of these existing assets but also to bring 0.8GW of currently idle units back online and increase capacity by up to 1.6GW.

A major sustainability milestone was also achieved in 2024, when Zambia's 180MW Ngonye Falls Hydroelectric Project became Africa's first gold-certified project under the Hydropower Sustainability Standard.



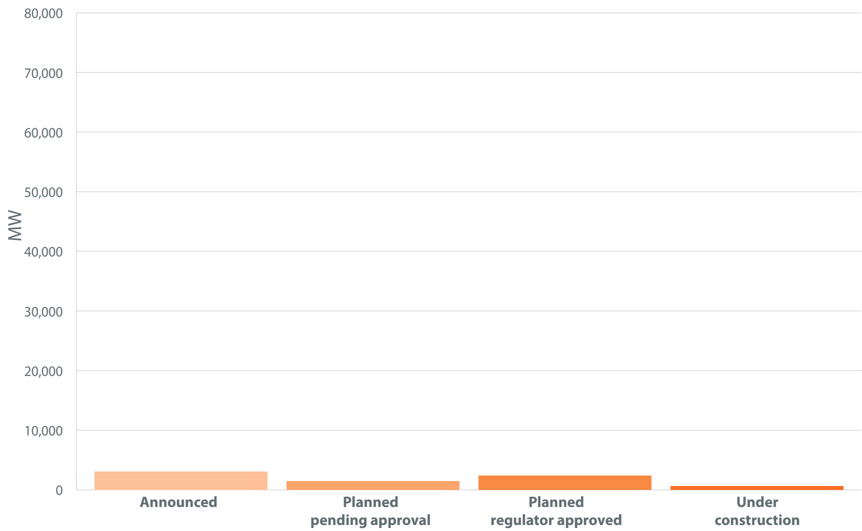
Boston Hydro Project, South Africa
Credit: Serengeti Energy

Policy and market overview

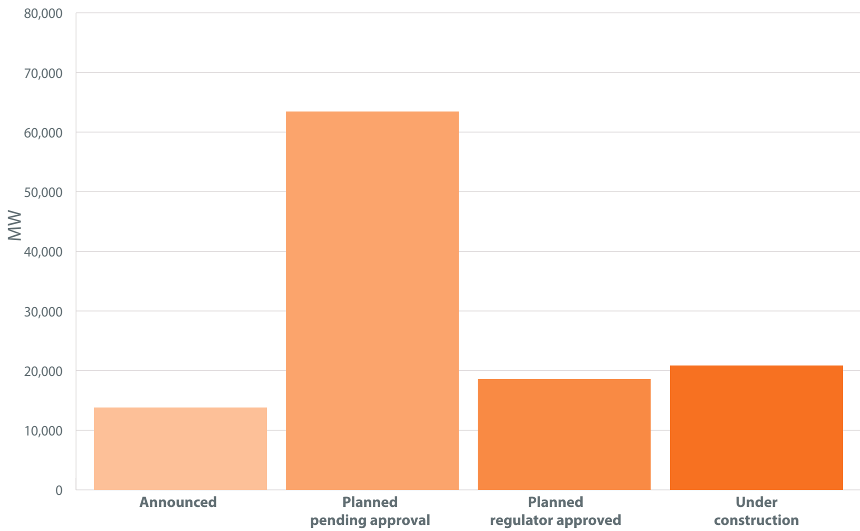
Africa has a significant pipeline of approved hydropower projects, but a key challenge remains reaching final investment decision (FID) and progressing to construction. More than 18.5GW of projects have secured approval but are not yet under construction. Combined with the 16GW currently being built, this pool alone could increase the continent's operational conventional hydropower capacity by nearly 80%.

However, several barriers continue to stall progress at the financing stage. These include offtake risk, high foreign exchange hedging costs, and persistent concerns among lenders regarding project bankability and risk exposure. Without targeted interventions, these constraints will continue to delay delivery.

To address these challenges, IHA coordinated the development of the Abuja Action Plan, launched at a high-level roundtable in Abuja, Nigeria in May 2024. The Plan outlines practical recommendations to de-risk projects, attract finance and accelerate delivery. If implemented, it could transform the investment landscape and secure the long-term future of hydropower in Africa.



Africa PSH pipeline



Africa Conventional pipeline

Key points of the Abuja Action Plan

- African governments are called on to recognise and champion sustainable hydropower as a clean, green, modern and affordable solution to provision of secure electricity supply.
- African governments are recommended to make clear long-term plans for the development of renewable energy, including targets for the development of hydropower.
- All actors are called on to recognise and reward hydropower's role as an enabler of variable renewable energies and prioritise this technology accordingly.
- All actors are urged to implement policies that support decarbonisation by advancing sustainable hydropower projects.
- Governments are encouraged to speed up permitting of projects, while also improving the quality of decisions.
- International Financing Institutions and Sustainable Development Funds are asked to support renewable energy infrastructure projects.
- All actors should support efforts to ensure appropriate grid infrastructure.
- All companies planning, constructing and operating hydropower projects in Africa should do so in accordance with international good practice as defined by the Hydropower Sustainability Standard.
- Governments are encouraged to support the commitment to good practice by expediting projects that are certified under the Standard.

Download the full publication here

Capacity expansion project, Kainji hydropower project, Nigeria
Credit: Mainstream Energy Solutions Limited

Latest developments by country

Angola

Angola's Luachimo hydropower station has been modernised and expanded from 8.8MW to 34MW. Commissioned in May 2024, the upgrade included four 8.5MW turbines, a diversion canal and new electrical infrastructure. The US$212 million project was led by China Gezhouba Group, which is also constructing the 2,172MW Caculo Cabaça plant, expected to be commissioned in 2026.

Burundi

Private finance has been secured for two small hydropower projects in Burundi – Upper Ruvyironza (1.65MW) and Upper Mulembwe (9MW) – which will increase national generation capacity by 10%. Backed by a US$35 million loan from the Trade and Development Bank, the projects will generate more than 62GWh annually. Songa Energy is developing both under Burundi's public-private partnership framework.

Cameroon
The country fully commissioned its 420MW Nachtigal run-of-river project in March 2025, boosting national supply by 30%. Developed by a five-member consortium headed by EDF, the plant will provide baseload power for 35 years. The 30MW Lom-Pangar project was also completed in 2024. Construction of the 500MW Kikot-Mbébé scheme is scheduled to begin in 2026.

Cape Verde
A 20MW/160MWh pumped storage project will soon be operational at Chão Gonçalves on Santiago Island, supported by a €60 million loan from the European Investment Bank. Due online in 2028, the plant will help reduce fossil fuel use by 22% and support the national goal of sourcing 54% of electricity from renewables by 2030.

Congo
Construction has begun on the 600–800MW Sounda hydropower plant in Congo, following a memorandum signed with China Overseas Corporation in September 2024. With a US$9.4 billion budget, the project is nearly four times the size of the country's current installed hydropower capacity. Completion is expected by 2030, significantly expanding national generation potential.

Côte d'Ivoire
Côte d'Ivoire commissioned the 112.9MW Gribo-Popoli plant in July 2024, part of a planned 508MW cascade on the Sassandra River developed by the state power company, CI-Energies, and built by PowerChina. The 44MW Singrobo-Ahouaty project on the Bandama River is also nearing completion and will supply peak power under the country's first privately financed hydropower model. Developed by Ivoire Hydro Energy with Themis Group, the project won IJ Global's Power Deal of the Year and was backed by a €40 million loan from the African Development Bank.

Democratic Republic of the Congo
Two 200MW hydropower projects are progressing in the DRC. On the Lufira River, Kipay Investments SAS and Afreximbank are partnering on technical, legal and financial preparation for the country's first private renewable energy project. On the Lualaba River, Nzilo II will supply power to China-based mining firm CMOC, complementing solar generation at night. While the 44GW Grand Inga project remains in the planning stage, a US$22.1 million substation upgrade at Inga I and II is already improving grid stability and reducing energy losses.

Egypt
The Egyptian authorities have completed feasibility studies for two 1,000MW pumped storage projects in Luxor and Qena, with investment expected to reach US$2.5 billion. Both projects would use Nile water and are planned for private-sector development, though a timeline has not been confirmed. Meanwhile, the government is preparing to relaunch the tender process for the 2.4GW Ataqa Mountain PSH project, which uses treated wastewater, after initial financing efforts by Sinohydro were unsuccessful.

Eswatini
Construction has begun on Eswatini's first privately financed hydropower project following financial close in February 2025. The 13.5MW Lower Maguduza project is being developed by African Clean Energy Developments, with African Infrastructure Investment Managers and the Eswatini Public Service Pensions Fund as shareholders. The US$62.4-67.6 million scheme is backed by Standard Bank, with Zutari Eswatini overseeing construction on behalf of the project owners. Construction is expected to take 25 months.

Ethiopia
Ethiopia has commissioned the third and fourth units of the Grand Ethiopian Renaissance Dam in 2024, adding 800MW to the grid. Construction is nearly complete, with full capacity set to reach 5,150MW. Ethiopian Electric Power is also progressing with three major projects – Genale Dawa 5 (100MW), Geba Stage 1 and 2 (371MW), and Halelle Werabesa Stage 1 and 2 (422MW) – with African Development Bank support for technical studies.

Liberia
The World Bank has approved US$45 million for Liberia's Renewable Energy Solar Power Intervention Project (RESPITE), which will expand Mount Coffee hydropower plant from 88MW to 129MW and fund a 20MW solar facility – Liberia's first utility-scale solar project. A feasibility study is also underway for a potential 150MW hydropower plant upstream on the St Paul River.

Madagascar
Agreement has been reached on the 120MW Volobe II run-of-river project, clearing the way for financial close and construction. The €350 million plant will increase national generation capacity by approximately 20% and deliver 750GWh annually. Developed by CGHV – a consortium including Jovena, Scatec, Africa50 and Colas –Volobe II is expected to begin operation in 2028, subject to

construction timelines.

Mozambique

A draft energy transition strategy suggests authorities are considering 14,000MW of new hydropower in Mozambique, mainly from the Zambezi River, with 9,000MW to be added between 2030 and 2040. The plan builds on Cahora Bassa (2,075MW) and the under-construction 1,500MW Mphanda Nkuwa. It also outlines green industrial development and grid expansion, while controversially proposing to end power exports to South Africa after 2030.

Namibia

Namibia and Angola have signed an implementation agreement for the 600MW Baynes hydropower project on the Kunene River, which forms the border between the two countries. Output will be shared equally, and the site will also improve grid links between the two countries and support electricity exchange across the Southern African region. The plant is expected to operate during periods of intermediate and peak demand, helping to reduce reliance on costly imports.

Rwanda

Progress continues on the 206MW Ruzizi III Regional Hydropower Project, which will supply electricity equally to Rwanda, Burundi and the Democratic Republic of Congo. Developed as a public–private partnership, the project aims to finalise agreements with all stakeholders and financiers by September 2025. Construction would then begin, with commissioning scheduled for 2030.

Tanzania

East African power generation received a major boost in 2024 with the commissioning of six turbines at Tanzania's Julius Nyerere Hydropower Plant. The 2,115MW facility on the Rufiji River comprises nine 235MW turbines and is designed to supply Tanzania, Kenya, Uganda and Zambia. The US$2.9 billion project is expected to enhance regional grid stability and cross-border electricity access.

Uganda

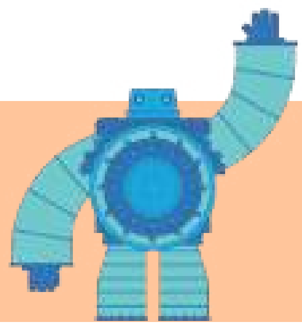
Uganda has fully commissioned the 600MW Karuma hydropower project, raising national generation capacity to 2,000MW. Built by Sinohydro, the US$1.7 billion plant was largely financed through loans from the Export-Import Bank of China, which provided US$1.4 billion. Uganda is now seeking funding for three additional Nile River projects – Ayago (840MW), Kiba (400MW) and Oriang (392MW) – which will boost capacity by a further 80%.

Zambia

Severe drought has reduced generation at the Kariba hydropower station, causing power cuts of up to 21 hours a day in both Zambia and Zimbabwe. While emergency measures are in place, Zambia is exploring new supply options, including raising solar to 30%, expanding hydropower in the wetter north, and controversially advancing coal projects that could worsen climate-related drought.

Interesting fact

Ethiopia's Grand Renaissance Dam (GERD) exceeded expectations in its first 10 months of operation, generating over 2,700GWh of electricity – 26% more than projected. This performance, driven by improved water management and efficient turbine operation, already makes GERD responsible for around 16% of Ethiopia's electricity generation. With two turbines currently active and 11 more planned, the dam is on track to become one of Africa's largest sources of renewable power and a future pillar of regional energy exports.

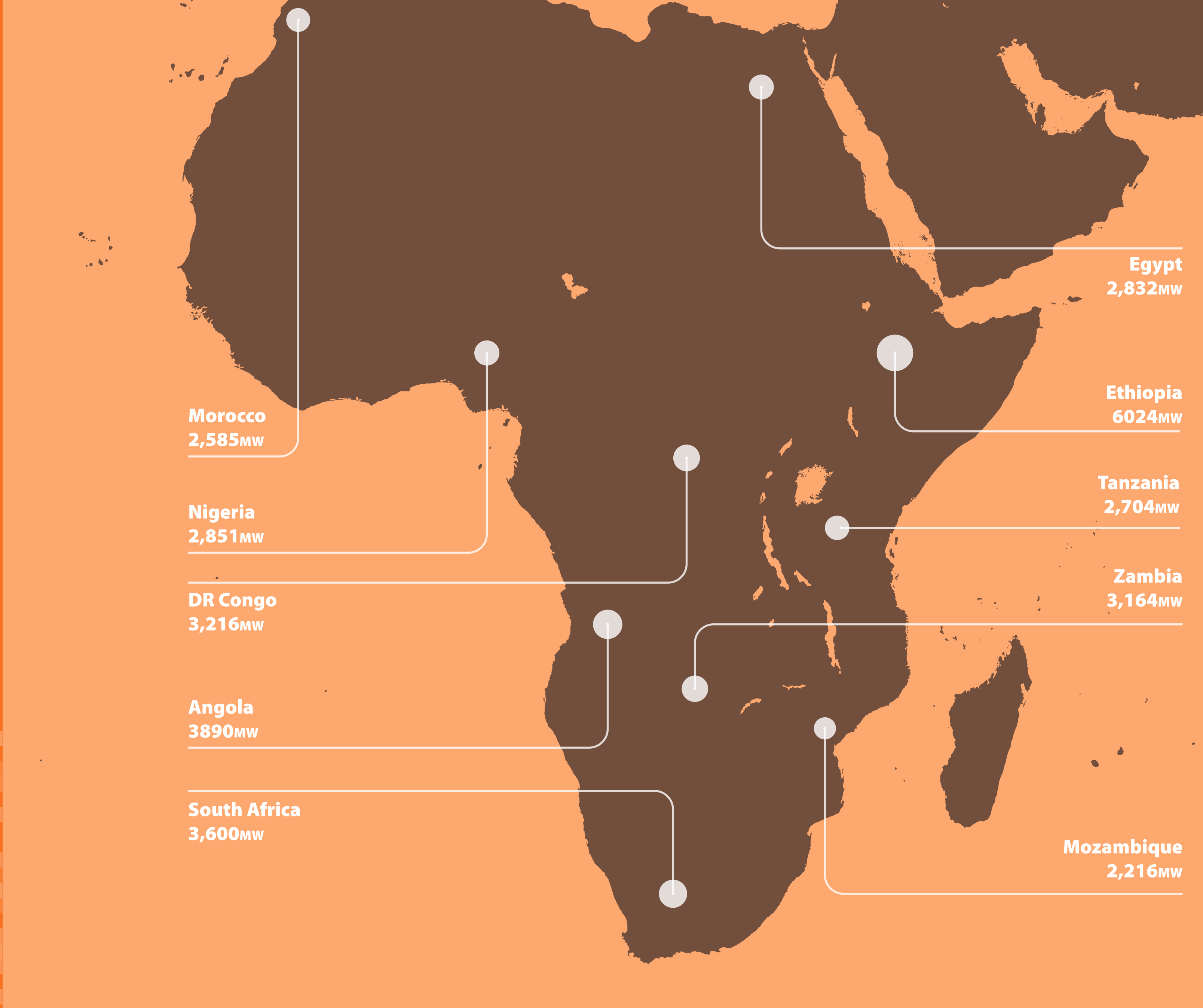


Africa

Top 5 Countries/region by capacity added in 2024

1. Tanzania 1,880MW
2. Ethiopia 1,200MW
3. Uganda 605MW
4. Morocco 349MW
5. Cameroon 300MW

Top 10 countries ranked by total installed hydropower capacity



Africa

Countries to watch

Key
Low unexploited potential/minimal policy activity/limited project pipeline
Moderate unexploited potential/some policy activity/intermediate project pipeline
High unexploited potential/strong policy activity/large project pipeline

COUNTRY	UNEXPLOITED POTENTIAL	POLICY ACTIVITY	DEVELOPMENT PIPELINE
Nigeria	Nigeria has considerable hydropower potential of over 14GW, especially in central and northern regions. Only about 15% of this capacity has been utilised.	Nigeria has launched the Sustainable Power and Irrigation Project, aiming to unlock 10,000MW of hydropower capacity by utilising existing dams and developing new projects.	Nigeria has a handful of mid-to-large projects under construction, like Mambilla (3,050MW), and many in approval stages.
Democratic Republic of the Congo	The DRC holds undeveloped hydropower reserves, notably along the Congo River. It potential of around 100GW (almost 13% of the world's total), but less than 3% of this capacity is exploited.	The DRC government is taking steps to exploit more of its hydro potential, through international partnerships and regional initiatives. It aims to reform its power sector to attract further investment.	Some smaller projects are in construction, but Inga III (4,800MW) is at the regulatory stage and the mega-project Grand Inga (44,000MW) is awaiting regulator approval and financing.
Mozambique	Mozambique has hydropower resources, particularly in the Zambezi River basin. The country's technically feasible hydropower potential is more than 12,000MW, of which only around 20% has been exploited.	The government is actively pursuing large hydro expansions through public-private and regional initiatives. Policy measures, like a feed-in tariff to encourage small hydro investments, and efforts to attract foreign partners are in place to integrate new hydropower, both for domestic use and export.	Mphanda Nkuwa (1,500MW) is under construction, supported by several regulator-approved mid-sized projects.
Ethiopia	Ethiopia boasts economically feasible hydropower potential of approximately 45GW. The country aims to harness a significant portion of this capacity to become a major power exporter in the region.	Hydropower is the backbone of Ethiopia's energy strategy with plans to become a regional electricity export hub by 2030. The government has proactively built dams for domestic supply and exports, achieving around 4.3GW hydro installed and 6.6GW under construction. It is opening the sector to independent power producers.	The country has a broad and active pipeline including multiple large projects under construction, such as Koysha (1,800MW) and the Grand Ethiopian Renaissance Dam (5,150MW).
Cameroon	Cameroon's economically exploitable hydropower potential is estimated around 12,600MW, with major potential in the Sanaga and Lom rivers. Only about 4% of this potential has been developed.	Cameroon has developed a National Water Policy and hydropower expansion is integral to its long-term development vision, Emergence 2035. The strategy is to use hydropower for energy access and become a regional power exporter, while ensuring new projects align with environmental and social standards.	Multiple large-scale projects are under construction, like Nachtigal Falls (420MW) and Grand Eweng (1,800MW), with several more regulator approved.
Morocco	Morocco already utilises PSH but is expanding further. The Office National de l'Electricité et de l'Eau Potable (ONEE) has mapped out around 1,606 potential PSH sites, with over 36% deemed highly suitable.	The country has integrated PSH into its renewable energy strategy, aiming for 52% of electricity generation from renewables by 2030. ONEE is advancing PSH projects to support its renewable energy targets.	Morocco has a robust pipeline with three PSH projects totalling nearly 1,000MW, including the operational Abdelmoumen project (350MW), and two projects under construction: Ifahsa (300MW) and El Menzel (300MW).
South Africa	The Department of Water and Sanitation has identified seven sites for potential PSH schemes, aligned with coal phase-out zones.	South Africa supports expansion of PSH to enhance grid stability and integrate renewable energy. Eskom, the national utility company, operates existing PSH schemes and is developing other projects, a priority under the Infrastructure South Africa Programme.	The 1,500MW Tubatse project has been announced with international interest.

South and Central Asia

Generation by hydropower in 2024
564 TWh

Capacity added in 2024
4,012 MW

Pumped storage capacity added in 2024
0 MW

Total installed capacity*
166 GW

Total pumped storage installed capacity
7,711 MW

Kairakkum hydropower project, Tajikistan
Credit: TGEM

Regional overview and outlook

South and Central Asia is making progress on regional cooperation, which is increasingly considered a cornerstone of energy development. In 2024, a series of cross-border agreements and partnerships underscored the region's commitment to shared energy security, economic integration and the development of low-carbon power systems, with hydropower playing a central role. In certain circumstances, governments are deepening cooperation on electricity trade, joint infrastructure projects and the integration of energy markets, recognising that transboundary collaboration is essential to managing water resources and balancing seasonal demand across borders.

In April 2024, Kyrgyzstan, Uzbekistan and Kazakhstan announced plans to import electricity from Azerbaijan. In May, the Energy Ministers of Azerbaijan, Uzbekistan and Kazakhstan signed a Memorandum of Understanding (MoU) to merge their energy systems and expand green energy exports between the countries. Subsequently in 2024, the Deputy Minister of Energy for Uzbekistan announced that Uzbekistan, Kyrgyzstan and Tajikistan would create a central electricity trade agreement, based on the draft "Roadmap of the Regional Electricity Market (ECO)" presented by the United Nations Economic Commission for Europe.

Electricity cooperation was further strengthened by the Russian Senate's ratification of an agreement enabling the parallel operation of energy systems with Kazakhstan. This growing regional alignment was reinforced through regular coordination between water and energy authorities in Kazakhstan, Kyrgyzstan and Uzbekistan. These meetings focused on ensuring stable cross-border energy and water flows during the critical autumn–winter period and advancing joint hydropower initiatives.

After decades of conflict, Kyrgyzstan and Tajikistan reached a landmark agreement to recognise their shared border and deepen cooperation. This included a bilateral arrangement ensuring mutual access to water and energy facilities. Regional collaboration expanded further, with Kazakhstan and Kyrgyzstan agreeing to a roadmap for the construction of small hydropower plants.

Bhutan and India are also scaling up joint hydropower efforts. Druk Green Power Company and Tata Power revived plans to develop the 600MW Kholongchhu project, which features a stream diversion to harness the Jablangchhu stream. In a separate agreement, India's Reliance Group committed to developing the 770MW Chamkharchhu-1 scheme. Meanwhile, Druk Green Power Corporation and the Adani Group signed a Memorandum of Understanding to support up to 5GW of new capacity, building on existing collaboration at the Wangchhu project.

Efforts to enhance regional electricity connectivity made progress with the commissioning of the Datka–Sughd transmission line, a key milestone for the CASA-1000 project linking Kyrgyzstan and Tajikistan. The full 500kV transmission corridor is expected to be operational by 2027.

Major project completions in the region included the commissioning of the first four units of the 1,020MW Punatsangchhu II project in Bhutan and the full operation of Pakistan's 884MW Suki Kinari facility. These assets strengthen energy security across South and Central Asia and mark growing momentum in large-scale hydropower development.

Rioni hydropower project, Levan Ioseliani, Georgia
Credit: Energo-Pro

Policy and market overview

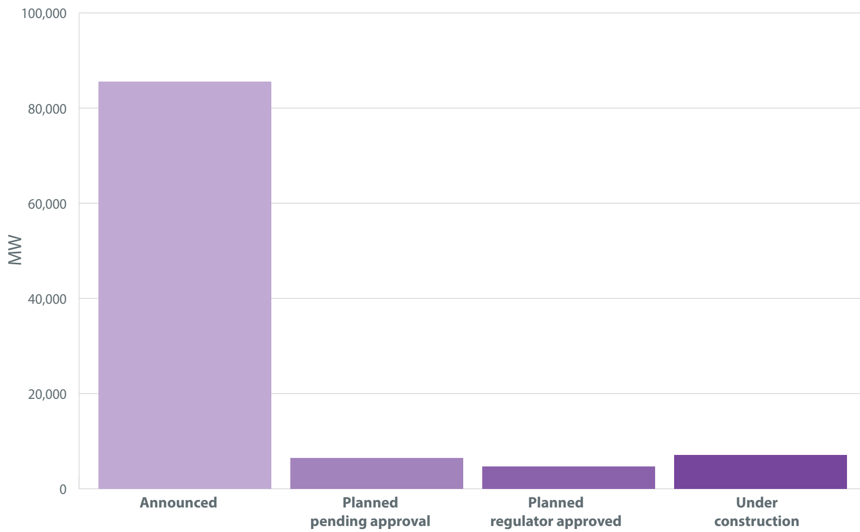
Climate volatility, resource competition and transboundary tensions continue to affect the pace and resilience of hydropower development across South and Central Asia.

Prolonged drought has reduced reservoir levels and generation capacity in several countries, and especially those bordering the Caspian Sea. In Tajikistan, over 1,000 glaciers have disappeared over the past three decades, contributing to reduced flows and forced electricity rationing in 2024. Sri Lanka reported hydropower assets operating at just 20% capacity in early 2025. In Iraq, hydropower output was severely constrained and the Dukan Dam halted generation due to lack of rainfall.

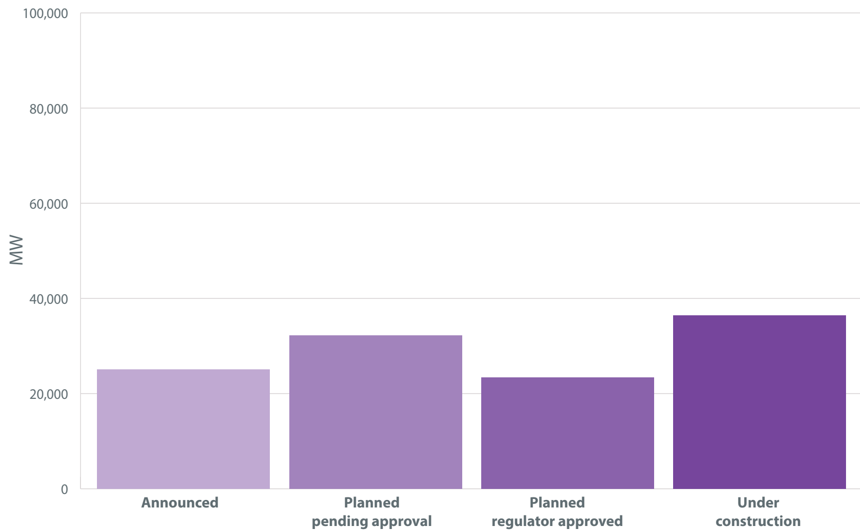
The region faces rising scrutiny over hydropower risk exposure to extreme weather events. In September 2024, flooding and landslides in Nepal affected 20 plants and reduced electricity production by at least 1.1GW. Sikkim's 510MW Teesta V station was damaged by a landslide in August 2024, adding to recent concerns following the destruction of Teesta VI by a glacial lake outburst. The collapse of a dam near Orsk, Russia, in April 2024 due to heavy rains led to severe flooding along the Ural River, affecting downstream infrastructure in Kazakhstan. The incident sparked investigations, evacuations and extensive economic damage on both sides of the border.

India–Pakistan relations over the Indus Treaty deteriorated in Kashmir in early 2025. The situation demonstrates water's critical role in regional diplomacy. Proposed hydropower projects on disputed rivers elsewhere on the continent have further highlighted the importance of dialogue on transboundary water cooperation for the region. Iraq faces declining flows in the Tigris and Euphrates. However, there are ongoing negotiations with the upstream states of Türkiye and Iran on water-sharing agreements.

As the region faces growing challenges from climate extremes and political uncertainty, hydropower can play a pivotal role in strengthening water and energy resilience. By supporting integrated infrastructure planning and fostering cross-border cooperation, it offers a pathway to both sustainable development and regional stability.



South and Central Asia PSH pipeline



South and Central Asia Conventional pipeline

Latest developments by country

Afghanistan

Afghanistan's planned 285km Qosh-Tepa canal could divert up to 20% of the Amu Darya's flow, raising concerns in Uzbekistan and Turkmenistan; and in early 2025 Uzbekistan called for further dialogue. In 2024 heavy rains and snow caused severe flooding, destroying over 250 homes and damaging farmland over an extensive area.

Armenia

Armenia reported year-on-year growth in small hydropower in 2024, reaching 190 plants with a combined capacity of 402MW. An additional 59MW is under construction. Overall electricity generation rose by 6.5%, with hydropower contributing to the increase.

Azerbaijan

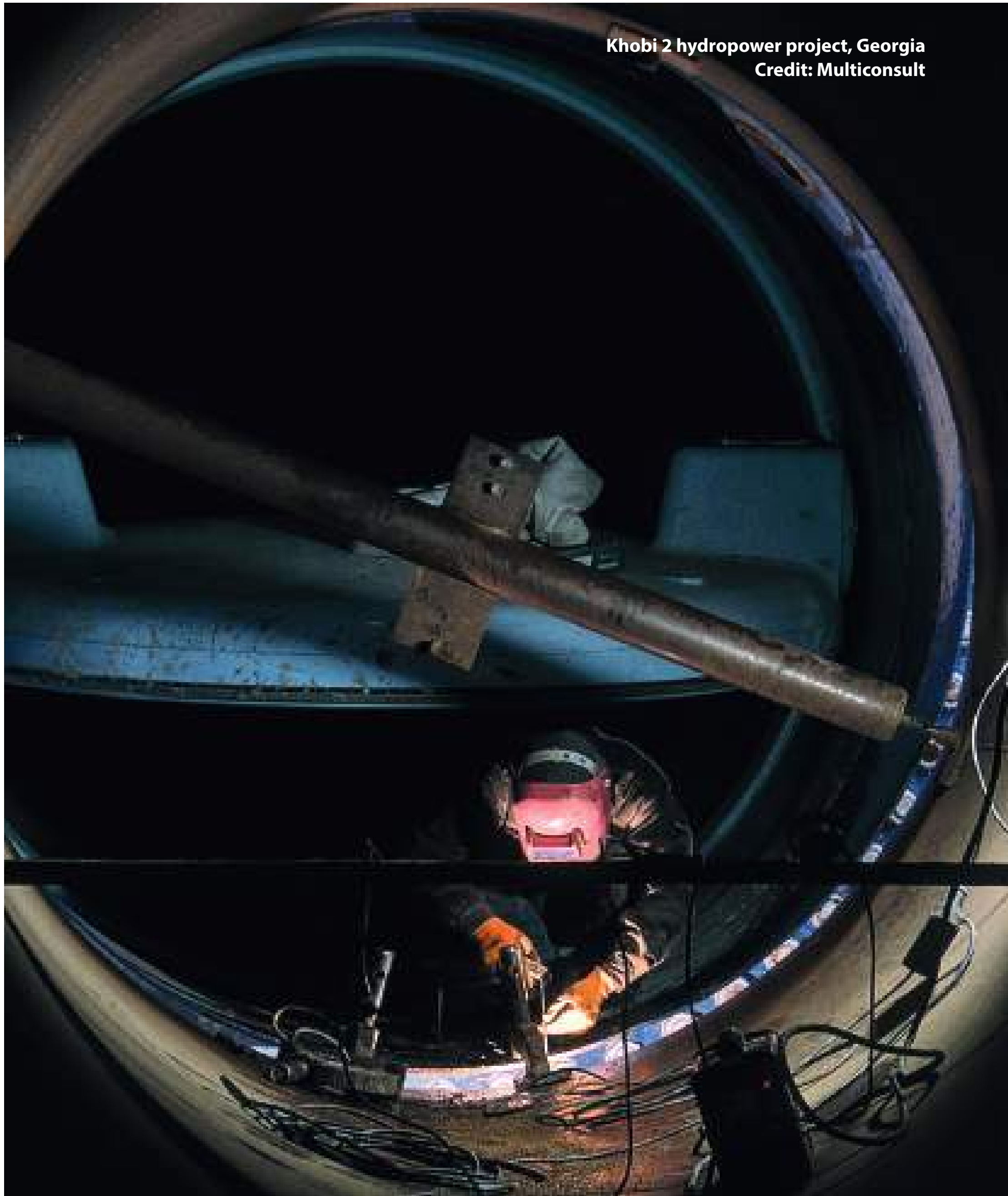
In 2024, Azerbaijan hosted COP29 with a focus on climate finance. Ahead of the summit, the government signed a memorandum of understanding with two Chinese companies to support the development of PSH and high-voltage transmission infrastructure.

Bhutan

In 2024, Bhutan's Electricity Regulatory Authority released its Strategic Plan and licensed the 118MW Nikachhu project. The first two turbines at the delayed 1,020MW Punatsangchhu II project came online in July 2024. Bhutan is also developing a US$830 million climate investment adaptation plan. Bhutan confirmed the European Investment Bank would provide €150 million in loans for 310MW at hydropower and solar projects, alongside ongoing dialogue with the World Bank to address a US$600 million finance gap for Bhutan's hydropower projects.

Georgia

The Georgian Economy Ministry has indicated that it is targeting 10GW of electricity generation by 2032 and that the share of hydropower will rise from 50% to 74% by that year. In 2024 the 44.5MW Khobi-2 hydropower project was commissioned, and the 22.4MW Kaspi Hydro Power Plant was announced and is set to be built on the Mtkvari River in the Kaspi Municipality.



Khobi 2 hydropower project, Georgia
Credit: Multiconsult

India

India is rapidly emerging as a global leader in PSH. It aims to add 51GW of PSH by 2032. To support India's storage targets, the Central Electricity Authority (CEA) has accelerated project approvals for six major projects totalling 7.5GW in 2024/25 and plans to approve at least 13 more projects (22GW) in 2025/26.

As of early 2025, approximately 44.5GW of pumped storage projects are at various stages of development. Three private players – Greenko, Adani Green, and JSW Energy – are poised to develop nearly two-thirds of the country's planned 51GW PSH capacity by 2032. Greenko will commission the 1.68GW Pinnapuram project – its first PSH plant – in September 2025, while Adani Green's 500MW Chitravathi project is slated for commissioning in 2027. Elsewhere in the country:

- In Madhya Pradesh, construction has begun on the 1.92GW Gandhisagar pumped storage project, with commissioning scheduled for June 2028. The 640MW Indira Sagar project is currently in the early stages of development.
- In Karnataka, the 2GW Sharavathy pumped storage project is under construction and is expected to be commissioned in December 2029. The 300MW Narihalla project is also in its early development phase.
- In Odisha, construction has started on the 600MW Upper Indravati project, following detailed project report (DPR) approval. In parallel, preliminary investigation work has commenced for the 500MW Balimela project.
- In Tamil Nadu, early-stage development is underway for the 1GW Upper Bhavani pumped storage project.
- In Gujarat, development is progressing on two projects: the 300MW Juni Kayaliwel project and the 300MW Amalpada project. Both projects have signed memoranda of understanding (MoUs).
- In Uttar Pradesh, the 1.5GW Panaura project has been identified as one of 33 potential pumped storage sites under evaluation in the state.
- In Maharashtra, construction has begun on the 1GW Bhivpuri and 1.5GW Bhavali projects, following DPR approvals in 2024–25. The 1.5GW Tarali and 1.8GW Shirwata projects are in the early development phase. Additionally, Maharashtra is advancing two 2GW pumped storage projects – Ghosla and Kamod – under a signed MoU with Megha Engineering & Infrastructures Ltd, with both projects expected to be completed by 2030.
- In Kerala, REC Limited has signed a memorandum of understanding to finance US$2.1 million in the pumped storage sector over the next five years. The state's Energy Management Centre has identified several viable sites and is conducting pre-feasibility studies, with the most promising projects to be selected for detailed feasibility reports.

In addition to India's support for PSH, conventional hydropower projects continue to progress, including major works completed on the 2GW Subansiri Lower hydroelectric project.

Rogun hydropower plant, Tajikistan
Credit: TGEM

South and Central Asia

Iran

Iran's hydropower output increased year-on-year in 2024, supported by strong rainfall and spring run-off that brought many reservoirs to 90% capacity. Sardasht and Darian plants recorded exceptional generation, with Darian exceeding 104% of its previous year's output by October 2024. By early 2025, spring rains caused Karun 4 and Rudbar Lorestan dams to reach full capacity. Iran's Minister of Energy called for accelerated pumped storage development, expediting construction of Karun II, upgrades to existing plants at Siah Bisheh, and greater youth engagement in the sector. Four small and medium projects were approved in July 2024, alongside ongoing major electricity market reforms on pricing and market structure.

Iraq

Iraq's President Abdul Latif Rashid called for urgent action on desertification, citing the increasing frequency of droughts and their impact on hydropower assets. He noted that nearly 40% of Iraq's land is affected, with water resources under severe strain. According to Environment Minister Helo Al-Askari, Iraq is making progress on its climate targets and emphasising a transition to sustainable energy sources, including hydropower.

Kazakhstan

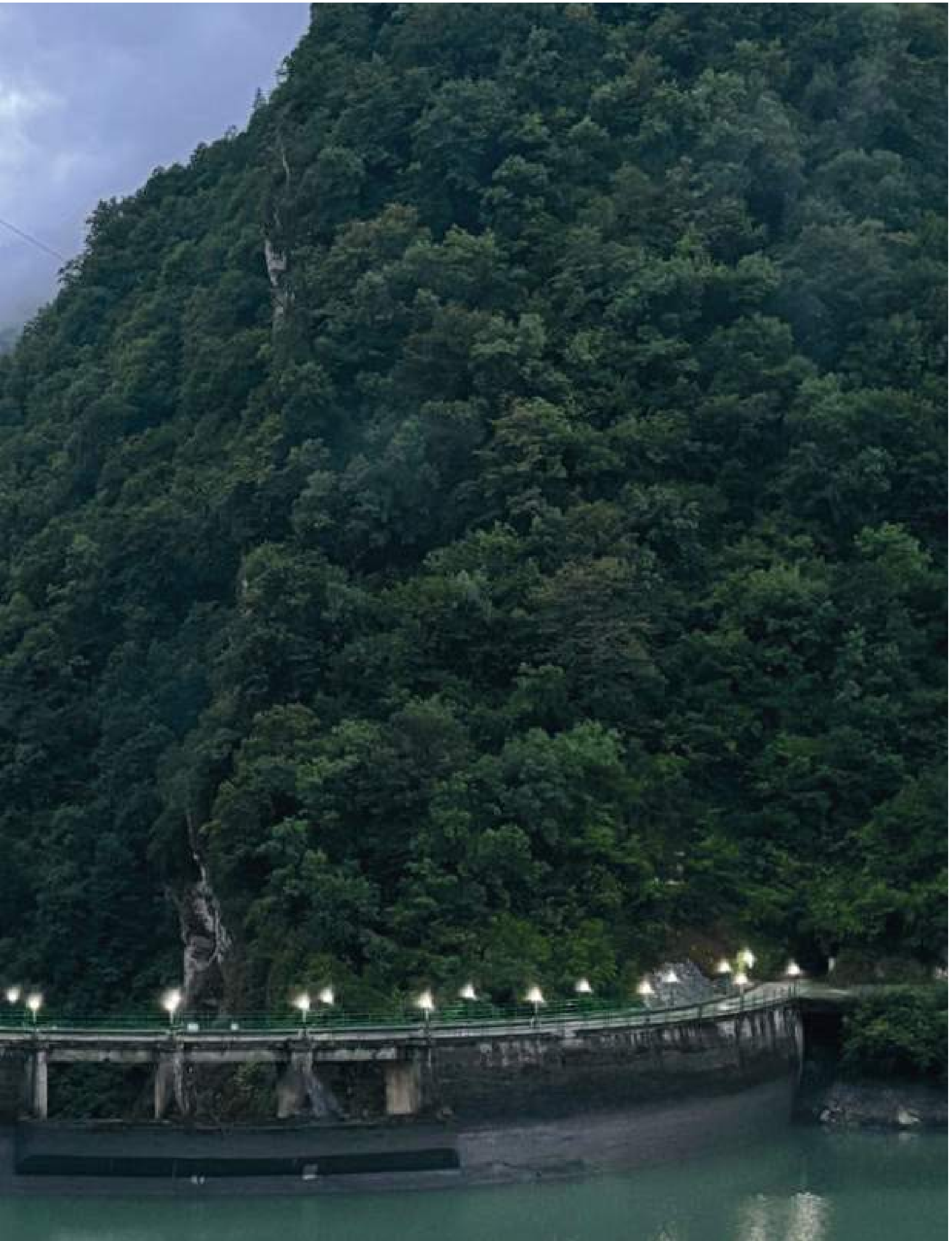
At the start of 2024, Kazakhstan announced plans to add 26GW of new generating capacity, including 600MW of hydropower by 2027–28. A national programme to modernise energy and communal infrastructure was also approved. Renewable electricity output, including small hydropower, increased into early 2025. In November 2024, 200MW of small hydropower was procured through auctions (7.3¢/kWh) followed by a second auction for 100MW at competitive pricing.

Kyrgyzstan

In 2024, Kyrgyzstan marked 50 years of Toktogul, the country's largest hydropower plant, which is now undergoing upgrades to increase capacity from 1.32GW to 1.38GW and extend its lifespan by 30 years. President Japarov inaugurated the 25MW Bala-Saruu plant which was completed in three years. A 1,305MW Suusamyr-Kokomeren cascade was announced in partnership with the China National Electric Engineering Co. The World Bank approved US$13.6 million to update feasibility and environmental plans for Kambarata-1.

Kyrgyzstan's government announced in 2024 that small hydropower will reach 405MW by 2027, with 18 new plants to be commissioned in 2025. Kulanak HPP (100MW) is due to be commissioned

Lajanuri hydropower project, Georgia
Credit: Energo-Pro



in 2026, and Kambarata-2 began early commissioning in 2025.

Nepal

At the start of 2025, Nepal's Supreme Court ordered a halt to development activities – including hydropower – within all protected areas. The ruling covers 12 national parks, six conservation areas, one hunting reserve, one wildlife reserve and 13 buffer zones. The Independent Power Producers' Association of Nepal noted the decision could affect nearly 300 hydropower projects and up to 20GW of potential capacity.

Meanwhile, support for large-scale projects continues. India's Renewable Energy Development Agency will invest in the 900MW Upper Karnali project, acquiring a 10% stake alongside its partnership with SJVN Limited. US-based BG Titan Group signed an MoU to develop the 650MW Tamakoshi 3 project. The UK's British International Investment (BII) also agreed a trade loan to support Nepal's renewable energy and manufacturing sectors, including hydropower.

Pakistan

Pakistan aims to expand hydropower to 20GW by 2030. In 2024, the 884MW Suki Kinari run-of-river project became fully operational on the Kunhar River under the China–Pakistan Economic Corridor. The World Bank approved US$1 billion for the Dasu project, while encouraging acceleration. The excavation of Dasu's foundation continued with the aim of completing the 4,320MW asset by 2027. Kuwait Fund for Arab Economic Development announced a loan of US$24 million to support the 800MW Mohmand project. Tarbela's 5th Extension is set to boost capacity from 4,888MW to 6,418MW by 2026. The 4.2MW Nai Gaj Dam construction began in 2024. Pakistan's major reservoirs recorded cumulative water storage which surpassed the five-year average in August 2024.

Russia

Russia's hydropower generation rose by 4.9% year-on-year in 2024. In early 2025, however, low snowmelt led to earlier-than-usual filling of the Volga-Karma hydropower cascade, highlighting growing hydrological variability.

In 2024, the Russian Ministry of Energy unveiled its Energy Strategy to 2050, which was approved in April 2025. The strategy targets a 17% increase in hydropower generation from 2023 levels and includes 7.8GW of new hydro and pumped storage capacity in Siberia and the Far East.

As part of the Unified Electricity System Operator's plans for grid modernisation through 2042, a new digital system

– SPDM – has been introduced to automate hourly balancing and enhance grid reliability. RusHydro's modernisation programme added 33.5MW of capacity in 2024 across Ust-Srednekanskaya, Ezminskaya, Nizhny Novgorod, Votkinskaya, Saratov, Volzhskaya and Cheboksary. Upgrades are also ongoing at the Uglich, Volzhskaya, Saratov and Nizhny Novgorod hydropower plants.

Sri Lanka

The 126MW Uma Oya project was inaugurated in April 2024 by the presidents of Sri Lanka and Iran. It will supply 290GWh annually and support irrigation. Sri Lanka is also progressing with its first 600MW pumped storage project, Maya Oya, as the Ceylon Electricity Board seeks long-term international funding to maintain affordable electricity tariffs for consumers.

Tajikistan

Tajikistan aims to reach 100% renewable energy by 2032, with more than 90% already sourced from hydropower. The National Water Strategy, adopted in late 2024, supports climate and development goals through 2040. Meanwhile, nearly US$1 billion funding has been secured for the Rogun Hydropower Project, including loans and grants from the World Bank, AIIB, OPEC and the Islamic Development Bank. An additional US$19 million in state funding from the Government of Tajikistan has also been allocated.

The country's electricity exports totalled US$82.3 million in 2024 as grid upgrades continue with a €20 million EBRD grant. Modernisation of units at the Nurek and Qayroqqum (Kairakkum) hydropower projects were completed in 2024. The President announced the creation of a new oversight agency for energy.

Russia and Tajikistan signed a cooperation agreement on the operation of the 670MW Sangtuda hydropower project, the second largest currently in operation in Tajikistan.

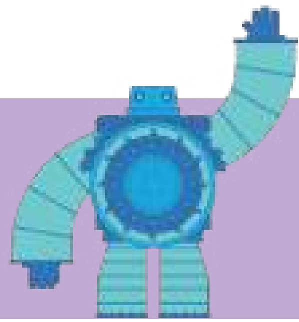
Uzbekistan

Uzbekistan declared 2025 the "Year of Environmental Protection and Green Economy" and the Government indicated Uzbekistan has 10GW of hydropower potential and plans to reach 6GW by 2028. To support this goal, state-owned power utility Uzbekhydroenergo aims to attract US$6.5 billion to build 140 plants. Hydropower generation rose 20% in 2024, supported by the modernisation of the Naryn cascade. In July 2024, the Senate approved the Law on Electric Power industry and the ADB approved US$400 million for policy reforms to the market-led power sector.

President Mirziyoyev announced plans to increase private investment in green energy and to build nearly 3,000 micro-hydro plants which will add over 160MW by 2026, of which more than 1,000 plants will be commissioned in 2025. Zarchob-1A HPP was commissioned on the nation's independence anniversary.

Interesting fact

In 2024, hydropower accounted for approximately 14% of Azerbaijan's total electricity generation, reflecting a significant rebound in output. Generation from hydropower plants reached 3.01TWh, marking a 71% year-over-year increase compared to 1.76TWh in 2023. This surge highlights hydropower's growing contribution to the country's renewable energy mix and its role in diversifying electricity sources.

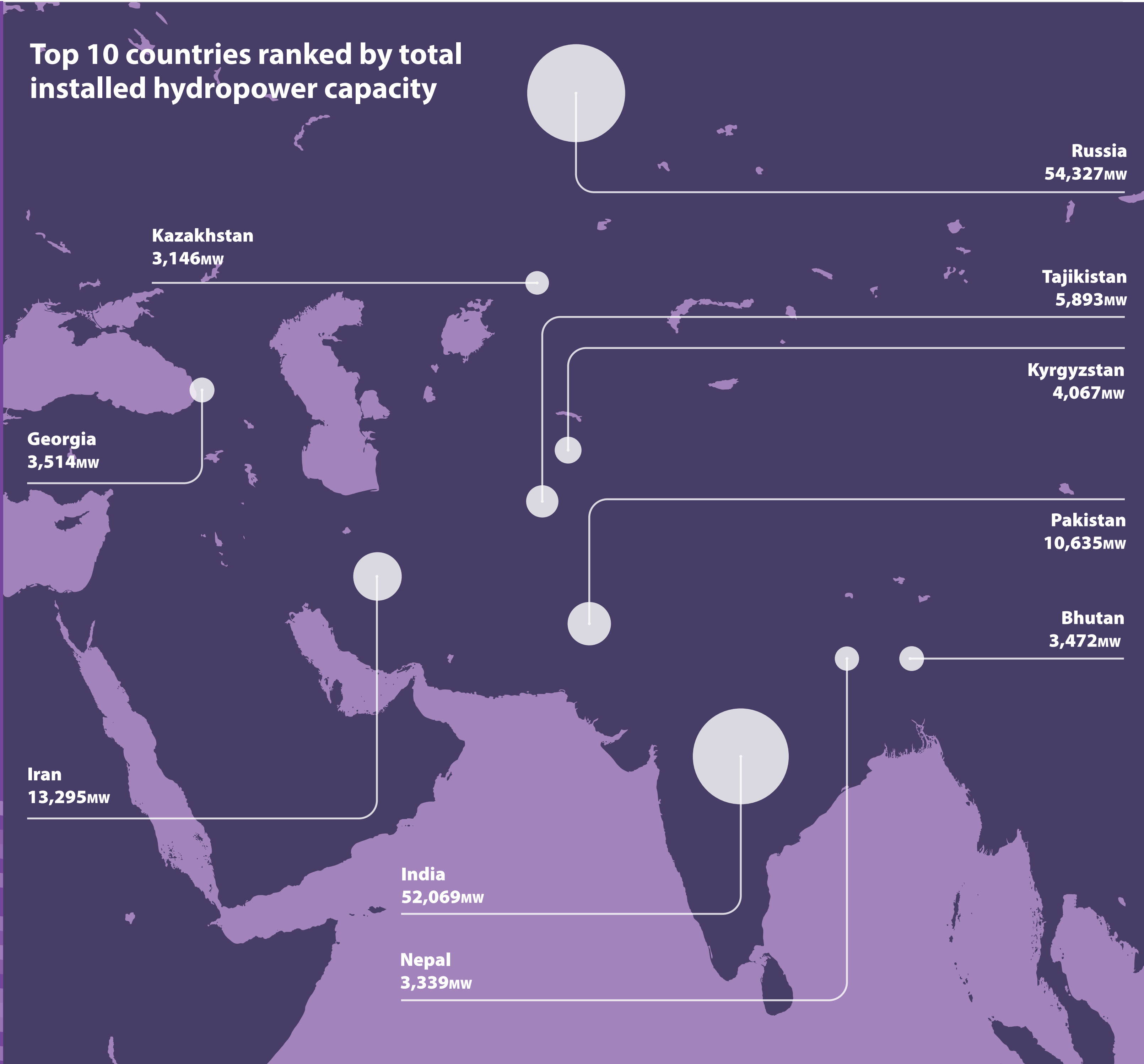


South and Central Asia

Top 5 Countries/region by capacity added in 2024

1. Bhutan 1,138MW
2. Pakistan 884MW
3. Nepal 699MW
4. India 172MW
5. Sri Lanka 127MW

Top 10 countries ranked by total installed hydropower capacity



Countries to watch

Key
- Low unexploited potential/minimal policy activity/limited project pipeline
- Moderate unexploited potential/some policy activity/intermediate project pipeline
- High unexploited potential/strong policy activity/large project pipeline

COUNTRY	UNEXPLOITED POTENTIAL	POLICY ACTIVITY	DEVELOPMENT PIPELINE
Kyrgyzstan	The country's hydropower potential is estimated at 140TWh per year, of which approximately 10% has been exploited.	Kyrgyzstan has been actively supporting intergovernmental agreements and regional electricity sharing initiatives related to the 1,860MW Kambarata-1 hydropower project.	Four projects are currently under construction, with several others announced, including the Suusamyr–Kokomeren cascade, which is expected to add 1,305MW of capacity.
Pakistan	The country has 60GW of hydropower potential of which approximately 18% has been exploited.	Pakistan launched its 'Decade of Dams' initiative in 2021, aiming to expand installed hydropower capacity from approximately 9GW to 20GW by 2030.	The 4,320MW Dasu and 800MW Mohmand dams are under construction. The Tarbela 5th Extension will increase the project's installed capacity from 4,888MW to 6,418MW.
Tajikistan	Tajikistan has the potential to generate 527TWh of electricity annually from hydropower, but only around 4% of this capacity has been developed to date.	Tajikistan has announced plans to achieve 100% renewable electricity by 2032, with hydropower playing a central role.	The country is seeking to become a regional electricity powerhouse through the 3,600MW Rogun project and the CASA-1000 transmission network.
Bhutan	Bhutan has an estimated 35GW of hydropower potential, of which approximately 9% has been developed. In July 2024, the first two turbine generators of the 1,020MW Punatsangchhu II project became operational.	In August 2024, Bhutan's Electricity Regulatory Authority released its Strategic Plan 2024-2029, aimed at strengthening regulatory frameworks and promoting innovation across the power sector. The country has also signed agreements with several regional governments to support its growing hydropower pipeline.	The 1,200MW Punatsangchhu-I is nearing completion as well as several other projects under construction. The 2,584MW Sankosh project has been announced.
India	With an estimated technical potential of up to 181.5GW across both on-river and off-river sites, PSH is recognised in India as a mature, proven solution for large-scale energy storage, grid stability and peak demand management.	The Indian government has developed national and state-level policies to support PSH, including the PSP Guidelines and the Hydropower Policy 2025. Policy momentum remains strong, with new measures such as the Energy Storage Obligation, waivers on interstate transmission charges and proposed viability gap funding to incentivise PSH deployment.	Several projects are nearing completion that will nearly double India's installed capacity from 4.7GW to 8GW.
Iran	Iran operates the 1,040MW Siah Bisheh pumped storage plant and is progressing with development of the Azad pumped storage project.	Iran's Minister of Energy, Dr Abbas Aliabadi, has called for the accelerated implementation of pumped storage projects, although limited policy progress has been made to date.	Iran's 510MW Azad pumped storage project is planned for completion in 2027.

East Asia and Pacific

Generation by hydropower in 2024
1,804 TWh

Capacity added in 2024*
15 GW

Pumped storage capacity added in 2024
8 GW

Total installed capacity*
577 GW

Total pumped storage installed capacity
98 GW

*Includes pumped storage

Burrendong hydropower project, Australia
Credit: Water NSW

East Asia and Pacific

Regional overview and outlook

China continues to dominate hydropower development in the East Asia and Pacific region, adding 14.4GW of new installed capacity in 2024 to reach a total of 435.95GW. PSH accounted for more than half of the new capacity, with 7.75GW added that year, bringing total installed PSH capacity to 58.69GW. With more than 200GW of PSH under construction or approved, China is on track to exceed its 2030 target of 120GW, potentially reaching 130GW by the end of the decade. The country's updated Energy Law, enacted in January 2025, includes a regulation to support the orderly development of PSH, reinforcing China's leadership in this field. Elsewhere across the region, hydropower and PSH remain integral to energy transition strategies. Governments are embedding these technologies into long-term plans to improve grid stability, energy security and renewable integration. Australia, Vietnam, the Philippines, Thailand, Laos and China are advancing new projects and refining regulatory frameworks, while Malaysia and Indonesia are exploring hybrid hydro-solar models.

Key trends include:

- **Policy support for hydropower and PSH:** Countries including Australia, Vietnam, and the Philippines have reinforced policies incentivising hydropower investment, particularly in PSH.
- **Grid integration and transmission developments:** Major transmission projects, such as Australia's HumeLink, Indonesia's SuperGrid and Laos' grid connection with China are enhancing hydropower integration.
- **International energy trade**: Similarly, Malaysia through Sarawak Energy on the island of Borneo, has the aspiration to be the "Battery of ASEAN" with focus on realising and expanding the ASEAN Power Grid in the East System, comprised of Brunei, Indonesia, Malaysia, and the Philippines. Also, Singapore is expanding hydropower imports via regional collaborations.
- **Collaboration between energy production and ecological protection:** China has made major breakthroughs in fields such as "ecological regulation technology for large-scale reservoir groups" and put them into practice through the joint regulation of cascade reservoirs along the major rivers, in order to minimise the ecological impacts and make them more eco-friendly.

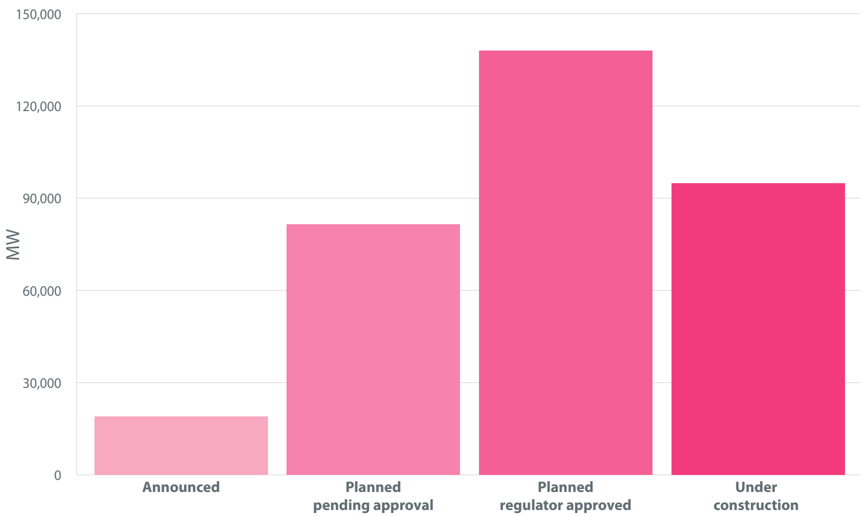
PSH development is also gaining momentum. In the Philippines, the country's Green Energy Auction is attracting investor interest in pumped hydro. Australia is progressing PSH projects despite rising costs, while Indonesia is advancing land acquisition and infrastructure readiness. Hydropower also plays a stabilising role as countries integrate variable renewables. Vietnam relies on hydropower to manage solar and wind intermittency under its revised power plan, and in Japan, PSH helps to smooth renewable energy fluctuations.

Wivenhoe pumped storage hydropower project, Australia
Credit: Victoria Cardenas

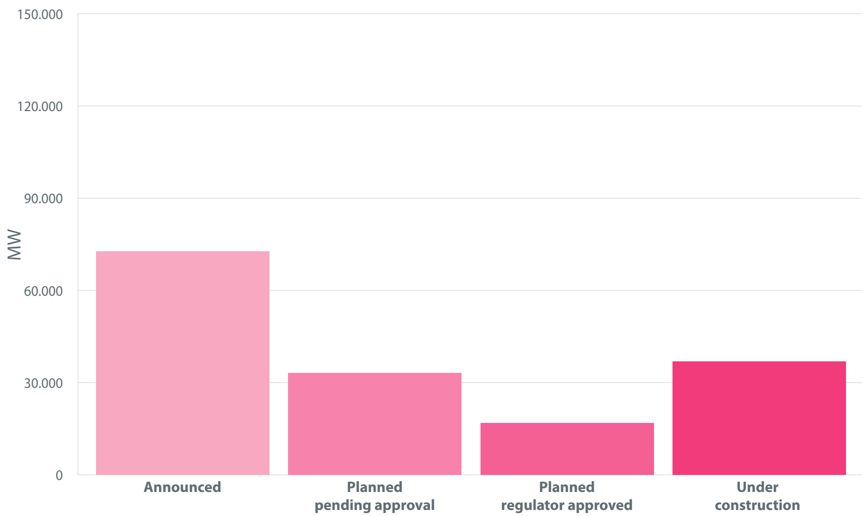
Policy and market overview

Five major challenges continue to curtail hydropower and PSH development within the region, despite substantial investment and strong policy commitments outside of China.

- **Financing constraints:** Funding remains a persistent challenge, despite hydropower's status as a strategic priority. High upfront capital requirements and extended payback periods often deter private sector participation. While blended finance approaches have had some success, public–private partnerships in hydropower development remain limited. A lack of payment for capacity services in some markets can limit who is able to raise finance to those with bankable private offtake contracts.
- **Regulatory and permitting delays:** Hydropower projects often face logistical and construction challenges due to remote, rugged locations, leading to higher costs and longer timelines in countries such as Australia, Vietnam and Indonesia. Delays are further compounded by complex permitting processes, unclear land rights, and lengthy environmental assessments, requiring innovative solutions and strong engagement with local communities and authorities.
- **Grid integration and stability:** The rapid expansion of solar and wind power has increased reliance on inverter-based generators, raising concerns over grid stability. Many hydropower assets face transmission infrastructure constraints that limit their ability to deliver power to national grids efficiently.
- **Climate change and water availability:** Changes in rainfall patterns and prolonged droughts are increasingly affecting hydropower output. Countries including Australia, Laos and Vietnam have experienced reduced generation due to climate variability, prompting changes in project design, location and operational strategy. This is also increasing focus on water security and politics for rivers that cross multiple boundaries.
- **Environmental and social considerations:** The ecological and social impacts of large-scale hydropower and PSH projects continue to raise concerns. In Laos, Cambodia and Myanmar, projects along the Mekong and Salween rivers have come under increased scrutiny due to their potential effects on biodiversity, fisheries and community livelihoods.



East Asia and Pacific PSH pipeline



East Asia and Pacific Conventional pipeline

East Asia and Pacific

Hydropower and PSH remain essential for regional energy security and flexible grid operation in East Asia and the Pacific. However, overcoming financial, regulatory, environmental and climate-related challenges will be critical to unlocking their full potential. Progress will depend on coordinated efforts to streamline permitting, scale innovative financing models and integrate hydropower sustainably alongside other renewable energy sources.

Latest developments by country

Australia

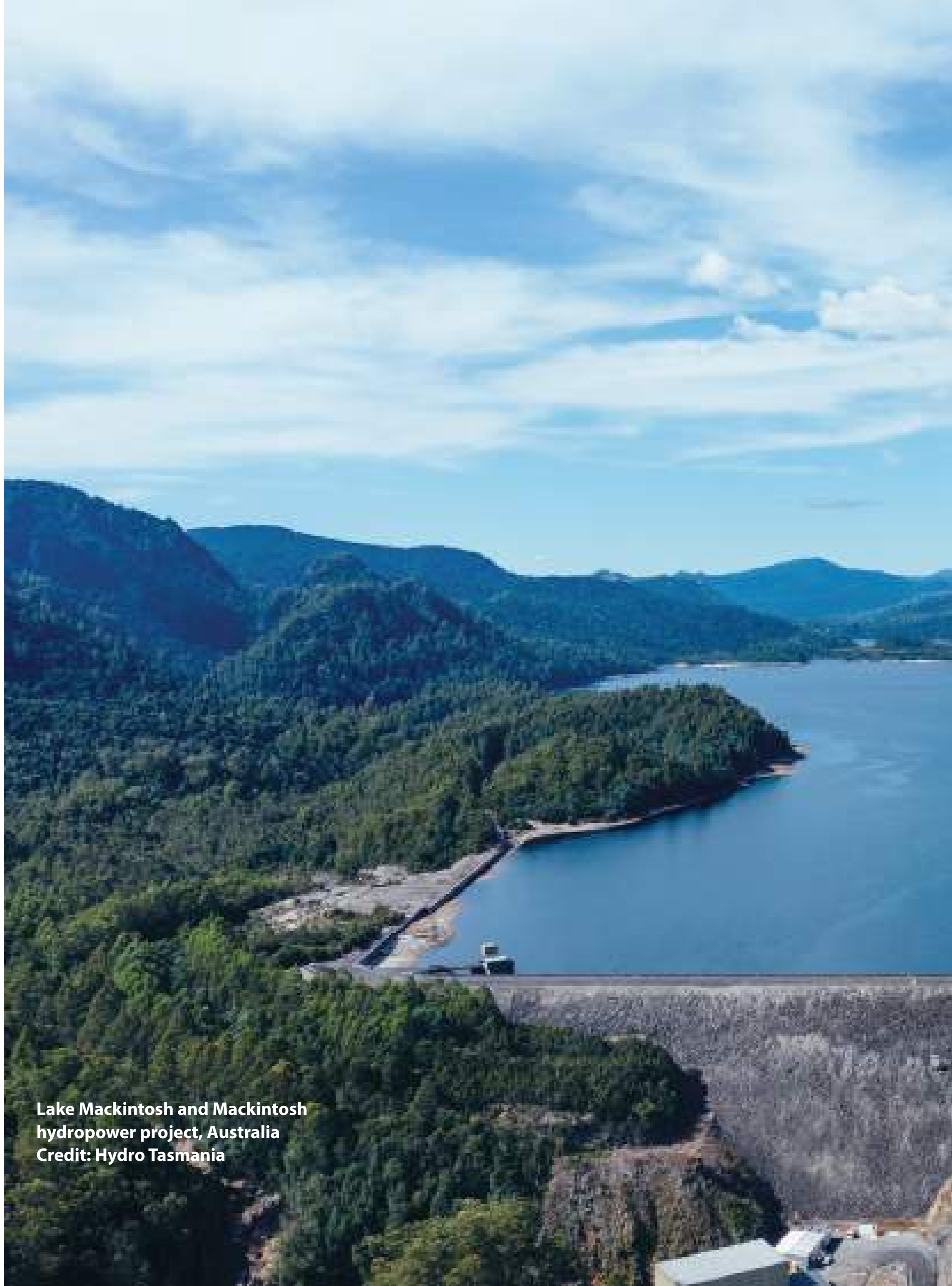
Australia continues to integrate hydropower, particularly PSH, into its energy transition strategy, with the goal of reaching 82% renewables by 2030. The 2,000MW Borumba project has seen its cost rise from A$14bn (US$9bn) to A$18.4bn (US$11.8bn), prompting a review of its scale and a revised completion date of 2033. Private investment is growing, including a proposed 1.6GW PSH project using WaterNSW reservoirs. Meanwhile, Upper Hunter Hydro is exploring projects at Glenbawn and Glennies Creek; Glenbawn is planned at 770MW/7.7GWh (10-hour duration). The Snowy Hydro 2.0 PSH project continues, with completion delayed to 2028. Permitting is being streamlined, and the A$5bn (US$3.2bn) HumeLink transmission line is due to begin in 2025 to support grid integration.

Cambodia

In October 2024, Cambodia announced plans to increase its power import capacity by more than 50% over two years, targeting more than 600MW from neighbouring countries including Laos and Thailand. The initiative forms part of a broader strategy to strengthen regional interconnection and grid stability in response to variable hydropower output linked to climate conditions.

China

China remains the global leader of hydropower development, with ongoing growth in both conventional hydropower and PSH. While conventional project development has slowed from previous peaks, notable progress continues. The 1,200MW Yangqu station in Qinghai Province, commissioned in 2024, is part of a



Lake Mackintosh and Mackintosh hydropower project, Australia
Credit: Hydro Tasmania

cascade along the Yellow River and is expected to produce 4.7TWh annually. Meanwhile, PSH is emerging as China's primary hydropower growth area. In 2024, the 3.6GW Fengning project in Hebei Province, now the world's largest PSH facility, was commissioned by State Grid Xinyuan, underscoring China's emphasis on energy storage and system flexibility.

Indonesia

Indonesia continues to expand its hydropower sector in alignment with regional energy goals. In February 2025, the government released its updated Electricity Supply Business Plan (RUPTL) for 2025–2034, targeting an increase in renewable energy from 12% to 35% of the national energy mix, including an additional 16GW of hydropower capacity. Multiple projects are scheduled to commence operations in 2025:

- Upper Cisokan Pumped Storage Power Plant: Indonesia's first pumped storage facility (1,040MW), located in West Java.
- PLTA Asahan 3 and Jatigede: Part of 37 strategic electricity projects commissioned in January 2025, collectively adding 3.2GW.
- PLTA Peusangan and Merangin: Peusangan 1 (45MW) and 2 (43MW) in Aceh, and the 350MW Merangin plant in Jambi.
- Batang Toru Hydropower Plant: A 510MW project in North Sumatra delayed by funding and environmental concerns, now expected online in 2025.

Laos

Laos has emerged as a regional hub for hydropower development in South East Asia, with strong investment flows and export-driven policies. The country is targeting 13GW of capacity by 2030, up from 9GW in 2020. With an estimated potential of 26GW, expansion is ongoing. Over 4,000MW is under construction, including Pak Beng (912MW) and Pak Lay (770MW), while more than 6,000MW is under feasibility review, largely along the Mekong River. Strong investment from China, Thailand and Vietnam continues to drive growth, supporting both domestic supply and electricity exports.

Malaysia

As ASEAN chair from January 2025, Malaysia is prioritising cross-border electricity trade from clean sources such as hydropower, solar and wind to strengthen regional energy security and sustainability. The country continues to advance its renewable energy strategy through policy initiatives and project development, with several hydropower projects moving towards commissioning.

- Sarawak's hydropower developments: Sarawak Energy is progressing major schemes, including the 1,285MW Baleh Hydroelectric Plant, expected to begin operations by 2029/2030.
- Tenaga Nasional Berhad (TNB) projects: TNB is developing the 300MW Nenggiri Hydroelectric Plant in Kelantan, targeting operation by 2027.
- Floating solar initiatives: In December 2024, Sarawak commissioned a 50MW floating solar project, co-owned with an independent power producer (IPP and Sarawak Energy), marking progress in solar-grid integration.

Philippines

The Philippines is targeting an ambitious 35% renewable energy share by 2030 and 50% by 2040, up from 22.8% in 2022. Recent policies include the auctioning of 300MW of impounding hydro and 4,250MW of PSH projects, which attracted nearly 7GW in pumped storage bids. A US$15 billion agreement with Masdar supports up to 1GW of solar, wind, and battery storage by 2030 and 10GW by 2035. Around 250MW of small hydropower is also planned, contributing to energy diversification and rural electrification.

Singapore

Singapore is strengthening its energy strategy by importing regional hydropower and expanding grid infrastructure. It endorsed the COP29 Global Energy Storage and Grids Pledge in December 2024. With 95% of electricity from imported natural gas, improving storage and grids is key to integrating renewables. Under the LTMS-PIP cross-border electricity trading initiative Singapore began importing 100MW of hydropower from Laos in 2022, doubling to 200MW by 2024. It plans to import up to 6GW of low-carbon power by 2035.

Solomon Islands

The Solomon Islands has a 2030 target for nationwide electrification, and yet only around half of the population is currently connected to the national grid. Ongoing projects include the Tina River Hydropower Project, which is 23% complete and aims to provide 78GWh annually from a 15MW plant, meeting nearly 70% of Honiara's electricity demand by early 2028. Construction of the project's main dam began in November 2024, marked by a ceremony attended by ADB and government representatives

Thailand

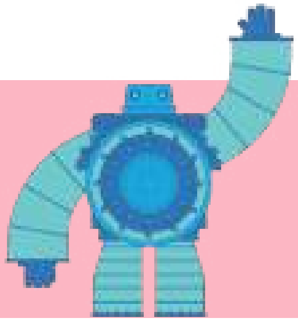
Thailand's Electricity Generating Authority (EGAT) has completed a 24MW floating solar PV system at Ubol Ratana Dam in 2024, creating a hybrid solar–hydro setup. A 6MWh battery energy storage system enables smooth transitions, with solar power used during the day and hydro at night. Thailand is also negotiating hydropower imports from Laos. While no formal agreement has been signed, a deal is expected by 2025 or 2026, with exports potentially beginning in the late 2020s or early 2030s, depending on infrastructure completion. EGAT is also in the early stages of developing PSH projects in Thailand.

Vietnam

Vietnam remains a key hydropower producer, with growing investment in PSH supported by overseas funding and a revised energy plan. The country's Power Development Plan VIII highlights hydropower's role in ensuring grid stability amid rising solar and wind capacity. Vietnam continues to address environmental challenges, particularly flood management and transboundary water coordination. In October 2024, India's Adani Group announced plans to develop 10GW of overseas hydropower projects, with Vietnam identified as a key country for potential investment.

Interesting fact

Cambodia's Upper Tatai Hydropower Station development, financed by Sinomach and designed by Changjiang Institute of Survey, Planning, Design and Research (CISPDR), reached a major milestone in December 2024, with the main powerhouse completed six months ahead of schedule. The Cape River Dam, a key control structure, was also filled to crest elevation six months early. Located 20km from Tatai Station, the 150MW plant is due for completion within four years. The cascade system is designed to increase renewable energy, reduce shortages, and support flood control. It has attracted over 300 enterprises and created 30,000 local jobs, making it a major national employer.



East Asia and Pacific

Top 5 Countries/region by capacity added in 2024

1 China 14,410MW

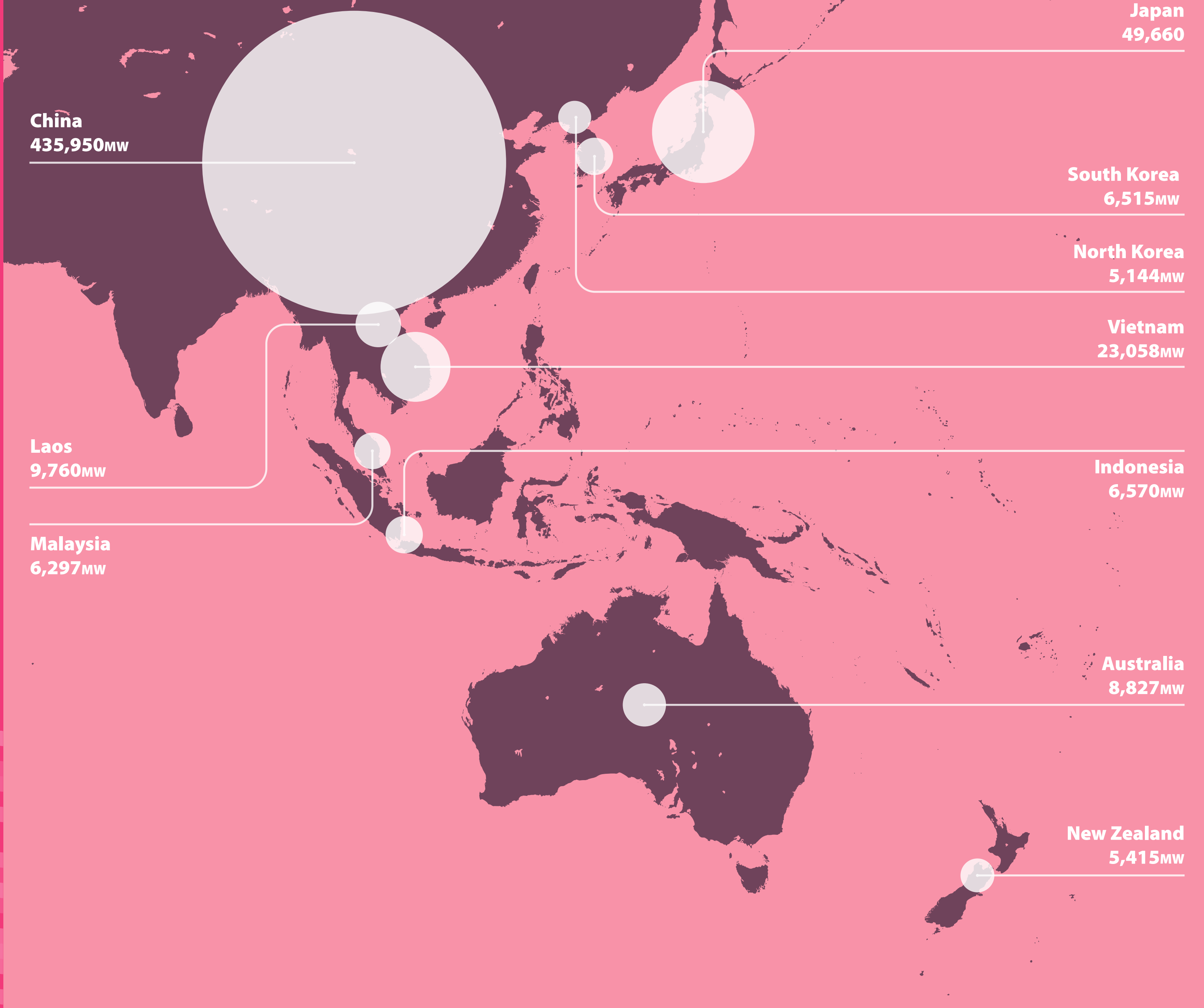
2 Vietnam 180MW

3 Malaysia 40MW

4 Taiwan, China 16MW

5 Cambodia 5MW

Top 10 countries ranked by total installed hydropower capacity



East Asia and Pacific

Countries to watch

Key
- Low unexploited potential/minimal policy activity/limited project pipeline
- Moderate unexploited potential/some policy activity/intermediate project pipeline
- High unexploited potential/strong policy activity/large project pipeline

COUNTRY	UNEXPLOITED POTENTIAL	POLICY ACTIVITY	DEVELOPMENT PIPELINE
Laos	Laos holds a vast reserve of undeveloped hydropower capacity, enabling a policy to become a key regional electricity exporter and the "Battery of Southeast Asia".	This country has implemented policies like the Sustainable Hydropower Development Policy and Renewable Energy Strategy with the aim of becoming a key regional energy supplier, targeting electricity exports of up to 14,800MW by 2025.	It is actively expanding its hydropower sector, with more than 4,000MW of new projects currently under construction. Key projects include the 1,400MW Luang Prabang Dam, the 728MW Phou Ngoy Dam, and the 1,060MW Pak Beng Dam, all located on the Mekong River.
China	China continues to expand its conventional hydropower capacity and is aggressively expanding its pumped storage hydropower capacity.	China's latest energy policy strategies set out plans for expansion. The 13th Five-Year Plan for the electricity sector outlines plans to add 60GW of new conventional hydropower capacity.	The country has a significant pipeline of projects underway, with large-scale conventional projects in major river basins such as the Jinsha, Dadu, and Yalong Rivers. There are more than 200 PSH projects in the pipeline backed by substantial funding, streamlined permitting, and supportive market reforms to accelerate implementation.
Indonesia	Indonesia has completed a comprehensive survey of potential sites and identified the most favourable locations.	This country is committed to the expansion of hydropower capacity. The updated Electricity Supply Business Plan (RUPTL) for 2025–2034 targets a 35% renewable energy share by 2034, with 16GW of new hydropower capacity.	There are notable projects in the development pipeline. In 2025 alone, the Upper Cisokan Pumped Storage Plant (1,040 MW) and conventional projects at Jatigede (110 MW), Asahan 3 (174 MW), Peusangan 1 and 2 (88 MW) and Merangin (350 MW) are due online.
Malaysia	Malaysia still holds significant potential. While large projects continue, Malaysia is shifting toward small hydropower (SHP) and hybrid hydro-solar initiatives.	Malaysia's National Energy Policy (2022–2040) designates hydroelectric power as a key technology for renewable energy development. The government aims to achieve 31% renewable energy capacity by 2025 and 40% by 2035, with hydropower playing a significant role in meeting these targets.	Malaysia has a number of projects at various stages of the development pipeline. These include major projects like the 1,285MW Baleh plant in Sarawak, expected by 2029/30, and the 300MW Nenggiri plant in Kelantan, slated for 2027.
Vietnam	Vietnam has considerable untapped hydro resources due to its abundant river systems and mountainous terrain.	Vietnam's Power Development Plan VIII, initially approved in May 2023, underscores strong government support for hydropower, prioritising both traditional and pumped storage projects to enhance energy security and promote clean, sustainable growth.	Vietnam is actively developing its pumped storage hydropower capacity, with the 1,200MW Bac Ai Pumped Storage Plant currently under construction. Several other pumped storage projects are in the feasibility study phase.
Australia	Australia has identified significant PSH potential across multiple states, especially in areas transitioning from coal.	The country is making proactive moves toward PSH and long-duration energy storage (LDES), supported by strong government backing, although it does not recognise LDES or PSH in its net zero policy wording.	It has a significant volume of PSH projects at various stages of the development pipeline, from detailed planning (Oven Mountain, Phoenix, Lake Lyell, Borumba) through procurement (Capricornia), to active construction (Snowy 2.0, Muswellbrook).
Philippines	The Philippines has considerable hydro and PSH potential, with strong demand for grid stabilisation.	The country has proactively moved on its PSH expansion strategy, with an oversubscribed auction. The Philippine Department of Energy set a 4,250MW target for PSH in the 2025 Green Energy Auction, which drew bids of 7GW.	A number of pumped storage projects are currently in the early stages of development. A total of 11 major energy projects (~4,500MW) received DOE endorsement for grid impact studies in February 2025, with PSH projects constituting the bulk of this capacity.

Installed capacity and generation 2024

North and Central America

Country/Region	Total Installed capacity including pumped Storage	Pumped storage (MW)	Generation (TWh)
Anguilla	0	0	0
Antigua and Barbuda	0	0	0
Aruba	0	0	0
Bahamas	0	0	0
Barbados	0	0	0
Belize	55	0	<1
Bermuda	0	0	0
Canada	84,300	177	342
Cayman Islands	0	0	0
Costa Rica	2,353	0	8
Cuba	65	0	<1
Dominica	7	0	<1
Dominican Republic	641	0	1
El Salvador	639	0	2
Grenada	11	0	<1
Guadeloupe	0	0	0
Guatemala	1,516	0	5
Haiti	78	0	<1
Honduras	849	0	4
Jamaica	30	0	<1
Martinique	0	0	0
Mexico	12,614	0	23
Montserrat	0	0	0
Nicaragua	159	0	<1
Panama	1,848	0	8
Puerto Rico	98	0	<1
Saint Bartholemy	0	0	0
Saint Kitts And Nevis	0	0	0
Saint Lucia	0	0	0
Saint Pierre and Miquelon	0	0	0
Saint Vincent and The Grenadines	6	0	<1
Trinidad And Tobago	0	0	0
Turks and Caicos Islands	0	0	0
United States	102,096	22,266	242
Virgin Islands, British	0	0	0
Virgin Islands, U.S.	0	0	0
Total	**207,475**	**22,443**	**637**

South America

Country/Region	Total Installed capacity including pumped Storage	Pumped storage (MW)	Generation (TWh)
Argentina	11,137	974	33
Bolivia	759	0	4
Brazil	109,982	20	415
Chile	7,566	0	26
Colombia	13,218	0	55
Ecuador	5,419	0	23
French Guiana	119	0	<1
Guyana	3	0	4
Paraguay	8,810	0	53
Peru	5,515	0	32
Suriname	180	0	<1
Uruguay	1,538	0	7
Venezuela	18,366	0	73
Total	**182,613**	**994**	**725**

Europe

Country/Region	Total Installed capacity including pumped Storage	Pumped storage (MW)	Generation (TWh)
Albania	2,203	0	8
Andorra	46	0	<1
Austria	11,939	3,512	49
Belarus	96	0	<1
Belgium	1,494	1,308	2
Bosnia and Herzegovina	2,298	420	5
Bulgaria	3,211	1,404	2.9
Croatia	2,155	281	7
Cyprus	0	0	0
Czechia	3,457	1,172	4
Denmark	7	0	<1
Estonia	8	0	<1
Faroe Islands	41	0	<1
Finland	3190	0	15
France	5,187	0	75
Germany	14,561	9,449	22
Gibraltar	0	0	0
Greece	2,730	0	3
Greenland	91	0	<1
Hungary	61	0	<1
Iceland	2,289	0	14
Ireland	512	292	<1
Italy	22,089	7,256	46
Kosovo	115	0	<1
Latvia	1,558	0	3
Liechtenstein	90	10	<1
Lithuania	1,029	900	<1
Luxembourg	1,332	1,296	<1
Macedonia	644	0	1
Malta	0	0	0
Moldova	64	0	<1
Monaco	0	0	0
Montenegro	649	0	2
Netherlands	38	0	<1
Norway	33,909	1,401	140
Poland	2,676	1,761	3
Portugal	8,352	3,867	15
Romania	6,774	92	14
San Marino	0	0	0
Serbia	3.151	614	11
Slovakia	2.623	993	5
Slovenia	1.309	180	5
Spain	22,747	5,650	35
Sweden	16,399	99	65
Switzerland	17,533	4,055	37
Türkiye	32,770	0	75
Ukraine	5,629	1,470	9
United Kingdom	4,723	2,833	6
Total	**262,763**	**56,105**	**680**

Africa

Country/Region	Total Installed capacity including pumped Storage	Pumped storage (MW)	Generation (TWh)
Algeria	266	0	<1
Angola	3,890	0	13
Benin	33	0	<1
Botswana	0	0	0
Burkina Faso	34	0	<1
Burundi	119	0	<1
Cameroon	1,114	0	6
Cape Verde	0	0	0
Central African Republic	19	0	<1
Chad	0	0	0
Comoros	1	0	<1
Congo (republic)	214	0	1
Côte d'Ivoire	992	0	3
Democratic Republic of the Congo	3,216	0	13
Djibouti	0	0	0
Egypt	2,832	0	15
Equatorial Guinea	128	0	<1
Eritrea	0	0	0
Eswatini	60	0	<1
Ethiopia	6,024	0	20
Gabon	331	0	2
Gambia	0	0	0
Ghana	1,584	0	10
Guinea	1,156	0	3
Guinea-Bissau	0	0	0
Kenya	839	0	<1
Lesotho	74	0	<1
Liberia	93	0	<1
Libya	0	0	0
Madagascar	189	0	<1
Malawi	391	0	2
Maldives	0	0	0
Mali	451	0	<1
Mauritania	48	0	<1
Mauritius	61	0	<1
Morocco	2,585	814	<1
Mozambique	2,216	0	18
Namibia	347	0	2
Niger	0	0	0
Nigeria	2,851	0	11
Reunion	134	0	<1
Rwanda	143	0	<1
São Tomé and Principe	3	0	<1
Senegal	81	0	<1
Seychelles	0	0	0
Sierra Leone	64	0	<1
Somalia	0	0	0
South Africa	3,600	2,912	1
South Sudan	0	0	0
Sudan	1,923	0	12
Tanzania	2,704	0	4
Togo	66	0	<1
Tunisia	66	0	<1
Uganda	2,107	0	6
Western Sahara	0	0	0
Zambia	3,164	0	11
Zimbabwe	1086	0	6
Total	**47,300**	**3,726**	**167**

South and Central Asia

Country/Region	Total Installed capacity including pumped Storage	Pumped storage (MW)	Generation (TWh)
Afghanistan	468	0	<1
Armenia	1,368	0	2
Azerbaijan	1,329	0	3
Bahrain	0	0	0
Bangladesh	230	0	<1
Bhutan	3,472	0	11
Georgia	3,514	0	11
India	52,069	4,746	198
Iran	13,295	1,040	18
Iraq	2,816	240	1
Israel	307	300	<1
Jordan	9	0	<1
Kazakhstan	3,146	0	11
Kuwait	0	0	0
Kyrgyzstan	4,067	0	14
Lebanon	282	0	<1
Nepal	3,339	0	3
Oman	0	0	0
Pakistan	10,635	0	40
Qatar	0	0	0
Russia	54,327	1,385	212
Saudi Arabia	0	0	0
Sri Lanka	2,099	0	7
Syria	1,505	0	<1
Tajikistan	5,893	0	21
Turkmenistan	2	0	<1
United Arab Emirates	0	0	0
Uzbekistan	2,382	0	8
Yemen	0	0	0
Total	**166,553**	**7,711**	**564**

East Asia and Pacific

Country/Region	Total Installed capacity including pumped Storage	Pumped storage (MW)	Generation (TWh)
American Samoa	0	0	0
Australia	8,827	2712	14
Brunei	0	0	0
Cambodia	1,796	0	7
China	435,950	58,690	1424
Cook Islands	0	0	0
Fiji	138	0	<1
French Polynesia	49	0	<1
Guam	0	0	0
Indonesia	6,570	0	25
Japan	49,660	27,470	80
Kiribati	0	0	0
Laos	9,760	0	40
Malaysia	6,297	0	32
Marshall Islands	0	0	0
Micronesia, Federated States of	2	0	<1
Mongolia	23	0	<1
Myanmar	3,225	0	10
Nauru	0	0	0
New Caledonia	82	0	<1
New Zealand	5,415	0	26
Niue	0	0	0
North Korea	5,144	0	17
Papua New Guinea	325	0	1
Philippines	4,425	729	10
Samoa	20	0	<1
Singapore	0	0	0
Solomon Islands	<1	0	<1
South Korea	6,515	4,700	11
Taiwan, China	4,725	2,602	4
Thailand	4,569	1,531	7
Timor-leste	<1	0	<1
Tonga	0	0	0
Tuvalu	0	0	0
Vanuatu	2	0	<1
Vietnam	23,058	0	96
Total	**576,578**	**98,433**	**1,804**

World

	Total Installed capacity Including pumped Storage	Pumped storage (MW)	Generation (TWh)
Total	**1,443,437**	**189,412**	**4,578**

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