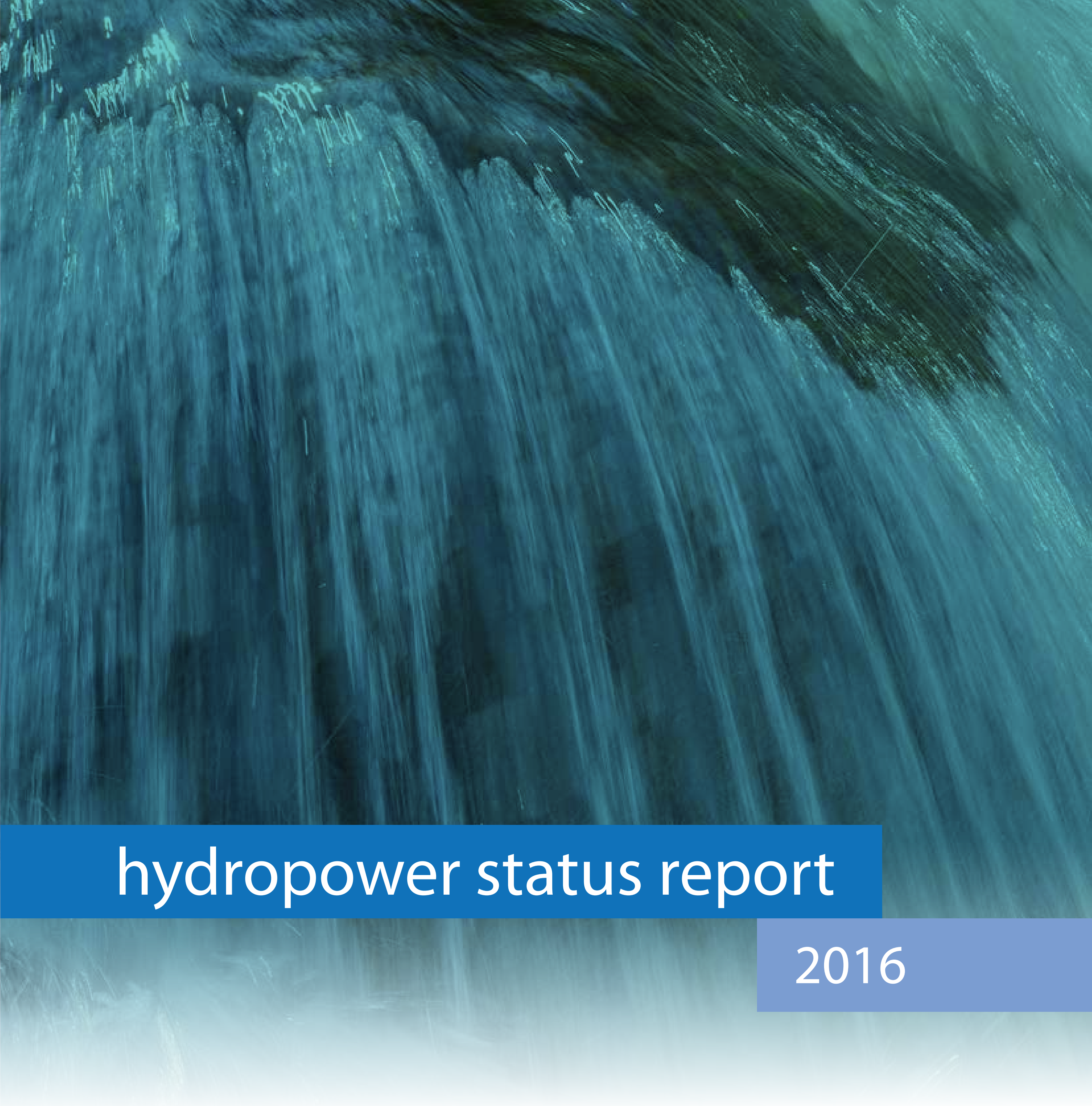

hydropower status report

2016

international hydropower association

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Methodology

Statistics are compiled by IHA using data from publicly published sources, IHA members, government representatives, industry sources and media monitoring. The data is regularly tracked, stored and updated to account for new information as it is received. Data verification exercises are an ongoing process, leading to corrections as and when needed.

IHA's database houses data for all sizes of hydropower assets, in all locations and of all types.

Conversely, IHA is working to separate out hydropower generation derived by pumping, in spite of combined reporting from various sources.

For hydropower generation, statistics are a combination of official government reports and IHA estimates based on averaged capacity factors.

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FOREWORD

The *2016 Hydropower Status Report*: an insight into recent hydropower development and sector trends around the world.

33.7 GW
of new installed capacity in 2015 (including pumped storage)

1,212 GW
global hydropower capacity (including pumped storage)

We publish this report following a year of significant hydropower development. In 2015, 33.7 GW of new capacity was installed, including 2.5 GW pumped storage, bringing total hydropower capacity to 1,212 GW worldwide.

The year also witnessed the global community adopting a new sustainable development agenda and global agreement on climate change, which will catalyse further actions and investment towards a low-carbon, resilient and sustainable future. This brings a particular focus on clean and renewable energy. Hydropower will play a significant role in supporting energy and water systems in their transition towards a more sustainable future.

Through our global monitoring, we observe a dynamic sector that is evolving alongside the increased deployment of solar and wind power, with an increased understanding of climate-change impacts. Renewable hybrids are advancing, with hydropower playing a central role, while the value of pumped storage is becoming more appreciated worldwide.

Managing the uncertainty of climate change is affecting the way decision-makers think about development. New financial instruments are blending public and private finance, sharing risks in a more realistic way. The climate bond market is attracting strong hydropower interest to promote sustainable and climate-friendly investments.

In Africa, which will host the 2017 World Hydropower Congress, transformative projects are progressing and driving regional interconnections with the potential to deliver reliable, clean and affordable energy across national borders. In Asia and South America, hydropower has continued its considerable growth, with many projects providing multiple benefits to both power and water supply.

Our global database of hydropower stations and companies has continued to grow and underpins the trends and conclusions laid out in this report. The database is a product of a collective collaboration including regulators, ministries, agencies, and station owners and operators.

The in-depth articles and regional and country overviews have benefited greatly through contributions and reviews from IHA's extensive network of members and partners around the world.

By bringing the expertise and perspectives of our community together, we can move closer to our goal of advancing sustainable hydropower. We cannot achieve our vision without building and sharing this knowledge. This report seeks to inform and cultivate a vibrant, inclusive and proactive hydropower community.

We would like to extend our sincere gratitude to everyone who contributed to the production of the *2016 Hydropower Status Report*, and invite everyone to join the conversation on the trends and figures presented in this document.

Richard Taylor
Chief executive

EXECUTIVE SUMMARY

In 2015, hydropower development continued its strong growth trend. Globally, the drivers for this include a general increase in demand not just for electricity, but also for particular qualities such as reliable, clean and affordable power.

DURING 2015

- An estimated 33.7 GW of hydropower capacity was put into operation, including pumped storage, bringing the world's total installed capacity to 1,212 GW
- 2.5 GW of pumped storage capacity came online, with significant capacity under construction or in the planning stages
- Total hydropower generation for the year is estimated at 3,975 TWh
- China once again dominated the market for new development, adding 19.4 GW of new capacity within its borders
- Other countries leading in new deployments include Brazil (2.5 GW), Turkey (2.2 GW), India (1.9 GW), Iran (1 GW) and Vietnam (1 GW)

Key trends and noteworthy developments

New international policy and agreements will drive further hydropower growth

In September 2015, the UN Sustainable Development Goals were officially adopted. Superseding the Millennium Development Goals, the SDGs include a specific goal related to energy: "ensure access to affordable, reliable, sustainable, and modern energy for all," which calls for a substantial increase in the share of renewables by 2030.

In December 2015, the parties to the UNFCCC agreed to reduce anthropogenic greenhouse-gas emissions in order to limit global warming to "well below 2°C". Both agreements will drive further growth in the hydropower sector, especially in emerging and developing economies.

Advanced hydropower control technologies enable renewable hybrids

The need to minimise the real-time variations of power provided to the grid has led to innovative hydropower control systems. In 2015, China completed phase II of the Longyangxia solar park, raising capacity from 320 to 850 MW.

The solar park is coupled directly to one of four turbines at the nearby 1,280 MW Longyangxia hydro station; the advanced control system allows the turbine to regulate the variable supply from the solar park before dispatching firm power to the grid. This minimises the grid's need for reserve capacity, frequency control and voltage regulation, and maximises PV utilisation and conserves water.

Climate aspects increasingly influence project design

Potential climate change impacts are changing hydropower decision-making processes. For example, the Qairokkum station in Tajikistan will be rehabilitated to bolster the plant's resilience to climate change, and take advantage of higher peak flows by increasing installed capacity from 142 to 170 MW.

Similarly, the decision to expand capacity at Iceland's Búrfell station by 100 MW was made with the expectation of increased glacial run-off as a result of a warming climate. Increased run-off has already been observed in Iceland, and is taken into account in the operation of the country's existing hydro system.

The value of pumped storage is being recognised worldwide

Storage hydropower accounts for over 97 per cent of global energy storage capacity, and will continue to grow. China, following its ambitious target of 70 GW pumped storage capacity by 2020, has more than 27 GW under construction. Iran commissioned the 1,040 MW Siah Bishe project, its first pumped storage station, while Japan and the USA added capacity at existing sites.

Over 5 GW could come online in 2016, including Ingula (1,332 MW, South Africa), Tehri (1,000 MW, India), Reisseck II (430 MW, Austria), Linth-Limmern (1,480 MW, Switzerland), and Zagorsk-II (840 MW, Russia). New projects continue to be discussed in Egypt, Chile, Indonesia, Lesotho, Morocco, Turkey and Vietnam.

New financial instruments are making hydropower investment more attractive*

Historically, hydropower financing was the responsibility of public utilities. As electricity markets began to deregulate, models were developed to encourage private sector finance into generation. This has been problematic for hydropower due to larger capital requirements, longer gestation periods and greater development risks.

However, the re-engagement of multilateral agencies has been a catalyst for hydropower's resurgence. World Bank guarantees are leveraging resources to mobilise private sector finance; IFC is now participating in equity as well as debt finance, injecting risk capital, adding investor confidence; and public–private partnership models are enabling concessionary public funds to be blended with private finance.

Climate bonds market attracts strong hydropower interest*

A record USD 41.8 billion of labelled green bonds were issued worldwide in 2015, representing an annual increase of 13 per cent. All three of the largest energy-related bond offerings to date – by EDF, Engie (formerly GDF Suez) and Iberdrola – include hydropower.

While the criteria for green bonds are under review, hydropower remains the largest sub-sector within climate-aligned bonds. Notable green bonds issued for hydropower include two Norwegian examples worth USD 282 million combined, which were both oversubscribed within three hours, and a USD 176 million bond for the Kokish hydro station in Canada.

*Read more in the section on trends in hydropower financing on page 14

Mergers and acquisitions point to a larger role for the private sector

During 2015, a number of state-owned hydropower assets and concessions were transferred to the private sector. Brazil sold its operating rights for 29 hydropower plants for USD 4.51 billion. In Turkey, the National Privatisation Administration (ÖİB) announced tenders for the privatisation of ten hydropower plants with a combined installed capacity of 538 MW.

Canadian group Brookfield Renewable bought the controlling stake in Isagen, the third-largest power generation company in Colombia, for USD 1.99 billion. On the manufacturing side, General Electric completed the acquisition of Alstom's power and grid business.

The China sector continues to go global

China is continuing to promote regional hydropower development in Eurasia and Africa through the One Belt, One Road initiative. The Karot project (720 MW) in Pakistan is the first project to be financed by the Silk Road Fund.

State Power Investment Corporation agreed to buy Pacific Hydro, reportedly for USD 3 billion. State Grid Corporation of China was awarded the contract for Brazil's longest transmission line (2,550 km), connecting the Belo Monte project to Rio de Janeiro. China Three Gorges Corporation purchased operating rights for the Jupia and Ilha Solteira stations for USD 3.7 billion, becoming the second-largest private power generator in Brazil.

Transformative projects are moving forward in Africa

Ethiopia continued development in 2015 in order to meet growing demand. Gilgel Gibe III (1,870 MW) brought the first two of ten 187 MW units online, with the remainder expected in 2016. The Grand Ethiopian Renaissance Dam (6,000 MW) expects to commission its first two 375 MW turbines in 2016.

Guinea almost tripled its installed hydro capacity when the 240 MW Kaleta project came online. DR Congo announced plans to begin construction of the 4,800 MW Inga 3 project in 2017. Zambia began construction at the 750 MW Kafue Gorge Lower project, which will boost domestic and regional supply.

Hydropower drives regional interconnections

Large-scale hydro often produces more power than is required to meet current national demand. Therefore, regional interconnections are essential to make projects financially viable.

Many cross-border projects reached milestones in 2015, including: stations commissioned along the Turkey–Georgia border that utilise the recently completed Black Sea transmission line; the Dagachhu station in Bhutan, which will export power to India; further development of Laotian hydro resources for export to Thailand; a Malaysia–Indonesia transmission line linking Sarawak hydropower with West Kalimantan; and plans for a Northern Pass USA–Canada interconnection to meet growing demand for clean energy in the USA.

REGIONAL TRENDS IN BRIEF

North and Central America

- 949 MW added in 2015, of which 700 MW was in Canada and 117 MW in the United States, including 73 MW of new pumped storage.
- Transmission projects under development include a 1,000 MW line from the Canadian border to New York City, expected to be in service by 2017, and an 833 MW line linking Manitoba and Minnesota.
- In Mexico, CFE signed a memorandum of understanding with Innergex, a Canadian power producer, to jointly study potential renewable energy project opportunities.
- Costa Rica operated on 100% renewable energy for 285 days, powered largely by hydropower.

Read more on pages 32–37

South America

- 3,842 MW added in 2015, including 2,457 MW in Brazil.
- Valhalla Energía, a Chilean developer, announced plans to build a solar / pumped storage hybrid power station in the Atacama Desert.
- The 400 MW El Quimbo station was completed, representing the first private sector hydropower project to be built in Colombia.
- In Peru, the 172 MW Cheves station commenced operation

Read more on pages 38–43

Africa

- 692 MW added in 2015, including 374 MW in Ethiopia and 240 MW in Guinea.
- Guinea commissioned all three units at the 240 MW Kaleta plant during 2015, effectively tripling the country's installed capacity.
- Several interconnections are expected to be completed in 2016, which will facilitate power exports from large hydropower schemes in Ethiopia.
- In South Africa, Eskom, the national utility, is overseeing construction of the 1,332 MW Ingula pumped-storage project, with the first two units commissioned in early 2016.

Read more on pages 44–51

Europe

- 290 MW added in 2015.
- Hydropower will continue to complement the increased penetration of variable renewables into the European power grid.
- Pumped storage remains a focus of activity, with 8,600 MW planned or under construction, including 2,500 MW expected in the Swiss Alps by 2017.
- Another focus is the refurbishment and modernisation of projects to increase the life-span and efficiency of existing plants and to minimise ecological impacts.

Read more on pages 52–59

South and Central Asia

- 5,502 MW added in 2015.
- Turkey added 2,225 MW, including the 582 MW Beyhan 1 plant.
- Dagachhu, a 126 MW run-of-river scheme in Bhutan which began commercial operation in 2015, marks the first public–private partnership in infrastructure investment in the country.
- Seven projects in Nepal were scheduled to be completed in the first half of 2016. Many of these projects were expected to come online in 2015, but were delayed due to the April–May earthquakes in the country.

Read more on pages 60–67

East Asia and Pacific

- 22,457 MW added in 2015, 86% of which was in China, more than the rest of the world's additions combined – bringing the country's total installed hydropower capacity to an estimated 319,370 MW.
- Laos added 599 MW, bringing its total installed hydropower capacity to 4,186 MW.
- Vietnam commissioned four hydropower stations totalling 1,030 MW in 2015, affirming the country's commitment to further hydropower development to meet rising demand.
- Myanmar commissioned the 140 MW Upper Paunglaung project in December 2015, a significant milestone towards the country's target of achieving a 50% electrification rate by 2020.

Read more on pages 68–75

2015 witnessed the global community adopting a new agreement on climate change, which will catalyse further actions and investment towards a low-carbon, resilient and sustainable future, and a particular focus on clean and renewable energy.

CLIMATE RESILIENCE

Climate change has the potential to impact the hydropower sector through changes in rainfall and water availability, protracted drought events, significant variation in historical temperature regimes, and more frequent and severe weather events, including floods. As such, many countries are seeking a better understanding of climate-change impacts, and are beginning to build climate adaptation strategies and climate resilience into their plans.

Hydropower facilities have the capability to provide adaptive capacity through flood and drought regulation and rapid response to load variation. However, the sector must continue working to ensure that existing and future hydro facilities are designed or enhanced to be resilient to a much more variable climate.

Climate change adaptation versus climate resilience

Climate resilience is often understood as the ability of infrastructure or systems to recover after an external stressor or extreme event. The OECD defines it as the "capability to succeed in an environment dominated by uncertainty".

Another definition is "the capacity of a facility or system to withstand or adjust to the possible impacts of climate change". Actions for climate resilience are those that seek to reduce sensitivity, or increase adaptive capacity, to climate change.

From a policy-making standpoint, climate resilience calls for the development of systems that are inherently capable of absorbing change, and even capable of utilising climate change to become more efficient.

Climate adaptation is usually defined as actions or adjustments taken to help communities and ecosystems cope with and adapt to changing climatic conditions. The climate adaptation services provided by storage hydropower include flood protection and the provision of a more secure water supply for agricultural, industrial, urban and/or environmental purposes.

Current state of climate resilience

In October 2015, IHA conducted a survey on hydropower and climate resilience. While the survey indicated that some organisations are taking action on the impacts of climate change, responses seem to point to a lack of a systematic internal approach.

Respondents appear to be more comfortable investing in data analysis regarding climate data, rather than more concrete measures such as improving the resilience of physical infrastructure. In November 2015, IHA and the World Bank Group jointly hosted a workshop on the resilience of hydropower and dams to climate change and natural disasters, bringing together stakeholders from the hydropower and water sectors to share their current understanding of climate resilience and hydropower.

Both the survey and workshop highlighted that there is a significant appetite in the industry for guidelines and a robust framework for approaching climate risks. Such guidelines should be developed in close dialogue with industry and other stakeholders in the hydropower community.

More recently, the World Bank has undertaken a new initiative to develop a set of guidelines. The objective is to encourage the hydropower and water sectors in both developing and developed countries to build resilience into the operation and maintenance of existing hydropower projects and into the design of future projects.

Looking ahead

The climate resilience workshop and survey proved to be an effective means of extracting current thinking on how to build climate resilience into the hydropower sector.

Risk management is business-as-usual. Developers and operators already deal with a range of risks, including hydrological variability. However, climate risks and climate resilience need to be incorporated into these processes.

Changing climatic conditions are already having a palpable effect on the sector, and these impacts are expected to become more pronounced in the future. Hydropower businesses are faced with direct economic impacts due to increased or decreased capacity to generate electricity. Developers and operators may also need to make changes in the design and operation of schemes and systems to improve resilience or adapt to new conditions.

Changes to the climate may also bring new opportunities for the hydropower sector, which may include higher hydropower potential due to increases in precipitation, as well as the roles which storage projects can play in helping societies adapt to climate change. Flexible project design is an approach which incorporates an early understanding and preparation for climate change adaptation but allows for flexibility in scheduling implementation of measures to adapt to a range of futures.

Climate resilience can be defined both in terms of specific assets and at the system level. However, a more general framework will be required to guide local assessments and define international standards of quality. A wide range of stakeholders will need to be involved to determine the appropriate metrics.

There is a case for public funds to be invested in climate screening and assessment. Public funds may be appropriate due to longer time horizons and broader constituent bases.

Developers are wary of adding costs to the project preparation phase. There is a need for a standard assessment for climate resilience which is recognised by investors and financial organisations, but it is important to seek ways to finance this without over-burdening project developers. Further clarity is also required on the role of regulators.

There is a need to communicate climate resilience and adaptation measures to stakeholders in a simple and clear manner. Investment decisions will consider a range of factors and compare other options, so climate risk and resilience measures must be presented clearly, necessitating consensus on standards and definitions in the sector.

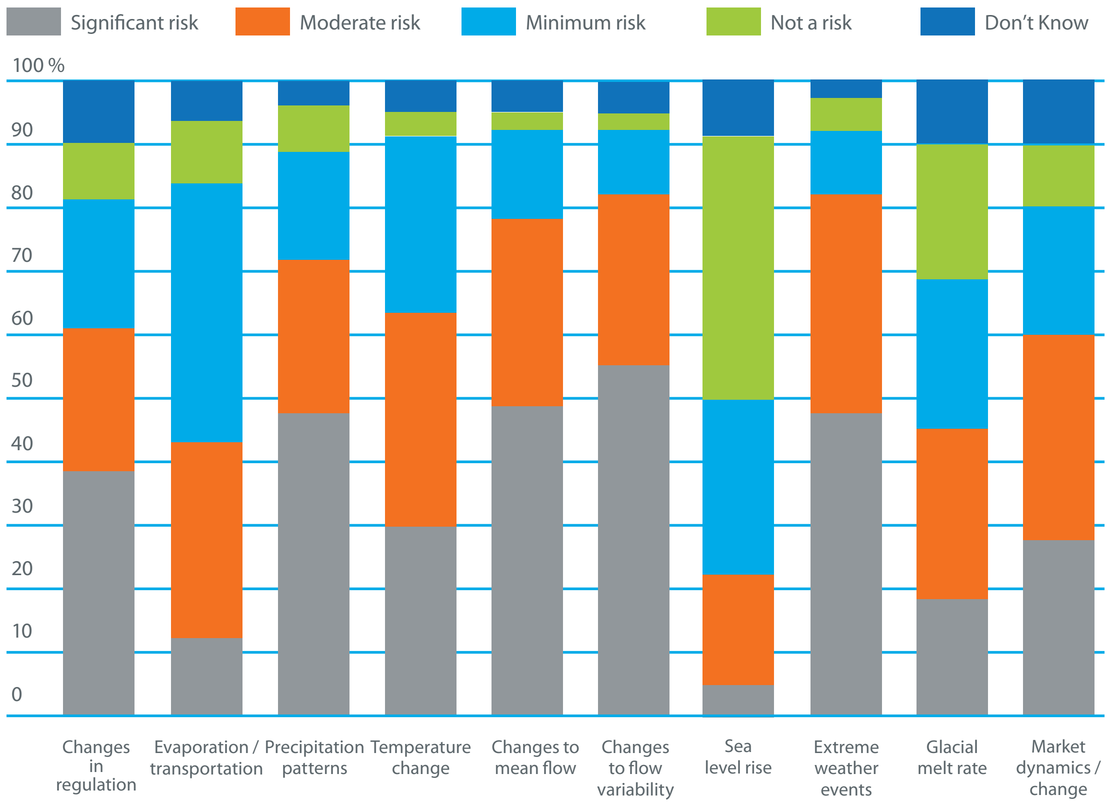
The next step among partners working in this space is to work towards hydropower sector guidelines for climate resilience. While the path towards this is not yet defined, any guidelines will need to be developed through a process that includes research, analysis, openness, transparency and consensus-building.

While the IHA survey was the first to examine the hydropower sector's views on climate resilience from the company perspective, further research could examine how governments view this risk and how they are responding to it.

IHA, in conjunction with partner organisations, will continue to examine climate resilience in the hydropower sector, and will engage with international organisations such as the World Bank Group, the European Bank for Reconstruction and Development and others who are active in this space.

Workshop findings

- Risk screening for project financing now includes an increased emphasis on climate change impacts and natural disaster risk.
- The World Bank is working with its clients to make their activities more resilient to climate change.
- The International Finance Corporation (IFC) can support climate-smart projects through blended climate finance.
- Hydropower companies are already working closely with scientists to forecast the future impacts of climate change.
- Adapting to climate change can mean increasing the capacity for electricity generation and/or water storage at hydropower facilities.
- Some organisations are already adopting policies and guidelines on climate change, adaptation and resilience.
- Innovative partnerships are emerging in response to the projected impacts of climate change.
- Operators and developers need guidelines on how to plan for climate variability.
- Outside pressure related to addressing climate resilience exists.



When thinking of your organisation, please indicate the level of risk associated with each of these potential impacts of climate change

Survey highlights

IHA undertook the survey of more than 50 companies active in the hydropower sector to determine how they view climate risks and what actions they are or are not taking to address those risks.

63 per cent of respondents felt that the main impacts of climate change are already being felt by their organisation. A further 36 per cent stated that impacts will be felt within the next 10–30 years. Given that hydropower stations are characterised by their longevity, with lifespans of 100 years or more and turbines lasting approximately 30–40 years, these expectations imply that investment decisions being made now should factor in climate-change impacts.

Despite the majority of respondents indicating that climate-change is already materially impacting their organisation, only 22 per cent are already taking steps to increase resilience. Less than half of the respondents (44 per cent) had carried out a climate change risk assessment, and only 10 per cent of the organisations surveyed had existing guidelines on climate risk and resilience.

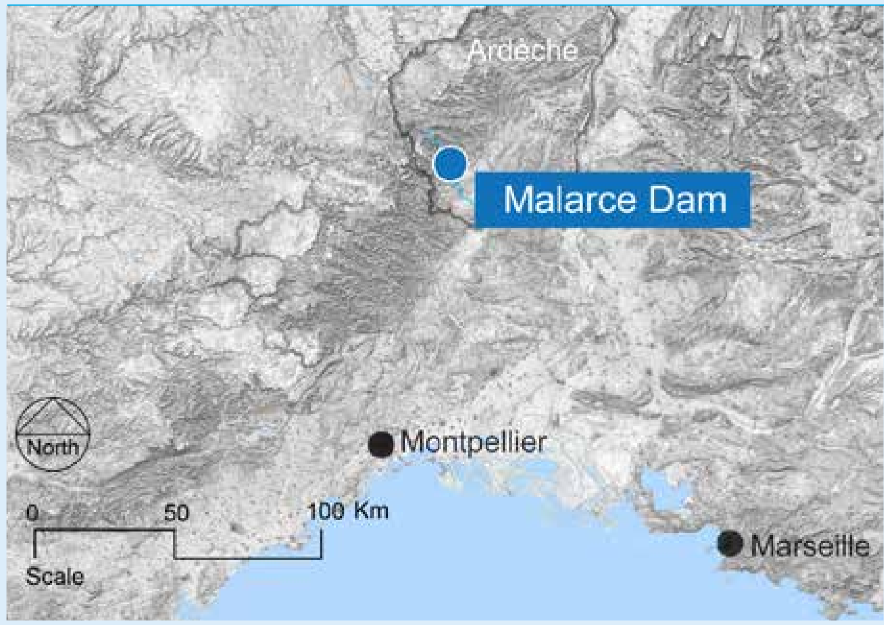
70 per cent of respondents felt that a changing climate may bring potential opportunities for their business. However, a noticeably smaller proportion of organisations indicated potential opportunities related to climate change.

60 per cent of respondents have developed collaborative partnerships with research organisations to better understand climate change. However, corresponding risk screening programmes, risk management strategies and climate-proofing have not been undertaken as extensively.

83 per cent of respondents indicated that sector guidelines on climate risk/ resilience would be useful. These results are consistent with the numbers of respondents who indicated concerns and impacts associated with climate change, relative to their own business and operational processes.

CASE STUDY

CLIMATE RESILIENCE CASE STUDY: PIANO KEY WEIRS



Under the conditions of climate change, exceptional flooding events are becoming more frequent. In order to reduce the impacts of extreme flooding, EDF's Hydro Engineering Centre (CIH) develops a new technological solution for increasing the discharge capacity of spillways: the piano key weir (PKW).

The name of this solution refers to its innovative design, with distinctive rectangular discharge tanks which look like the keys of a piano. Their shape provides a larger surface area for the flow of water, dramatically increasing the discharge capacity of spillways. This is particularly important for dams which are situated in narrow gorges, where it can be essential to rapidly evacuate excess water from flooding.

In 2015, EDF received a Climate Solutions Award, a scheme launched in the wake of COP21, for the company's role in the development of PKW technology. Yves Giraud, director of EDF's hydro division, received this prize in the "adaptation to climate change" category from Ségolène Royal, the French minister of ecology, sustainable development and energy. This award demonstrates the increased international recognition for PKW technology.

In 2012, EDF installed PKW technology at the Malarce dam in Ardèche, France. To date, this is the largest PKW project installed in EDF's hydropower fleet. Situated on the Chassezac River, the Malarce dam is exposed to an unpredictable and extreme hydrological regime from September to June. Twelve "piano keys" are now installed at the dam, increasing the discharge capacity to 4,600 m^3 of water per second, enough to evacuate a millennial flood.

EDF has already installed this technology at a further eight dams in France. The solution has also been implemented at other sites in France, as well as in Vietnam, Sri Lanka, Australia and Scotland (UK). EDF is now incorporating the concept into the study phase of international projects, particularly in Africa. Other developers are currently implementing the technology in Algeria, the USA and South Africa. There are very few technological innovations in hydropower that have spread so quickly around the world.

Why has the global uptake of PKW technology been so rapid? In a sense, PKW is an "open source" technology. The concept was first proposed by HydroCoop, a non-profit organisation, and the University of Biskra (Algeria). Then EDF and other institutes, such as the Swiss Federal Institute of Technology in Lausanne, the University of Liège and the Vietnamese Comitee of Large Dams, took part in further development. In parallel, EDF designed and built the first PKW at Goulours dam, France. While none have sought to protect or patent this important solution, stakeholders have rather been working collaboratively to share the PKW design with the wider hydropower community.

PKW builds on an earlier solution: the labyrinth spillways which were developed in the 20th century. Labyrinth spillways can only be implemented in certain types of dams, and they must generally be included in the project design from the earliest stages of development. By contrast, PKW technology can be installed at an existing dam. Another advantage is that it is suitable for a wider range of dam types, including far narrower dams than the labyrinth spillways, where the need to increase discharge capacity is of far greater importance.

TRENDS IN HYDROPOWER FINANCING

It has long been accepted that every hydropower project is unique, and that bespoke design solutions are required for each project. It has also been recognised more recently that the market and concession arrangements for each project require tailored financing solutions.

With the plethora of financial instruments and funding sources now available, including new products such as green bonds, there is great scope for innovation, and bespoke solutions can be developed to suit the needs of individual developers.

Problems with the BOOT mechanism

Historically, hydropower financing was the responsibility of public sector utilities that typically used concessionary finance from bilateral or multilateral sources. In the 1990s, with moves to deregulate electricity markets, models were developed to encourage private sector finance into electricity generation. These tended to be based around build, own, operate and transfer (BOOT) and similar arrangements.

While BOOT proved reasonably effective for thermal generation, it has not been as successful for hydropower, with its larger capital requirements, longer gestation periods and greater development risks. There is growing recognition that alternative concession models are required for hydro, with more equitable risk-sharing and blending of public and private sector finance. The problem is particularly acute in sub-Saharan Africa, where no large-scale private hydro project has achieved financial close since Bujagali in 2007.

New concession models are emerging with more equitable risk sharing, and in particular some of the hydrological and geological risks are being carried by the concession awarder. More innovative models are under development, focused on improving the security and bankability of the concession.

Impact of cheap oil and gas

The impact of USD 40 per barrel oil and depressed prices of other fossil fuels are having some impact on hydro development. Although retail prices of electricity continue to rise or are holding steady, bulk electricity supply prices have been falling in many countries. This has resulted in falling revenues for utilities, reducing their ability to invest in hydropower. Low fossil fuel prices are also reducing tariffs available on the spot market, and are influencing the acceptability of prices for long-term power purchase agreements, contracts for difference or other secure tariff instruments.

Low fuel prices also reduce the comparative price of the "least cost thermal alternative" typically used in economic cost-benefit analysis. However the discount rates used in economic analysis have also been reducing and as a consequence good projects are still showing positive returns.

There does not appear to have been any significant drop-off in hydro development resulting from low fossil fuel prices, probably because the positive drivers for hydro development remain strong.

Low cost of capital

Hydropower is one of the most capital-intensive generation technologies, and hence is very sensitive to the cost of capital. In the current environment with yields on secure hard currency instruments approaching zero or negative, expectations of investment returns are at an all-time low.

Infrastructure assets are proving attractive to investors, and hydropower is benefitting from the large pool of funds seeking improved yields. Long-term investors, such as pension and infrastructure funds, are acquiring existing hydropower assets and venture capital funds are taking construction risk on the back of low-cost capital, with the prospect of on-selling the completed projects.

The market appears to be flush with funds seeking good investment opportunities, and well-conceived hydropower projects are able to capitalise on this.

Valuation of ancillary non-energy products

As the only commercially viable despatchable renewable generation technology, hydropower is increasingly seen as a key component of low-carbon power systems. With growing penetration of variable renewables on many power grids, the need for ancillary services such as frequency response, reactive power, inertia and fast response are increasing. Hydropower, both conventional and pumped storage, is well placed to provide these services, and ancillary services are starting to provide a significant revenue stream in some markets.

Revenue from ancillary services seems likely to increase as markets become more sophisticated, intermittent generation becomes more prevalent and demand grows for more stable and reliable power systems. The power regulators and system operators are defining wider ranges of products for which payment is made, enabling hydropower operators to monetise ancillary benefits that were in the past provided to the system for free. For example, in Ireland, a country with an island grid and high penetration of intermittent generation, the DS3 programme has been developed to provide grid security through payment for ancillary services.

Re-engagement of the multilaterals

Led by the World Bank, multilateral agencies are increasingly recognising the importance of hydropower in sustainably delivering poverty alleviation, and are reinforcing their support for hydro. In all regions the development banks, including the Asian Development Bank, African Development Bank, European Development Bank and Inter-American Development Bank, are supporting the construction of hydropower projects.

The World Bank Group is offering a wide range of products that are available to hydropower customers through its four member institutions:

- International Bank for Reconstruction and Development (IBRD) offers technical assistance, loans and policy advice to governments of middle income countries
- International Development Association (IDA) provides technical assistance, interest-free loans and policy advice to governments of the poorest nations
- International Finance Corporation (IFC) offers equity, loans, risk management and advisory services to private sector companies in member countries
- Multilateral Investment Guarantee Agency (MIGA) offers political risk insurance to foreign investors in member countries.

Similar products are offered for hydropower development by other multilateral agencies. The amount of funding available from the multilateral agencies falls well short of the levels needed, and hence the products are generally aimed at leveraging or facilitating commercial investment.

Expanded participation of IFC

IFC is playing an increasing role in private sector hydro development, and is proving to be one of the most innovative funding agencies involved in the sector. Three primary financial products are offered:

- loans: IFC is syndicating or participating in major loans to hydropower developers such as Enerjisa in Turkey and CSAIL in Pakistan. It is also participating in project loans such as for the Gulpur project in Pakistan and for the Kabeli A project in Nepal
- equity: IFC has taken equity stakes in developers such as CSAIL, which is promoting the Karot project in Pakistan, and AGL, which is developing the Shuakhevi project in Georgia
- venture capital: IFC Infraventures has injected early-stage project development capital into projects such as Shuakhevi in Georgia and Upper Trishuli-1, in Nepal, becoming co-developer with its private sector partners.

The provision of early-stage risk capital through IFC InfraVentures to fund feasibility and pre-investment studies is innovative; IFC's involvement in the studies also gives access to their experience in project development, which can be a significant benefit to inexperienced developers. It also gives confidence to other equity investors and debt providers.

Donor-backed finance

The Private Infrastructure Development Group (PIDG) was established in 2002 by a number of donor agencies to facilitate the mobilisation of private finance into infrastructure. Although the participation of PIDG in hydropower has been limited, its portfolio is expanding, and a number of hydropower schemes are included in the pipelines of InfraCo and its development companies.

In these projects, PIDG aims to provide early-stage finance up to financial close, and to assist promoters with their project development experience. Debt finance, guarantees and other financial products are available through PIDG.

Public–private finance

There is growing appetite for public–private partnership (PPP) models for hydropower. In Nepal, the GMR Group has signed a project development agreement that provides 27 per cent of free equity to the government in a PPP model.

In Laos, the PPP model is well established, and most hydropower developments include participation of the government in the project company. In Rwanda, DR Congo and Burundi, the Ruzizi III project is progressing as a PPP. In 2015, the African Development Bank approved a package whereby USD 139 million of concessionary finance is channelled through the public sector partners, while USD 50 million of funding is available to the private partner.

The PPP model is seen as a means of giving the public sector some control and involvement in the project, enabling it to monitor progress and influence the configuration of the scheme to suit the needs of the system. It also provides an income stream for the government that is geared to the profitability of the project, enabling the nation to derive revenue from the success in developing the hydropower resource. Participation of the government at a meaningful level can also facilitate the negotiation of licences, land acquisition and other dealings with government authorities.

As in the Ruzizi III model, PPP can provide a route for channelling concessionary finance for projects with developmental benefits and where the risk-reward profile is insufficiently attractive for full commercial funding.

Non-traditional funders

The trend for non-traditional finance continues, with nations and utilities seeking alternatives to the traditional bilateral and multilateral agencies. In Ethiopia, construction of the Grand Ethiopian Renaissance Dam continues using a mix of funding sources including public bonds. In Latin America, BNDES, the development bank of Brazil, is funding numerous hydropower projects both within and outside Brazil.

Chinese finance has been available for many years, typically in support of Chinese goods and services. Many hydroelectric projects in Africa and Asia have benefitted from China Exim Bank support for EPC contracts or equipment.

In the last few years, the options available for Chinese finance have become more diverse. Whereas in the past Chinese finance focused on support for the export of Chinese goods and services, today China Exim Bank also provides loans for foreign investment, supports trade through "accounts receivable" products and offers a range of guarantees and other instruments. China Exim Bank is also syndicating loans with foreign agencies such as commercial banks, for example on the Karot hydropower project in Pakistan.

Other sources of Chinese finance include the Silk Road Fund, conceived by the government of China to promote investment in Central and South Asia, and Africa, under the One Belt, One Road initiative. The Silk Road Fund is also participating in the financing of the Karot project through China Three Gorges Corporation.

Commercial bonds

The use of bonds to finance or re-finance hydro projects is not new: Rule 144A bonds with various lengths of tenor were used in the late 1990s to finance the Casecnan hydro project in the Philippines. However, bond finance is resurging in popularity as developers seek to lock in historically low interest rates, and financing is sought with tenor closer to the operating life of hydro schemes.

A wide variety of project, corporate and government bonds are on offer. The tax-free bonds being used to finance the Grand Ethiopian Renaissance Dam project are offered to Ethiopian nationals or foreigners of Ethiopian origin, and carry a coupon rate of between LIBOR+1.25% to LIBOR+2% depending on the tenor, and are available in a variety of international currencies. In China, banks are issuing bonds to fund domestic hydropower projects. In India, the government is proposing an issue of 30-year bonds to fund hydro. In Pakistan, the Water and Power Development Authority (WAPDA) is planning an issue of sukuk (Islamic) bonds backed by its existing infrastructure assets to finance new hydro.

In North America, Europe and elsewhere, bond funds have been established to invest in hydropower, although these are often aimed at the acquisition of existing assets rather than new-build. As an example, German-based Aquila Capital has launched a 20-year bond for investment exclusively in hydropower assets.

Green bonds

There is a growing market in green bonds for the development of environmentally sustainable infrastructure projects. This class of fixed-coupon and tenor instruments was introduced by the multilateral development banks in the first decade of this century, with bonds issued by the European Investment Bank, World Bank, African Development Bank and others. Unlike other development bank bond issues, green bonds proved popular with long-term commercial investors.

More recently green bonds have been issued by corporations such as EDF, Engie and Iberdrola to fund sustainable energy projects including hydro. Brookfield Renewable issued a green bond for its Kokish hydro plant, and NTE and BKK of Norway have issued green bonds to fund hydropower. In Asia, the Sumitomo Mitsui Banking Corporation (SMBC) has launched a green bond fund which is likely to include hydropower among the renewables in which the fund is invested.

However, the definition of 'green' has not been fully resolved. The World Bank has provided examples of 'green' projects, and ratings companies and other agencies have attempted definitions. It seems likely that harmonised eligibility criteria will emerge, and the market for such bonds is likely to grow.

Innovative mixed finance

With the availability of equity from a variety of sources, concessionary and commercial debt, bonds and other financial products, the choices available to project promoters is growing. Increasingly, a blend of financial instruments is used to match the needs of hydro promoters through the various stages of development, construction and operation with the appetite and capacity of the financiers.

Financial advisors are becoming adept at innovating to create bespoke solutions, and this is seen as the key to unlocking the pool of capital that is available for hydropower development.

RESETTLEMENT

Resettlement is an aspect of project development that requires a great deal of expertise and sensitivity, and is often a risk factor in causing project delays. During the project preparation phase, clear resettlement strategies, and programmes for compensation and improvement of affected livelihoods should be designed in partnership with affected people. Experience indicates that even well-prepared resettlement programmes can face challenges during implementation. Continuous engagement and monitoring of affected livelihoods are key elements in successful projects.

When resettlement cannot be avoided, it has the potential to add more complexity to hydropower development, regardless of the number of people to be relocated. Lessons learnt from the application of the Hydropower Sustainability Assessment Protocol indicate that resettlement is one of the topics requiring more attention and guidance in the sector, in particular when it comes to the implementation of resettlement programmes.

Good planning is not enough; successful resettlement programmes require effective implementation and long-term monitoring of affected people. In general, the potential risks of resettlement increase with the number of people to be resettled; these risks can have significant impacts on project costs.

The experience of prior protocol assessments indicates that the success of resettlement programmes largely depends on how the elements described below have been prepared and implemented.

1. An assessment of resettlement implications

The socio-economic baseline studies and surveys usually take place during the preparation of the project impact assessment. The assessment should also consider any host communities, and include an economic assessment of costs for resettlement, and for improving living standards of both resettlees and to avoid or address impacts on host communities.

It is important to identify vulnerable sections of the community, different land tenure or occupancy arrangements, livelihoods, and the needs and expectations of all affected groups. Land occupancy may be informal, limiting resettlees' formally recognised rights to land or water. Data on living standards and pre-project conditions will assist in verifying that conditions have improved.

2. A resettlement action plan

The plan will include measures to be implemented as part of the resettlement process, including:

- *A compensation framework, eligibility and options.* If possible, resettlees should be involved in choosing compensation methods. Sometimes options are prescribed by government regulations or resettlement policies, and this has, in cases, posed limitations to providing extra measures for resettlees. Regulatory compensation is often guided by material measures, but experience indicates that if resettlees' livelihoods are land-based, and if consistent with their preferences, land-for-land compensation should be prioritised.
- *Timeframes and budget allocation.* Negotiations, land and assets valuation, compensation and acquisition should start early in the implementation phase. The time required for these activities should not be underestimated, and should be embedded into the overall project planning and implementation. Relocation should avoid critical times, such as harvesting or festive periods.
- *Measures for resettlement assistance and livelihood support, and monitoring procedures.* A review of monitoring results will indicate whether measures require adaptive changes to anticipate and manage new issues. For example, the project could monitor in detail the situation of the 'priority stakeholders' (affected by land acquisition) with regards to livelihoods, living conditions, and opportunities for employment in the project.
- *Organisational roles and responsibilities.* Clear allocation of responsibilities between the project developer and government authorities is very important, particularly when the government has responsibility to implement resettlement. It is vital that project representatives responsible for community liaison are accessible to the affected communities, and strong relationships are maintained.
- *Grievance redress mechanisms.* Processes should be in place for affected groups to raise issues and receive feedback, the developer should implement mechanisms to track and respond to them in a thorough and timely manner.

3. Processes for stakeholder engagement

Resettlement-affected stakeholders, their culture and their needs should be identified to elaborate appropriate two-way engagement and good-faith negotiation procedures. Engagement should commence as early as possible in the preparation stage, and continue through to implementation and operation. Relevant consultation, communication, information disclosure and participation activities should be implemented at appropriate times through the project.

Resettlees and host communities should also be involved in decision-making around relevant resettlement options and issues. For example, they can be involved in the design of new homes, identifying resettlement sites that meet their needs, and identifying impacts and risks. Formal agreements can document results of negotiations. Continuous engagement and surveys among priority stakeholders can measure resettlees' satisfaction with living arrangements.

4. Assessment of legal requirements and tracking conformance and compliance

A process for monitoring and reporting on conformance with the resettlement plan, compliance with national legislation, and (if required) international standards will help to demonstrate how the objectives and responsibilities have been met.

How to guide

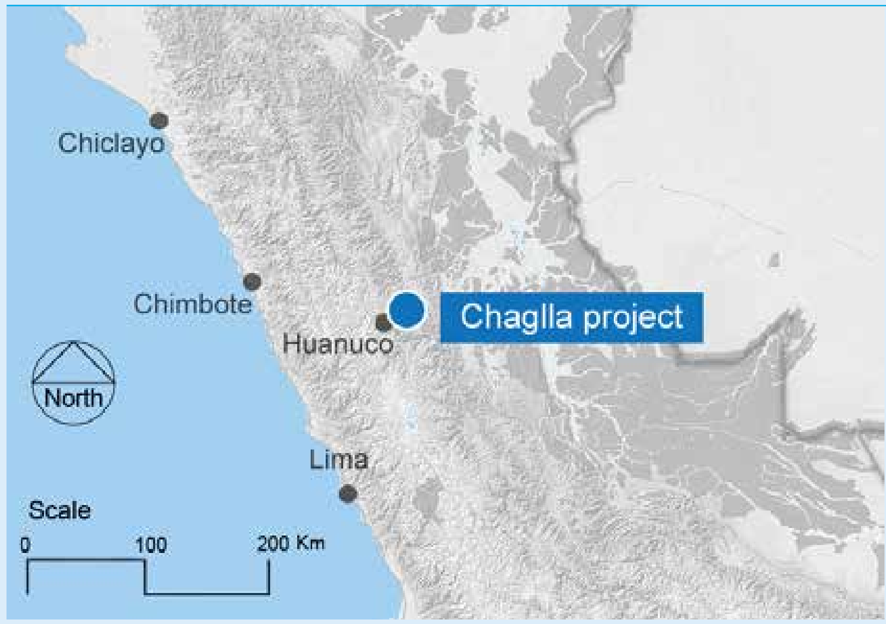
IHA, together with a group of international experts, is developing a 'how-to guide' on the topic of resettlement that will provide further guidance on these and other resettlement considerations through the protocol.

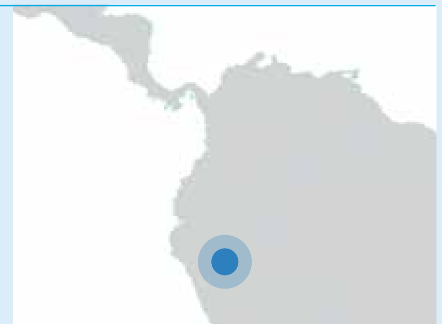
The case study of the Chaglla hydropower plant (see next page) shows examples of resettlement challenges, and how those were managed successfully through the implementation phase. This also shows that even well-prepared resettlement programmes for a relatively low number of people have to adapt and prepare for unforeseen risks.

Resettlement longhouse of the Murum hydropower project in Sarawak, Malaysia

CASE STUDY

RESETTLEMENT CASE STUDY: CHAGLLA





The Chaglla hydropower project (456 MW) is located on the upper Huallaga River on the eastern slopes of the Andes in Peru. The Huallaga River is a tributary to the Marañón River, which becomes the Amazon River when it joins with the Ucayali River. Empresa de Generación Huallaga S.A. (EGH), which was acquired by Odebrecht Energia S.A. in 2009, is the project developer and operator.

The dam forms a narrow 17 km long, 4.66 km² reservoir with a volume of 345 million m³. The project required a 29 km access road on the left bank, from the main road at Chinchavito bridge located downstream, to the dam site; and a 25 km long 34 kV transmission line from Piedra Blanca to provide power for construction. The project will feed into the national grid via a 127.5 km long 220 kV transmission line to a substation at Paragsha in the Pasco region.

Administratively, the project influence area is divided between Chinchao in the province of Huánuco, and Chaglla in the province of Pachitea. Most affected locations are in an area of traditional collective ownership. In 2010, some 3,000 people lived in the influenced area of the project (excluding the corridor for the transmission line). The Huánuco region is one of the least developed in Peru and has experienced outward migration for some time.

The project required the physical displacement of 33 families. In terms of compensation, householders were given a choice between receiving a new home – built a similar style, at least the same size and of better quality than the vacated property – or an equivalent cash compensation. Only five out of the 33 families opted to receive a replacement house, while the other 28 families preferred to receive monetary compensation.

The affected families were monitored closely and received priority in negotiations and employment opportunities. Almost all of them were involved in agriculture, and also received compensation for lost land or crops and/or were provided with new land.

A small number of the resettled families now reside in other communities, mostly in larger towns such as Tingo Maria and Huánuco. There were no expropriations or legal cases, and very few complaints from resettlees about the process and outcomes of resettlement. There were no notable impacts on host communities.

As is often the case, management practices had to be adaptable in order to address evolving challenges. These were typically resolved in close cooperation with community leaders. For example, at Chulla, near the main construction plant, there were fraudulent land sales by local residents and a small community established itself there, only to have to leave again with the support of the project. The intention of the occupants was probably to obtain compensation payments or to benefit from their close proximity to the construction site by setting up small shops. Some of the new occupants built houses at the site. Although they were not required to, EGH paid compensation to 15 households, which were relocated from this site.

There were also concerns with the timing of compensation for a number of occupiers in the reservoir area prior to filling. This issue was resolved through continuous dialogue and negotiations with the occupiers, avoiding the need to enter into a judicial process, which could have delayed the project scheduling.

The case study is based on the findings of an application of the Hydropower Sustainability Assessment Protocol undertaken by accredited assessors in June 2015. The topic of resettlement scored 5 on this assessment. A score of 5 – the highest possible – represents proven best practice. For further information on the Protocol and the Chaglla assessment, please visit: http://www.hydrosustainability.org.

INDIGENOUS PEOPLES

One of the greatest challenges for hydropower developers is to understand and properly manage project activities that affect indigenous peoples and their land. Experience shows that successful projects have dedicated time to consulting with indigenous peoples, respecting their cultures and practices, and ensuring that the project brings tangible benefits to communities affected.

Indigenous peoples account for 4.5 per cent of the global population. Living in more than 70 countries, they continue to be among the most marginalised and vulnerable population groups worldwide. Indigenous peoples can play a key role in protecting natural resources and hold a unique position in preserving traditional knowledge and ways of life.

Past hydropower projects have not always managed impacts on indigenous peoples in a consultative and balanced manner. The typical impacts of projects on these communities may include physical and economic displacement; reduced or loss of access to resources; increased exposure to outsiders, health risks and diseases; loss of cultural values, customs and sites of spiritual or cultural heritage; increased vulnerability of certain community groups (e.g. women, elders); and livelihood impacts. Managing these issues can be even more challenging in countries where there is no clear recognition or demarcation of indigenous peoples' land; lack of legislation recognising and protecting their rights; and less defined governance mechanisms, consultation or decision-making procedures relating to indigenous peoples' rights.

Addressing these issues requires comprehensive planning as well as a solid understanding of the reality of working with isolated, vulnerable communities. It is necessary to balance the needs and aspirations of individuals and groups in the community, which are likely to be quite varied.

In addition to obtaining agreements with individual leaders or gatekeepers, it is also important to bear in mind the project's impact on the established social organisation of the community in question.

As all communities are heterogeneous, it is necessary to have a good understanding of the internal organisation of the community and the diversity of needs across the various sub-groups in the community. These sub-groups may have highly varied aspirations, for example, mothers may be seeking to ensure a higher quality of life for their children, while elders may seek to perpetuate their status in the community and decision-making powers. Working successfully with indigenous people requires sensitivity to the rights and wants of all sub-groups within a community.

Experience from sustainability assessments

Gaining a comprehensive understanding of the challenges, nuances and aspirations of the various sub-groups should be the first step in a process of continuous engagement to manage the potential impacts of a project on a particular community, and the uncertainty which may be experienced as a result of the anticipated changes. . The Hydropower Sustainability Assessment Protocol provides a comprehensive, systematic means of approaching indigenous peoples' issues.

To date, there have been ten assessments of projects affecting indigenous peoples across a range of different countries, and development and economic contexts. Projects performing well on this topic have continuously worked from the pre-feasibility stage to engage and consult with indigenous peoples, respecting their culture, providing support and understanding their needs to deliver significant benefits.

A sound baseline incorporating local knowledge, and good-faith negotiations and grievance mechanisms agreed with the community are key steps during the preparation phase, and engagement should continue during the implementation and operation phases.

Experience shows that good preparation alone does not guarantee the success of the implementation phase, as new issues and risks may emerge that were not anticipated, and which may require additional management measures. For example, significant issues arising from assessments of projects under construction include delays in the implementation of indigenous peoples' programmes, and lack of capacity from agencies responsible for liaising with indigenous peoples.

Assessments have also highlighted examples of good practices to deliver benefits to indigenous peoples, such as project partnerships with indigenous peoples, which share part of the project revenue through the project operating life; improved skills through training programmes and employment opportunities; directly-negotiated contracts to provide long-term jobs; and compensation-benefit agreements to improve self-sufficiency in the long term.

How-to guide

IHA has brought together an international working group to develop a how-to guide on the topic of indigenous peoples, aiming to provide developers with practical guidance on interaction with these communities. It will be designed to be used by project planners, developers, owners and operators and aims to allow a non-expert to go through the process of addressing indigenous peoples on any hydropower project in relation to the Hydropower Sustainability Assessment Protocol. It will provide guidance on how to meet a score of 3, representing basic good practice, and later a score of 5, representing proven best practice, using the preparation, implementation and operation tools of the protocol.

The guide will be available in its final form later in 2016.

Photo credit: Bernt Rydgren

A protocol-accredited assessor interviewing indigenous peoples representatives during the Kabeli-A project assessment in Nepal (September 2014).

SUSTAINABILITY: PROJECT ASSESSMENTS IN 2015/16

The Hydropower Sustainability Assessment Protocol, launched in 2011, is a framework for assessing project sustainability across a range of social, environmental, technical and economic considerations. It was developed by a multi-stakeholder community of governments, commercial and development banks, social and environmental NGOs, and industry.

During 2015, the protocol continued progress around the world and has been widely applied, with increased uptake in developing countries. It has now been used in all regions of the globe.

The period has also seen a diversification of users, from industry-leading companies to other hydropower stakeholders such as the financial sector, governments and civil society.

As the managing body of the protocol, the International Hydropower Association supports the governance structures for the protocol. It also leads training courses for companies, banks and accredited assessors and facilitates assessments using the tool.

Recent protocol applications

There were five official project assessments between January 2015 and January 2016. Notably, this included one of the first applications of the protocol's early stage tool, which focuses on preliminary screening of potential projects from a sustainability perspective. This also represented the first application of the protocol in Africa.

This period has also seen greater uptake in developing and middle-income countries. Assessments have been implemented through 'sustainability partnerships', in which IHA works with a company to provide training and support, followed by the first assessment, and the period also saw a number of repeat assessments, with companies choosing to re-use the tool on different projects. Notably, the World Bank has commissioned a second protocol assessment through a competitive tender process.

The sustainability partnership model has proved successful in simplifying initial engagement with the tool, and will continue to be important for introducing new projects and users to the protocol. Partners now include developers across the globe, and extend beyond IHA's membership to governments, civil society and financial institutions.

The ability to demonstrate how the protocol works through published assessments has also built awareness of the tool's value, and has driven further interest. The assessment of the Chaglla project (456 MW) in Peru was a particularly important landmark, being the first published assessment in Latin America outside Brazil.

Looking forward, the sustainability partnership model will continue to evolve. While it continues to be a way for a growing body of developers and owners to engage with the protocol, it will also become a means of evaluating projects for finance and regulatory approval, and provide a framework for management systems and internal sustainability capacity-building.

The offerings available through the protocol will also grow in the next months and years to include focused training, assisted self-assessments and learning-by-doing to topic-specific workshops aimed at providing guidance on how to achieve 3 and 5 scores on specific protocol topics.

Projects

The protocol continues to enjoy strong support from third parties, and the contribution of SECO and Norad are gratefully acknowledged. The SECO project focuses on the early stage tool and providing support around protocol communication, while the Norad project focuses on driving protocol uptake in developing economies.

IHA is also working closely with the World Bank Group in driving protocol uptake through direct projects, including assessments and capacity-building workshops.

Training

There have been 42 training workshops run to date, ten of which took place between January 2015 and January 2016. The training has taken place across the spectrum of development agendas, in all regions in the world.

The training materials have expanded from week-long courses run by IHA to a fully flexible set of materials that is adaptable to the needs of each user. These materials are continually updated and expanded.

Besides providing training for sustainability partners before assessments, IHA provides support for introductory workshops for the full range of stakeholders now engaging with the protocol.

PUBLICATIONS

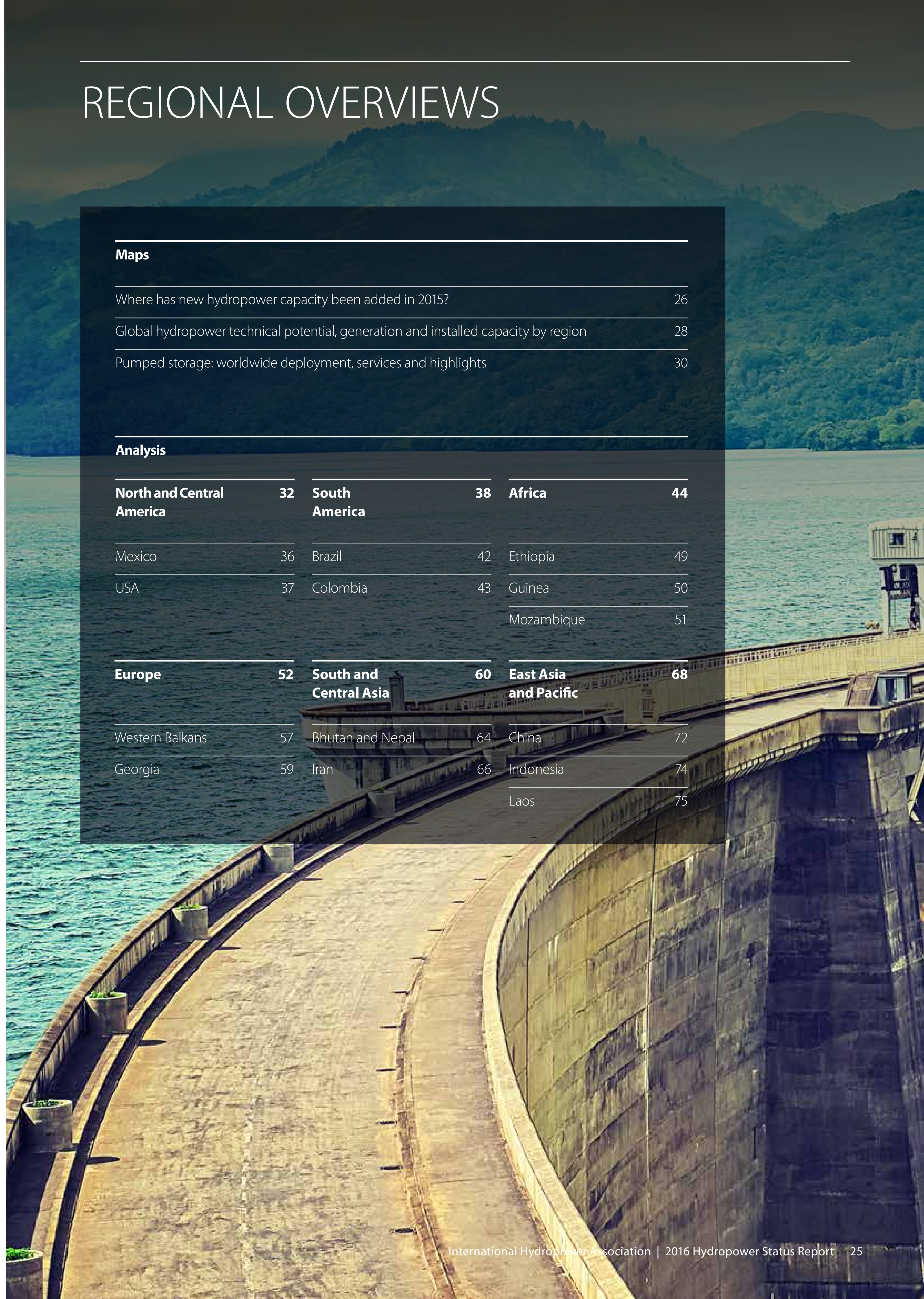
Many organisations now refer to the protocol in their own literature. A library of references is available at www.hydrosustainability.org/references.aspx and summarised here:

- Citibank: Hydropower sector brief
- Government of Germany: Compliance with environmental and social standards for large dam projects
- E.ON: The Hydropower Sustainability Assessment Protocol in practice – a utility's perspective
- International Commission for the Protection of the Danube River: Sustainable Hydropower Development in the Danube Basin: Guiding Principles
- IIED: Hydropower sustainability assessments can unlock carbon financing
- IIED: A review of social and environmental safeguards for large dam projects
- IIED: The business case for bilateral support to improve sustainability of private sector hydropower
- Organisation for Economic Co-operation and Development: Common Approaches
- Standard Chartered Position Statement: Dams and Hydropower
- WWF: Everything you need to know about the UN Watercourses Convention

SUSTAINABILITY: PROJECT ASSESSMENTS IN 2015/16

Protocol outreach January 2015 – January 2016

	Developer	Country	Date
1	Training with the Ministry of Power	**Ghana**	Jan-15
2	Training with TIWAG in Innsbruck	**Austria**	Jan-15
3	Early stage assessments	**Ghana**	Apr-15
4	Assessment with China Three Gorges Corporation	**Laos**	Apr-15
5	Training in collaboration with WWF	**Zambia**	Apr-15
6	Various protocol events at the 2015 World Hydropower Congress	**China**	May-15
7	Assessment of the Chaglla project	**Peru**	Jun-15
8	Training with the World Bank in Washington DC	**USA**	Jun-15
9	Training with the Chilean Generators Association in Santiago	**Chile**	Aug-15
10	Assessment of the Itaipu project	**Brazil - Paraguay**	Aug-15
11	Training with the China Society of Hydropower Engineering in Chengdu	**China**	Aug-15
12	Training in collaboration with WWF in Jinja	**Uganda**	Oct-15
13	Training with the Mangdechhu Hydroelectric Project Authority	**Bhutan**	Nov-15
14	Assessment of the Mangdechhu project	**Bhutan**	Jan-16
15	Training with EDF in Paris	**France**	Jan-16



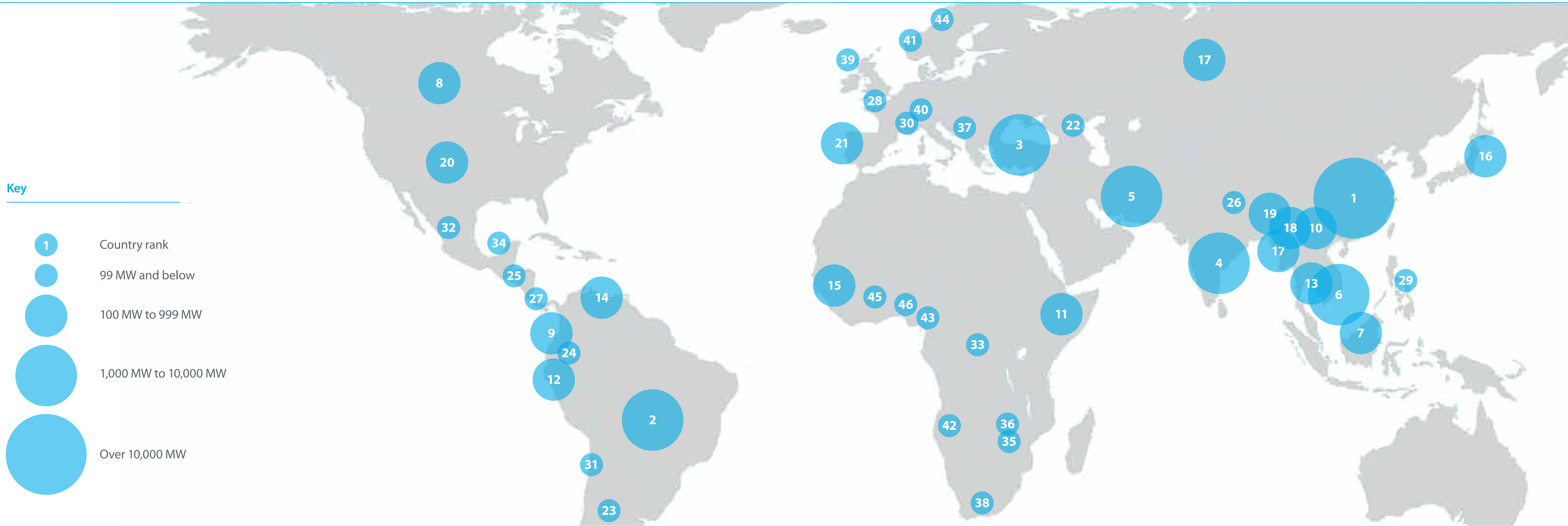
REGIONAL OVERVIEWS

Maps

Analysis

WHERE HAS NEW HYDROPOWER CAPACITY BEEN ADDED IN 2015?

WHERE HAS NEW HYDROPOWER CAPACITY BEEN ADDED IN 2015?



NEW INSTALLED CAPACITY BY COUNTRY*

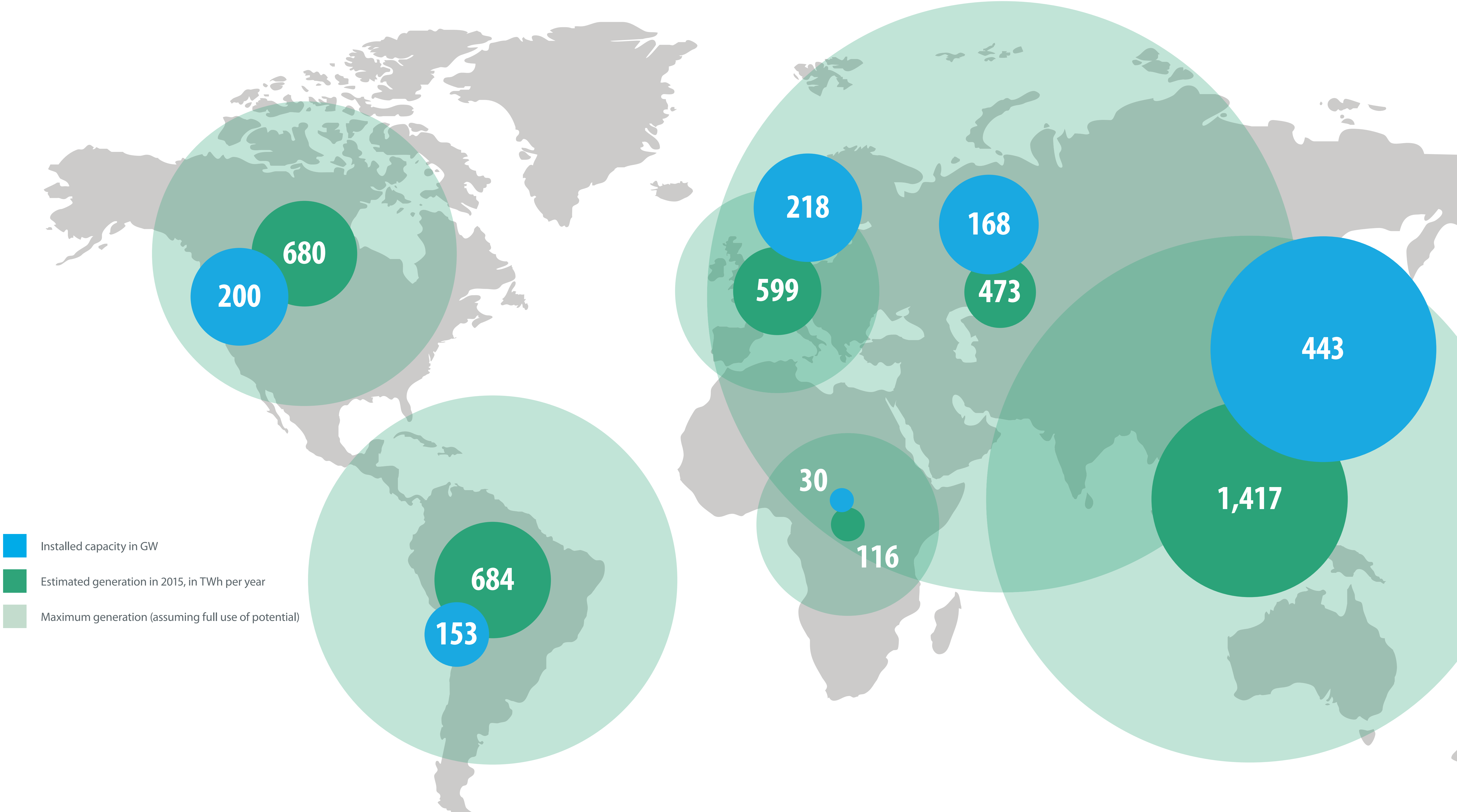
Rank	Country	Capacity added (MW)
1	China**	19,370
2	Brazil	2,457
3	Turkey	2,225
4	India	1,909
5	Iran	1,040
6	Vietnam	1,030
7	Malaysia	719
8	Canada	708
9	Colombia	599
10	Laos	599
11	Ethiopia	374
12	Peru	370
13	Cambodia	338
14	Venezuela	257
15	Guinea	240
16	Japan	232
17	Russia	156
18	Myanmar	140
19	Bhutan	126
20	United States	117
21	Portugal	104
22	Georgia	87
23	Argentina	65
24	Ecuador	60
25	Costa Rica	50
26	Nepal	47
27	Panama	33
28	France	30
29	Philippines	29
30	Switzerland	28
31	Chile	25
32	Mexico	25
33	DR Congo	23
34	Nicaragua	17
35	Zimbabwe	15
36	Zambia	15
37	Macedonia	11
38	South Africa	10
39	United Kingdom	9
40	Austria	9
41	Norway	7
42	Angola	6
43	Cameroon	5
44	Sweden	5
45	Ghana	4
46	Nigeria	0.4

*including pumped storage

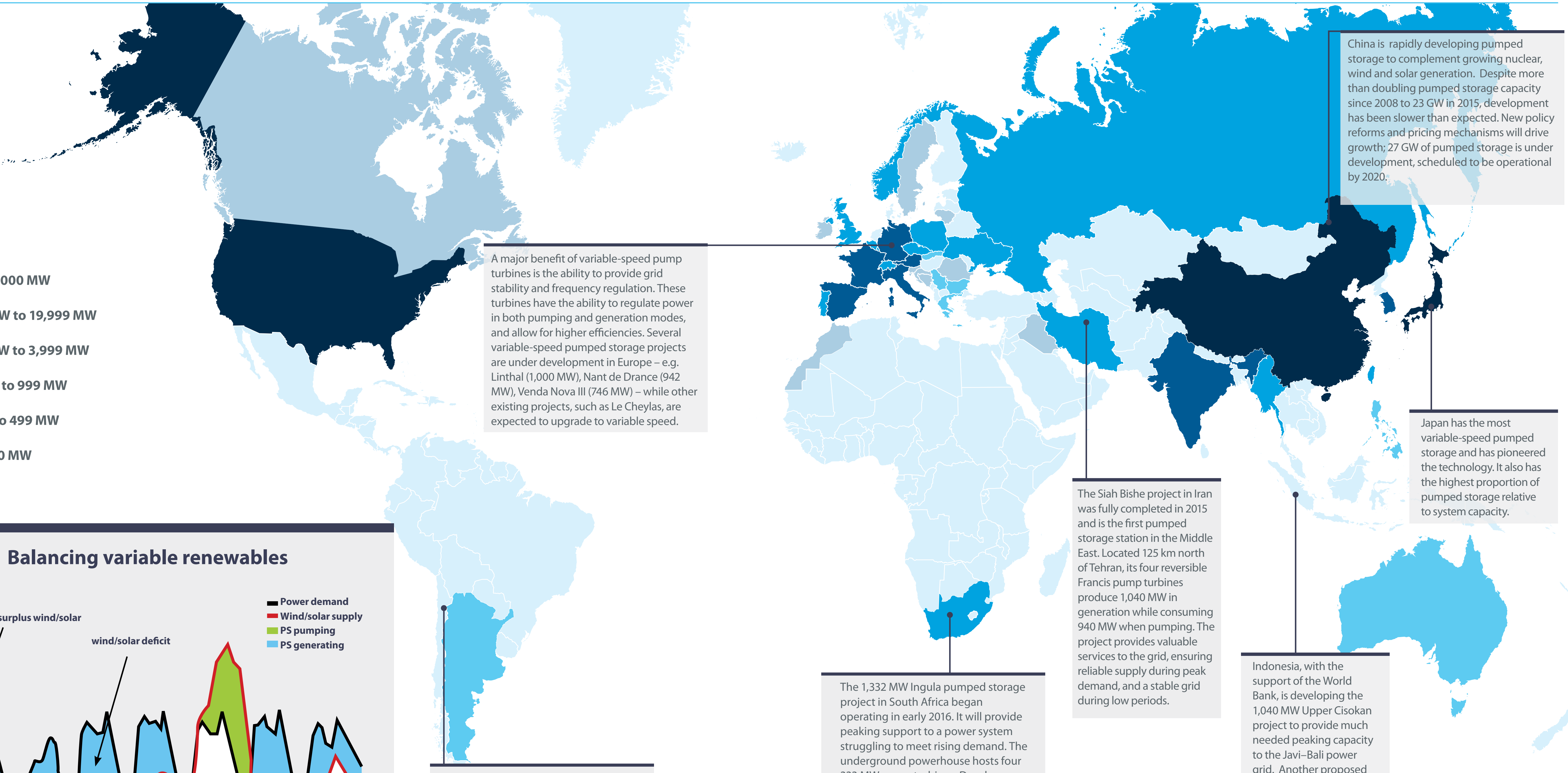
** Due to uncertainty about full station commissioning dates falling between 2014 and 2015, IHA's Hydropower Status Report is reporting 19 GW added in 2015, and REN21's Global Status Report is reporting 16 GW.

GLOBAL HYDROPOWER TECHNICAL POTENTIAL, GENERATION AND INSTALLED CAPACITY BY REGION

GLOBAL HYDROPOWER TECHNICAL POTENTIAL,
GENERATION AND INSTALLED CAPACITY BY REGION



PUMPED STORAGE: WORLDWIDE DEPLOYMENT, SERVICES AND HIGHLIGHTS



A major benefit of variable-speed pump turbines is the ability to provide grid stability and frequency regulation. These turbines have the ability to regulate power in both pumping and generation modes, and allow for higher efficiencies. Several variable-speed pumped storage projects are under development in Europe – e.g. Linthal (1,000 MW), Nant de Drance (942 MW), Venda Nova III (746 MW) – while other existing projects, such as Le Cheylas, are expected to upgrade to variable speed.

China is rapidly developing pumped storage to complement growing nuclear, wind and solar generation. Despite more than doubling pumped storage capacity since 2008 to 23 GW in 2015, development has been slower than expected. New policy reforms and pricing mechanisms will drive growth; 27 GW of pumped storage is under development, scheduled to be operational by 2020.

Japan has the most variable-speed pumped storage and has pioneered the technology. It also has the highest proportion of pumped storage relative to system capacity.

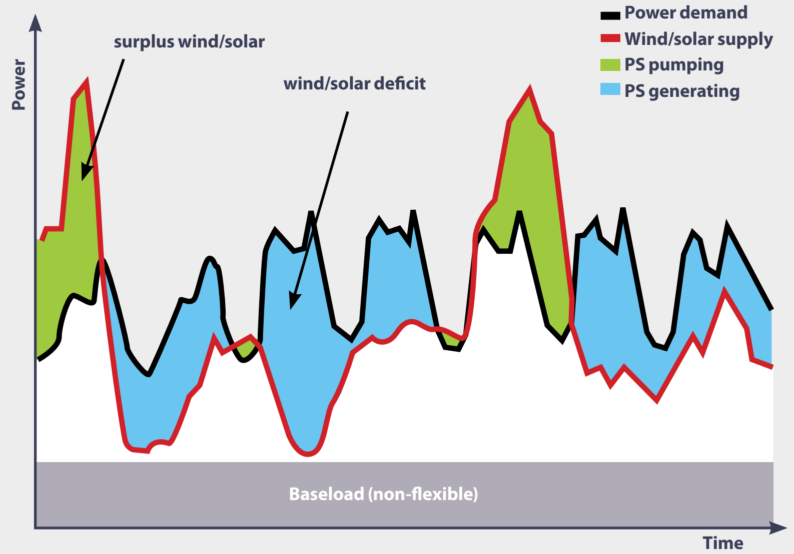
The Siah Bishe project in Iran was fully completed in 2015 and is the first pumped storage station in the Middle East. Located 125 km north of Tehran, its four reversible Francis pump turbines produce 1,040 MW in generation while consuming 940 MW when pumping. The project provides valuable services to the grid, ensuring reliable supply during peak demand, and a stable grid during low periods.

The 1,332 MW Ingula pumped storage project in South Africa began operating in early 2016. It will provide peaking support to a power system struggling to meet rising demand. The underground powerhouse hosts four 333 MW pump turbines. Developers have taken great lengths to minimise the impact on the fragile wetland and grassland ecosystems.

Indonesia, with the support of the World Bank, is developing the 1,040 MW Upper Cisokan project to provide much needed peaking capacity to the Javi–Bali power grid. Another proposed project nearby, the 880 MW Matenggeng, began feasibility studies in 2015.

Chile announced that it is investigating a 300 MW pumped storage project that would complement a 600 MW solar park nearby. The hybrid system would exploit Chile's natural coastal geography and high solar irradiation to provide steady power by pumping seawater to the reservoir during the day, and releasing it at night. The project will not require the construction of a dam.

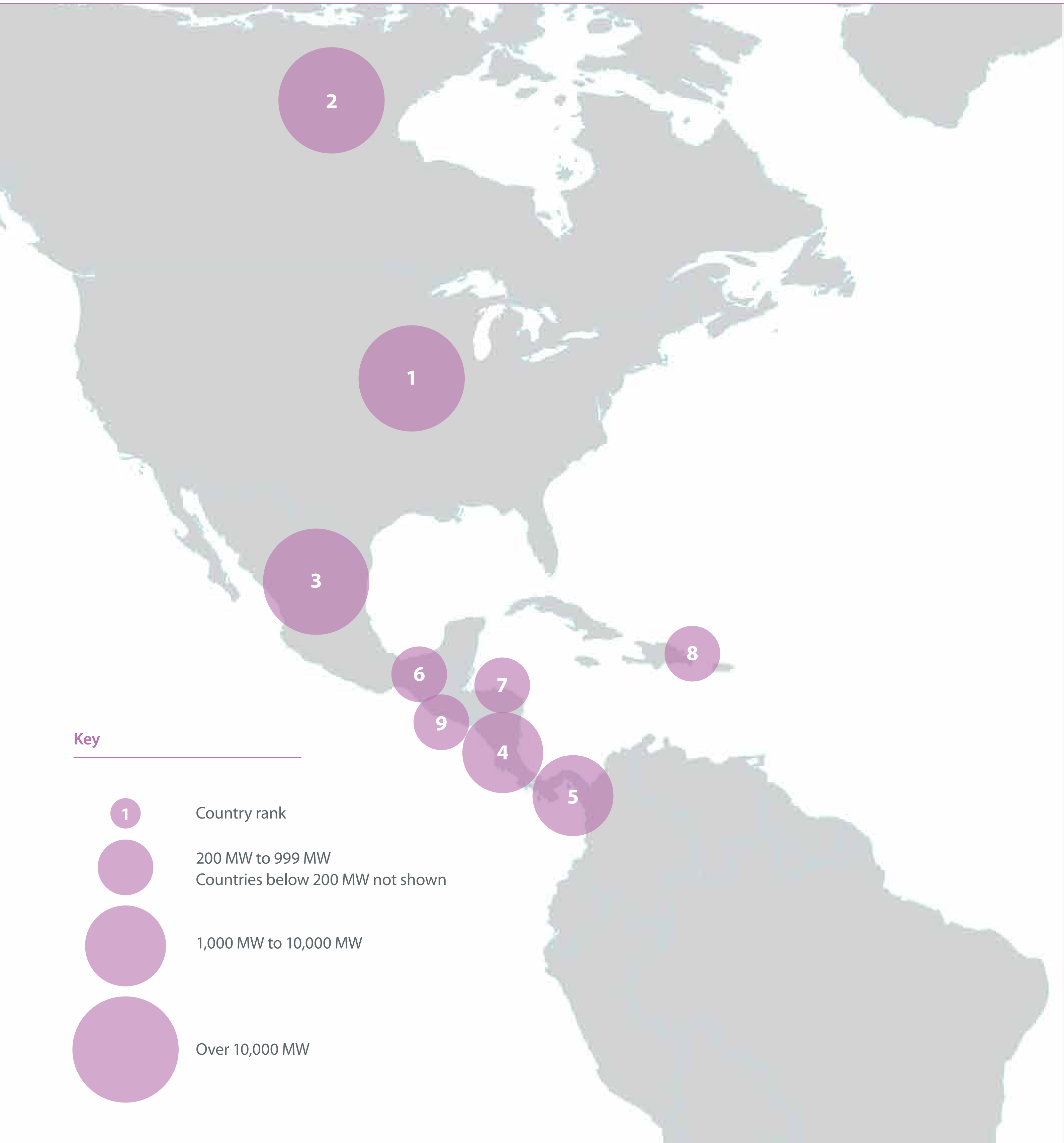
Balancing variable renewables



NORTH AND CENTRAL AMERICA **REGION MAP**

TOP SIX COUNTRIES BY INSTALLED HYDROPOWER CAPACITY (MW)* — **OTHERS:** 2,019 | **TOTAL: 199,857**

1	2	3	4	5	6
UNITED STATES 101,755	CANADA 79,202	MEXICO 12,435	COSTA RICA 1,800	PANAMA 1,655	GUATEMALA 991



NORTH AND CENTRAL AMERICA
CAPACITY BY COUNTRY

Rank	Country	Installed hydropower capacity (MW)*
1	**United States**	101,755
2	**Canada**	79,202
3	**Mexico**	12,435
4	**Costa Rica**	1,800
5	**Panama**	1,655
6	**Guatemala**	991
7	**Honduras**	558
8	**Dominican Republic**	543
9	**El Salvador**	472
10	**Nicaragua**	123
11	**Puerto Rico**	100
12	**Cuba**	64
13	**Haiti**	61
14	**Belize**	53
15	**Jamaica**	23
16	**Guadeloupe**	10
17	**Saint Vincent and the Grenadines**	7
18	**Dominica**	6

* includes pumped storage

NORTH AND CENTRAL AMERICA **OVERVIEW**

The United States and Canada are among the world's leading countries in terms of installed hydropower capacity, with 101.8 GW and 79.2 GW respectively (including pumped storage).

Hydropower currently contributes around 6 per cent of total electricity in the United States, while the figure in Canada is 63 per cent. Although both countries have very similar installed hydropower capacities, the share of hydropower in the generation mix is much higher in Canada due to the smaller size of the overall electricity system and diversity of watersheds relative to that of the US.

The electricity grids and markets of the USA and Canada are already well integrated, and Canada is a net exporter of electricity to the USA, currently exporting nearly 60 TWh per annum. There is the potential to increase the export of Canadian hydropower into the USA, which will depend on new cross-border transmission interconnections.

Transmission projects currently under development include the Champlain Hudson Power Express, a 1,000 MW line from the Canadian border to New York City, which is expected to be complete by 2017, and the Great Northern Transmission Line, an 833 MW line linking the states of Manitoba and Minnesota.

Demand for clean electricity in the US is driving the deployment of new hydropower projects in Canada, where more than 4,000 MW of capacity is under construction or near to entering the construction phase. An additional 7,000 MW of new capacity in the country has been announced or is in the early stages of development.

Notable milestones in 2015 include the completion of the 270 MW Romaine-1 station. Hydro-Québec announced the commissioning of the station's second and final turbine in December, eight months ahead of schedule. The Romaine-2 (640 MW) was commissioned at the end of 2014. Two new stations will be built at the site, Romaine-3 (395 MW) and Romaine-4 (245 MW), which are expected to be completed in 2017 and 2020 respectively. In total, the four-station Romaine complex will bring 1,550 MW in installed capacity to the grid.

Other notable deployments in Canada last year include the 21.2 MW Tretheway Creek run-of-river scheme and the 355 MW expansion of the Waneta facility in British Columbia.

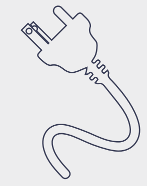
In Central America, Costa Rica made the headlines, achieving 100 per cent renewable electricity for 285 days of the year. 75 per cent of the country's electricity is provided by hydropower, which can support the increased penetration of more variable renewable sources.

Costa Rica also commissioned the 50 MW Torito project in November, which is accredited by the UN Clean Development Mechanism. This station, which was built and will be operated by Gas Natural Fenosa, a Spanish company, is on the Reventazón River and operates in cascade with the La Joya (50 MW) and Angostura (170 MW) hydropower plants.

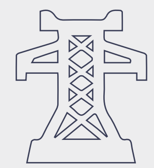
2015 saw Nicaragua commission its first hydropower project in 40 years: the 17 MW Larreynaga storage project. Located downstream of the existing Centro America hydropower station, the station was financed through funds from the Inter-American Development Bank, the Central American Bank for Economic Integration and Enel. It will generate an estimated 73 GWh per year and is an important step to meet the country's goal of 90 per cent power generated from renewable sources by 2020.

Meanwhile in Panama, Empresas Públicas de Medellín (EPM), a Colombian utility, commissioned the 32 MW Bonyic hydropower project in February.

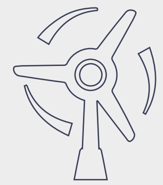
POLICIES



Canada
Program of Energy Research and Development (PERD) supports research and development for hydropower. The feed-in tariff programme in Ontario includes 40-year contracts for hydro plants, with specific incentives for projects featuring aboriginal and community participation.



Mexico
Grid interconnection contract for renewable energy supports small hydropower installations, requiring utilities to prioritise renewable sources and providing discounts of 50 to 70 per cent for transmission costs.



United States
The Wind and Water Power Program funds research and development on materials and manufacturing techniques to improve performance and lower costs of conventional hydropower. It also supports the development of marine and hydrokinetic technologies.

HYDROPOWER TARGETS

Country	Target
Canada	Reduce greenhouse gas emissions by 30 per cent below 2005 levels by 2030. 1.5 GW by 2025 in Ontario.
USA	Targeted share of renewables in electricity consumption of 15 per cent by 2017, 17.6 per cent by 2019 and 20 per cent by 2020.

NORTH AND CENTRAL AMERICA
MEXICO

Historically, hydropower has played a crucial role in electricity generation in Mexico. In remote parts of the country, stations dating from the 1920s remain in operation. Today, hydropower is the largest source of renewable energy in Mexico. At the end of 2015, 22 per cent of the country's total installed capacity was hydropower, accounting for 12 per cent of electricity generation.

Mexico has a considerable technical hydropower potential, which has been estimated at 53,000 MW, of which 27,000 MW have been estimated as economically feasible. The country added 25 MW of installed hydropower capacity in 2015, but also took 266 MW offline, bringing the total hydropower capacity to 12,028 MW, which is almost half of the economically feasible potential.

Mexico has set ambitious targets for the development of new renewable energy capacity. The General Law for Climate Change sets a national goal for renewables to make up 35 per cent of the electricity mix by 2024 and 50 per cent by 2050. In addition, Mexico's intended nationally determined contribution (INDC) submission to the United Nations Framework Convention on Climate Change (UNFCCC) includes the unconditional commitment to reduce greenhouse-gas emissions by 25 per cent below the business-as-usual scenario by 2030.

Faced with rising demand for electricity driven by urbanisation and expansion of the industrial sector, meeting these goals will be a significant challenge for the country. A key strategy will be increasing investment in new power plants with a view to bolster the share of natural gas in the mix; in 2014, natural gas comprised 40 per cent of the country's total energy consumption. Nonetheless, new renewable energy deployments will also be crucial to meet the country's targets.

The current installed hydropower capacity is concentrated in the western and south-western regions of the country, in river basins that drain into the Pacific. For example, three of the country's largest projects are located in the Río Grijalva basin in the south-east: Chicoasén (2,400 MW), Malpaso (1,080 MW) and Angostura (900 MW). All of these stations are owned and operated by the state-owned Comisión Federal de Electricidad (CFE).

CFE is the major player in the Mexican electricity sector, managing over 75 per cent of the country's generating assets, and the country's entire transmission and distribution infrastructure. CFE has identified approximately 100 river basins that are suitable for hydropower development, and is currently carrying out a number of studies on the sustainability of particular sites. For example, a study carried out in collaboration with the Nature Conservancy found that up to 40 per cent of hydropower potential in the Coatzacoalcos River basin could be developed with very little impact on river connectivity and downstream flow regimes. Basins like the Coatzacoalcos, which currently contain no major dams, will provide CFE with the opportunity to pioneer basin-level planning for sustainable hydropower development.

In 2015, CFE also signed a memorandum of understanding with Innergex, a Canadian power producer, to jointly study potential renewable energy project opportunities in Mexico, especially hydropower plants of less than 200 MW in capacity.

Private sector involvement is also expected to increase; major reforms to the energy market beginning in 2015 lifted restrictions on the private ownership of hydropower stations greater than 30 MW in capacity, significantly increasing the potential role of independent power producers in the Mexican market.

POPULATION
125,386,000

GDP
USD 1,295 bn

INSTALLED HYDROPOWER CAPACITY
12,435 MW

HYDROPOWER GENERATION
30,127 GWh

NORTH AND CENTRAL AMERICA
USA

Hydropower is already a highly developed sector in the United States. It is the country's largest source of renewable electricity, occupying almost half the share of generation from renewables in 2014 and providing around 6 per cent of the country's total power.

Although there is the potential for hydropower development in every US state, installed capacity is currently concentrated in the Pacific Northwest. The Columbia River basin alone provides more than 40 per cent of the country's hydropower. There is also a considerable deployment in New York State and the New England states in the north-east of the country.

There is the potential to develop a large amount of additional hydropower capacity in the United States – more than 65,000 MW in stream-reach developments, according to the US Department of Energy. A further 12,000 MW could be brought online by adding powerhouses to existing dams and water infrastructure.

There are more than 80,000 dams in the US, of which only 3 per cent currently have electricity-generating equipment installed. Adding power-producing capability to just 100 of the most viable sites – mostly locks and dams on the Ohio, Mississippi, Alabama and Arkansas Rivers managed by the US Army Corps of Engineers – could contribute approximately 8 GW of new hydropower capacity.

Nonetheless, investment has remained limited, partly due to uncertainties in the country's energy policy, markets and regulatory environment, which have discouraged capital investment. Social and environmental challenges have also dissuaded new development in some areas of the US.

In the US, hydropower is the only renewable electricity resource licensed at the federal level. It is also subject to reviews from the state and local levels of government. The US Congress is currently considering multiple pieces of legislation to update and modernise the licensing and relicensing process for non-federal hydropower projects.

Policy priorities differ from state to state, with some regions of the country moving more aggressively on clean and renewable energy programmes than others. However, the recognition and treatment of hydropower as a clean or renewable resource under these policies, including programmes like the Renewable Portfolio Standards (RPS), varies significantly from state to state. This further complicates the advancement of hydropower or other renewable options both within the US and in partnership with Canada.

Non-federal hydropower projects are subject to regulation by the Federal Energy Regulatory Commission (FERC). There are currently 223 proposed projects registered with FERC, which would amount to 23,981 MW of installed capacity. These projects are currently in various phases of the FERC licensing process (Preliminary Permits Pending, Preliminary Permits Issued and Original License).

American Municipal Power (AMP), a non-profit corporation, has been particularly active in new developments on the Ohio River. Three new run-of-river facilities totalling 191 MW in capacity are expected to commence commercial operation later in 2016. These projects – Cannelton (84 MW), Smithland (72 MW) and Willow Island (35 MW) – are all located at existing US Army Corps of Engineers dams. AMP is also expecting to commission the 105 MW Meldahl hydroelectric facility in 2016, a run-of-river project which will become the largest hydropower project on the Ohio River.

Additionally, Consumers Energy, a public utility in Michigan, is investing heavily to upgrade its Ludington Pumped Storage Plant. The USD 800 million renovation includes replacing six existing pump-turbine units, now running at about 70 per cent cycle efficiency, with larger units to improve the power output by nearly 15 per cent.. When complete, the upgrade will increase generating capacity from its current 1,872 MW to approximately 2,172 MW.

POPULATION
318,857,000

GDP
USD 17,419 bn

INSTALLED HYDROPOWER CAPACITY
101,755 MW
INCL. 22,241 MW PUMPED STORAGE

HYDROPOWER GENERATION
250,148 GWh

SOUTH AMERICA
REGION MAP

TOP SIX COUNTRIES BY INSTALLED HYDROPOWER CAPACITY (MW)*					**OTHERS:** 8,828 | **TOTAL:** 152,813
1	**2**	**3**	**4**	**5**	**6**
BRAZIL 91,650	VENEZUELA 15,393	COLOMBIA 11,392	ARGENTINA 10,118	PARAGUAY 8,810	CHILE 6,622

SOUTH AMERICA
CAPACITY BY COUNTRY

Rank	Country	Installed hydropower capacity (MW)*
1	**Brazil**	91,650
2	**Venezuela**	15,393
3	**Colombia**	11,392
4	**Argentina**	10,118
5	**Paraguay**	8,810
6	**Chile**	6,622
7	**Peru**	4,190
8	**Ecuador**	2,297
9	**Uruguay**	1,538
10	**Bolivia**	494
11	**Suriname**	189
12	**French Guiana**	119
13	**Guyana**	1

*includes pumped storage

SOUTH AMERICA **OVERVIEW**

South America remains a key market for hydropower development. The region has seen energy demand increase by one-third in just a decade, largely due to growth in the industrial and commercial sectors. Hydropower forms the backbone of many national power systems in the region, and there remains an estimated 430 GW of unexploited hydropower potential in the region. There is also a large and untapped potential for wind and solar power in the region. As an established load-balancing technology, hydropower can enable the increased penetration of these more variable sources of energy, and this role is becoming more recognised.

Approximately 3.8 GW of new capacity was commissioned in South America in 2015. As in previous years, the majority of new capacity comprised major projects in the Brazilian north-west; however there were also substantial additions in Colombia, Venezuela and Peru.

Chile is one of the region's frontrunners in supporting renewable energy technologies. Chile lacks domestic fossil fuel reserves, and therefore relies substantially on imported fuels for electricity generation. Consequently, the country now has some of the highest electricity prices in the region.

After the gas-supply crisis in 2008, the country re-evaluated its power infrastructure development scheme and imposed changes to diversify its energy mix through the promotion of renewables. The country has since focused much of its efforts on developing solar and wind energy resources, especially in the Atacama Desert, which is home to some of the best solar resources the world.

Energía Valhalla, a Chilean developer, has recently announced plans to build a solar / pumped storage hybrid power station in the Atacama Desert. The project will utilise excess solar power to pump sea water from the Pacific Ocean to a reservoir situated 600m above sea level. The Espejo de Tarapacá pumped storage plant (300 MW) will be connected to the 600 MW Cielos de Tarapacá solar PV plant.

Chile also commissioned two new hydropower stations totalling 25 MW in 2015. The 19.2 MW Picoiquén run-of-river plant was developed by a local firm, Hidro Angol, and will contribute power supply to industrial and commercial activities in the region of La Araucanía. Chile also commissioned the Los Hierros 2 plant (5.5 MW) in Colbún on the Melado River.

Hydroelectric power in Ecuador accounts for almost half of the country's power generation, with the remainder consisting of conventional oil-fired thermal power plants. Most of the nation's existing hydropower capacity is located in the southern-central highlands of the Azuay province. In order to address capacity shortages and to reduce oil-fired generation, the country has announced plans to add 2.8 GW of new hydropower capacity in the coming years. In 2015, Ecuador commissioned the 60 MW Manduriacu hydropower plant. The two Kaplan turbines, designed and constructed by Alstom, were installed in March 2015.

Ecuador has agreed to a number of oil-for-loan deals with China that guarantee oil exports to China in exchange for loans, many of which are dedicated to infrastructure projects involving Chinese companies. Several of these projects are nearing completion in 2016, including the Coca Codo Sinclair (1,500 MW), which is being built by Sinohydro for USD 2.2 billion; Sopladora (487 MW), which is being built by China Gezhouba Group; and Toachi Pilatón (253 MW), which is financed by a Russian consortium and built by CWE. Other stations expected to reach completion in 2016 are Minas San Francisco (275 MW) and Mazar Dudas (21 MW).

Peru commissioned three stations totalling 370 MW in 2015, continuing its drive to develop its considerable hydropower potential. The 172 MW Cheves station commenced operations in September. The station is the first South American project to be entirely developed and constructed by SN Power, a renewable energy company and subsidiary of Statkraft. The project received approximately USD 250 million in financing from the International Finance Corporation (IFC) in 2011. The projected 840 GWh per year will be sold under long-term power purchase agreements (PPAs) with eight local distribution companies.

Additionally, the second phase of the Machu Picchu power plant was completed with the commissioning of the 102 MW Machu Picchu 2 project. The station uses the waters of the Urubamba and Vilcanota rivers to turn a single turbine housed underground. Further downstream the 98 MW Santa Teresa station, which utilises the tail waters from the Machu Picchu stations to generate power, was also connected to the grid.

Venezuela commissioned the third and last 257 MW turbine at the Fabricio Ojeda, bringing the total capacity to 771 MW. The first two turbines were commissioned in 2013 and 2014. The 2,160 MW Manuel Carlos Piar project is also nearing completion on the Caroní River in Venezuela's Bolívar state. Tocoma will eventually house 10 Kaplan turbines. It is situated on the Lower Caroní River, and is the final plant in a major cascade of stations there.

Argentina began filling the reservoir of the Punta Negra station in September 2015. The two-turbine project will inject 65 MW to the national grid, but will also significantly contribute to the regional economy by providing water for irrigation to some 12,000 hectares of arable land. It is the second power station on the San Juan River, which also includes Los Caracoles (132 MW) and Quebrada de Ullúm (45 MW). A financing agreement for a fourth project on the river, the 75 MW El Tambolar, was signed in 2015 between the Argentinian government and PowerChina, and is expected to come online in 2020.

Elsewhere in the South American region, Guyana renewed efforts to develop hydropower in the country through assistance from a USD 80 million grant from Norway to conduct feasibility studies, resulting in five identified sites.

Binational projects in the pipeline include the Garabí-Panambí complex (2,200 MW) on the border of Argentina and Brazil, and the Corpus Christi project (2,880 MW), which will be shared between Argentina and Paraguay. Both these stations are in the pre-implementation stages and are waiting for the necessary approvals.

POLICIES

Chile
Utilities with more than 200 MW capacity will be required to generate 20 per cent of electricity from renewables by 2025. The Invest Chile Programme finances small hydropower projects and currently subsidises pre-investment studies for renewables.

Ecuador
2013–16 feed-in tariffs for hydropower, USD 7.81/kWh for <10 MW capacity, USD 6.86/kWh for 10–30 MW capacity, and USD 6.51/kWh for 30–50 MW capacity, all contracts awarded for a period of 15 years.

HYDROPOWER TARGETS

Country	Target
Argentina	60 MW small-scale hydropower by 2016.
Brazil	7.8 GW small-scale hydropower by 2021.
Ecuador	Increase hydropower's share of total generation from 46 per cent to 85 per cent by the end of 2017.

SOUTH AMERICA
BRAZIL

Hydropower has played an important role in catalysing economic growth in Brazil, and today, the country's installed hydropower capacity is second only to that of China's. Hydropower generation has recently declined due to the multi-year drought affecting several regions in the south-east and north-east, especially the states of São Paulo, Rio de Janeiro, Minas Gerais, Bahia and Pernambuco.

The country's major demand centres are also concentrated in the south-east of the country, and it was here that the first large-scale hydropower development began during the mid-20th century. Today, the majority of unexploited hydropower potential lies further north, largely in the Amazon region, where a number of projects are now under way. With new innovations in transmission and distribution infrastructure, it will be possible to deliver the hydropower generated here to demand centres in the southeast.

Brazil faced a severe drought 15 years ago. As a result, the country was forced to adopt power-rationing measures for eight months due to low reservoir levels. Since then, Brazil has expanded its transmission network and diversified its electricity supply mix while still expanding its hydropower capacity in order to ensure a more stable supply and increase the system's resilience to extreme weather events. When the last major drought occurred in 2001, hydropower had accounted for nearly 82 per cent of the country's electricity mix, as compared to only about 65 per cent today.

Due to the persistent droughts, operators of multipurpose projects have been compelled by the independent system operator to conserve water during the dry season, thereby reducing electricity generation. This provides an interesting example of the water–energy nexus in practice, and raises questions about how the operators of multipurpose projects are compensated for services which bolster resilience to climate change and extreme events.

In this case, the Brazilian government is preparing to compensate hydropower companies for the impacts of the current drought. As a result of their contractual obligations to power distributors, hydropower companies have had to resort to buying thermally generated power from the spot market. The government has proposed a mechanism to allow hydropower operators to recoup losses by granting an extension on current concession contracts, potentially for up to 15 additional years.

Still, Brazilian hydropower capacity has increased by almost 47 per cent since 2001, and in 2015 the country brought over 2.4 GW of new installed capacity online. Most notable is the addition of 1,275 MW at the Jirau Dam, which is situated in western Brazil 80 km from the Bolivian border. Once fully commissioned, the project will have a total installed capacity of 3,750 MW provided by 50 turbines, and will deliver power to the demand centres in south-eastern Brazil.

The Jirau project is part of a planned four-station complex on the Madeira River, which also includes the Santo Antônio run-of-river scheme. The Santo Antônio project will be comprised of 50 turbines totalling 3,568 MW in installed capacity; a further two 69.6 MW turbines were commissioned there in 2015. Both the Jirau and the Santo Antônio projects are expected to be fully commissioned by late 2016.

The other two projects in the Madeira complex are still in the planning phase. Guayaramerín (3,000 MW) will be located on the Brazil–Bolivia border, while Cachuela Esperanza (990 MW) will be situated further upstream in Bolivia.

2015 also saw Brazil install two of five 364 MW turbines at the Teles Pires project on the border of Mato Grosso and Pará and the last of three 84 MW turbines at the Ferreira Gomes project, also in the north. Brazil also commissioned a further 52 hydropower stations in 2015, varying in size from less than 1 MW to 30 MW, and totalling approximately 156 MW.

POPULATION
206,078,000

GDP
USD 2,417 BN

INSTALLED HYDROPOWER CAPACITY
91,801 MW

HYDROPOWER GENERATION
382,058 GWh

SOUTH AMERICA
COLOMBIA

Colombia's current installed electricity capacity is 16,488 GW, with around 70 per cent of this total provided by hydropower. Colombia's mining and power planning unit (UPME) has recently estimated that a further 56 GW of hydropower capacity could be developed in new run-of-river schemes.

The country's hydropower resources are concentrated in the Magdalena River basin. More than 60 per cent of the country's installed hydropower capacity is situated there, along with the majority of planned developments.

The hydropower sector has been very active in Colombia over recent years, benefitting from a well-established regulatory framework and firm policy support for low-carbon and renewable energy technologies. In its intended nationally determined contribution (INDC) to the UN Framework Convention on Climate Change (UNFCCC), Colombia committed to reduce its greenhouse gas emissions by 20 per cent with respect to the projected business-as-usual scenario by 2030.

Further hydropower development will be driven by the rising demand for electricity in the country. There is also considerable interest in developing new water infrastructure for other uses, including navigation, irrigation and flood management. Electricity demand increased by 4.4 per cent in 2014, with total consumption reaching 63,571 GWh in that year.

Increased regional integration will also provide an impetus for continued hydropower development. Colombia is participating in the Andean Electrical Interconnection System (SINEA) project, along with Ecuador, Peru, Bolivia and Chile. This initiative seeks to create a shared energy market between these counties, while securing energy supply in the region and promoting the increased penetration of renewable technologies. A 300 MW capacity interconnection between Colombia and Ecuador is expected to be complete by 2018. In addition to the SINEA project, another transmission line linking Colombia and Panama is also slated for completion by 2018.

Colombia commissioned a considerable amount of new hydropower capacity in 2015. Seven new stations totalling 599 MW commenced operations in the last year, including the Carlos Lleras Restrepo (78 MW), San Miguel (44 MW), Bajo Tuluá (20 MW), Suba (2.6 MW) and Usaquen (1.6 MW) projects.

The 400 MW El Quimbo station was completed in July. El Quimbo represents the first private sector hydropower project to be built in Colombia and it is expected to generate approximately 2.2 TWh per year, further enhancing the security and stability of domestic power supply. This project, which is owned by Emgesa, a subsidiary of the Enel Group, will also generate power for export to neighbouring countries.

Both turbines at the 55 MW Cucuana facility, a run-of-river scheme located in the Tolima department, were commissioned in 2015, in August and November respectively. This project, which is certified under the UN Clean Development Mechanism (CDM), is expected to produce 250 million kWh of electricity each year. It is owned by the operator Empresa de Energia del Pacifico S.A. (EPSA).

According to UPME, more large-scale capacity installations are slated for the next five years, including the 2,400 MW Ituango project, which is expected to come online between 2018 and 2020.

POPULATION
47,791,000

GDP
USD 378 BN

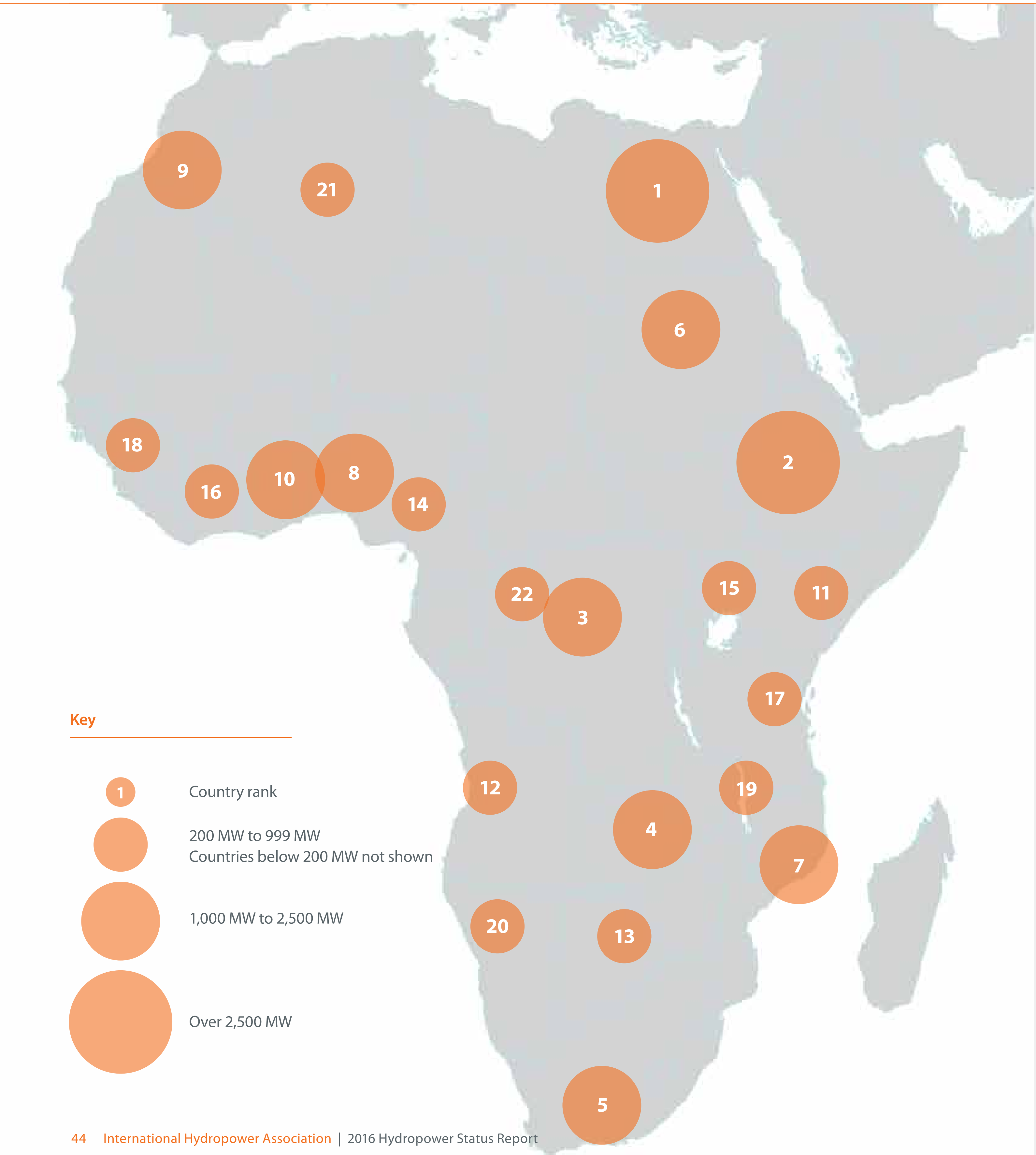
INSTALLED HYDROPOWER CAPACITY
11,392 MW

HYDROPOWER GENERATION
48,026 GWh

AFRICA
REGION MAP

TOP SIX COUNTRIES BY INSTALLED HYDROPOWER CAPACITY (MW)* **OTHERS:** 15,491 | **TOTAL:** 30,111

1	2	3	4	5	6
EGYPT 2,800	ETHIOPIA 2,552	DR CONGO 2,495	ZAMBIA 2,272	SOUTH AFRICA 2,251	SUDAN 2,250



AFRICA
COUNTRY RANKINGS

Rank	Country	Installed hydropower capacity (MW)*
1	**Egypt**	2,800
2	**Ethiopia**	2,552
3	**DR Congo**	2,495
4	**Zambia**	2,272
5	**South Africa**	2,251
6	**Sudan**	2,250
7	**Mozambique**	2,187
8	**Nigeria**	2,040
9	**Morocco**	1,770
10	**Ghana**	1,584
11	**Kenya**	818
12	**Angola**	766
13	**Zimbabwe**	765
14	**Cameroon**	741
15	**Uganda**	706
16	**Côte d'Ivoire**	604
17	**Tanzania**	562
18	**Guinea**	368
19	**Malawi**	364
20	**Namibia**	341
21	**Algeria**	228
22	**Congo**	209
23	**Gabon**	170
24	**Madagascar**	164
25	**Mali**	157
26	**Equatorial Guinea**	127
27	**Réunion**	121
28	**Rwanda**	99
29	**Mauritania**	97
30	**Lesotho**	80
31	**Tunisia**	66
32	**Togo**	65
33	**Mauritius**	60
33	**Swaziland**	60
35	**Burundi**	54
35	**Sierra Leone**	54
37	**Burkina Faso**	32
38	**Central African Republic**	25
39	**São Tomé and Príncipe**	4
40	**Benin**	1
40	**Comoros**	1

*includes pumped storage

AFRICA
OVERVIEW

Many of the fastest-growing economies in the world are situated in the resource-rich African continent. Burgeoning economic growth in the region has been driven by high commodity prices and substantial investment from Asian countries, especially China, which is leading on foreign investment in African infrastructure. However, growth in sub-Saharan Africa has not always been inclusive, and access to modern energy, water and other basic services remains low across the region.

645 million Africans have no access to electricity. Power consumption per capita in Africa is the lowest of all regions at 181 kWh/y (whereas in Europe the rate is 6,500 kWh/y). The hydropower potentials of Europe and Africa are similar; however, Europe has an installed capacity of 218 GW, while Africa only utilises 30 GW.

Moreover, frequent electricity outages and load shedding are the norm in as many as 30 African countries. Energy access will remain high on the policy agenda, especially as the new UN Sustainable Development Goals include a dedicated goal to provide universal access to modern energy services, building on the Millennium Development Goals which they supersede in 2016.

In addition, the New Deal on Energy for Africa, a transformative effort led by the African Development Bank, will drive further dedicated investments through public-private partnerships for innovative financing into energy infrastructure. The initiative has the aspirational goal of achieving universal access to energy on the continent by 2025. Hydropower will play a large role in achieving the New Deal's targets to add 130 million more on grid connections, a 160% increase, and 75 million off-grid connections – a 20 fold increase from today. This amounts to 160 GW of new capacity by 2025.

Hydropower, with some 300 GW of total potential in the region, has only utilised around 8 per cent of this, and will play a significant role in achieving these goals.

A number of large-scale projects are currently under construction across the continent, including schemes listed in the Programme for Infrastructure Development in Africa (PIDA). Adopted in 2012, this framework seeks to address the infrastructure deficit in the continent via coordinated regional development of large-scale water, energy and transport projects. Led by the African Union and African Development Bank, one of the programme's goals is to boost energy trade within and between African power pools, moving towards an integrated continental grid.

As hydropower projects often produce far more power than is required to meet present domestic demand, regional interconnection is the driver that makes these projects financially viable. Notable large projects driving regional grid expansion and interconnections include Ethiopia's Gilgel Gibe III (1,870 MW) and the Grand Ethiopian Renaissance Dam (6,000 MW), as well as the Inga projects in DR Congo, where there is the possibility to install 40 GW in capacity. The first two of ten 187 MW turbines came online at Gilgel Gibe III in 2015, with the remaining eight expected to enter operation during 2016.

Elsewhere, Guinea commissioned all three units at the 240 MW Kaleta plant during 2015, effectively tripling the country's installed capacity. The cooperative project between China and Guinea was completed after three years of construction and received funding from the China Exim bank.

In the Eastern African Power Pool (EAPP), several interconnections are expected to be completed in 2016, which will facilitate power exports from hydropower schemes in Ethiopia. These include the Ethiopia–Kenya interconnection (500 kV HVDC with 2,000 MW capacity) and the Ethiopia–Sudan interconnection (500 kV double circuit HVAC with 2 x 1,600 MW capacity).

Uganda has also committed to export 50 MW to Rwanda and 30 MW to Kenya, and will import 400 MW from Ethiopia by 2018. The power will be transmitted through a new high-voltage line linking Rwanda and Ethiopia: the 400 kV regional electricity power exchange line running from Olkaria in Kenya through Uganda to Birambo in Rwanda. Uganda and Kenya are already interconnected. According to the Nile Equatorial Lakes Subsidiary Action Programme (NELSAP), the investment programme of the Nile Basin Initiative based in Entebbe, Uganda, the countries in East Africa will start electricity trading after six cross-border transmission lines are completed and commissioned by the end of 2016. The project, which is coordinated by NELSAP, covers construction of cross-border transmission lines in the Nile Equatorial Lakes Countries, namely Burundi, DR Congo, Kenya, Rwanda and Uganda. Power exchange and trading between these countries is expected to commence in April 2016.

Meanwhile, in the Southern African Power Pool (SAPP), several large projects are set to drive grid expansion. Most notable among them is Inga 3, where up to 4,800 MW is slated to be deployed in two phases. South Africa and DR Congo are engaged in joint feasibility studies, including transmission corridors for the project. In 2015, the World Bank announced that the construction of the Inga 3 project would begin in 2017. The World Bank is supporting the project with USD 73 million in financing, approved in 2014. Situated near the mouth of the Congo River, the site is already home to the Inga 1 (350 MW) and Inga 2 (1,400 MW) stations, both of which are currently undergoing refurbishment.

In South Africa, Eskom, the national utility, is overseeing construction of the 1,332 MW Ingula pumped-storage project. The first two units came online in early 2016. Unmet demand in the Southern African Development Community (SADC) is driving regional cooperation in hydropower development. In addition to the Inga projects, South Africa has plans to import hydropower from Mozambique, Zambia and Zimbabwe.

The 700 MW Cambambe hydropower plant is currently under construction in Angola. In addition, Angola and Namibia are working on a cross-border interconnection project with the objective to supply power from the planned 300 MW Baynes project in Angola. A number of other transmission interconnections are under way in the SADC region. In 2015, DR Congo and Zambia commissioned the 220 kV transmission interconnector project. Meanwhile, work on the Tanzania–Zambia interconnector is ongoing; this project will link the SAPP and EAPP by 2019. The Zimbabwe–Zambia–Botswana–Namibia transmission project (ZIZABONA) is expected to reach financial close during 2016. The Mozambique–Zimbabwe–South Africa (MOZISA) interconnector project is at an advanced stage in terms of preparation; detailed feasibility studies and environmental and social impact assessment studies are currently under way. For the planned 400 kV Mozambique–Malawi interconnection, the assignment of technical and environmental feasibility studies is in progress.

POLICIES

Ghana
Feed-in tariffs for hydropower, GHS 53.6223/kWh for <10 MW capacity and GHS 53.884/kWh for 10–100 MW capacity, both for ten-year agreements. Rates are reviewed every two years.

Kenya
Feed-in tariffs for hydropower units up to 10 MW in capacity, standard rate of USD 0.0825/kWh.

Madagascar
A credible policy framework has been developed that has helped to abolish monopoly power and attract private investors to hydropower generation

Mauritius
Feed-in tariffs for small hydropower units, including rate of MUR 10/kWh for 10–50 kW capacity, all for a period of 15 years.

Nigeria
Multi-Year Tariff Order 2 establishes regulated prices for hydropower plants up to 30 MW capacity until 2017, including rates of NGN 29.643/MWh in 2015 and NGN 32.006/MWh in 2016.

Rwanda
Renewable energy feed-in tariff available for hydropower units from 50 kW to 10 MW.

Uganda
Global Energy Transfer Feed-in Tariff (GET FIT) Programme comprises additional payments per kWh beyond the regulated feed-in tariff levels for hydropower projects between 1 and 20 MW capacity.

Rwanda
Renewable energy feed-in tariff available for hydropower units from 50 kW to 10 MW.

HYDROPOWER TARGETS

Country	Target
Burundi	147 MW additional capacity by 2018
Cameroon	450 MW additional capacity by 2017
Egypt	2,800 MW by 2020
Ethiopia	22,000 MW by 2030
Kenya	794 MW by 2016, 5 per cent of total capacity by 2031
Morocco	14% of total capacity by 2020
	2,000 MW by 2031
Mozambique	2,000 MW (no date)
Nigeria	2,000 MW by 2025 additional capacity by 2025
Sudan	63 MW by 2031
Uganda	1,200 MW by 2017
	85 MW by 2017

AFRICA
ETHIOPIA

Ethiopia boasts considerable water resources. With two major rivers, the Blue Nile and the Omo, cascading from its high central plateau, the untapped hydropower potential in the country amounts to around 45,000 MW.

Hydropower currently accounts for over 80 per cent of the electricity produced in Ethiopia. The landlocked country is set to become a regional leader in the power supply business, exporting electricity to countries across the Eastern Africa Power Pool (EAPP) and beyond.

Ethiopia's economy is one of the fastest growing in the world: growth averaged 10.8 per cent each year during the period 2003–13 according to the World Bank. Nonetheless, development has been constrained by power shortages and frequent outages.

Meanwhile, demand for electricity is expected to grow at a rate of 12.7 per cent each year according to the Ethiopian Electric Power Corporation. The rapid growth in demand is driven in part by concentrated efforts to increase the electrification rate and widen access to modern energy services.

To meet the growing electricity demand, both at home and in the region, Ethiopia has entered a second stage of concentrated, large-scale hydropower development over the last decade.

Gilgel Gibe III (1,870 MW), a USD 1.8 billion project, brought the first two of its ten 187 MW units online last year, while the remaining eight are expected to be put into service during 2016.

Situated in the south-west of the country on the Omo River, the station will contribute power to the national grid, which is exporting power to neighbouring countries in the EAPP, such as Djibouti, Sudan and Kenya. Ethiopia is currently exporting power to Djibouti and Sudan. Agreements have also been signed with Tanzania, Rwanda, South Sudan and Yemen.

Although Chinese firms and investments are supporting many of the large infrastructure projects in Ethiopia, the 6,000 MW Grand Ethiopian Renaissance Dam (GERD) is being funded without any foreign assistance.

There are also government plans to sell bonds in global markets in the future, and Ethiopia expects to recoup its investments through export revenues, which are projected to reach USD 1 billion per year by 2021.

Construction has already started on a 1,045 km transmission line between Ethiopia and Kenya, which will deliver electricity from GERD and other projects currently under construction. This USD 120 million project is financed by the World Bank and the African Development Bank (AfDB) on the Ethiopian side.

Despite its projected benefits to regional markets, GERD has been received with some controversy in the downstream Nile River countries, particularly Egypt. Nonetheless, an agreement between Ethiopia, Egypt and Sudan signed in March 2015 included an assurance from Ethiopia that the project will not significantly decrease the availability of water downstream.

BRL Group, a French consultancy, is carrying out an environmental impact study on behalf of the three countries. The Nile Basin Initiative is also running a regional power trade project which will help countries in the basin to implement hydropower projects of common interest.

GERD, Gibe III and Genale Dawa 3 were included in Ethiopia's 2010–15 development strategy, the first Growth and Transformation Plan (GTP1). Together, they are set to boost the country's installed capacity to over 10,000 MW by late 2016.

Moving forward, the second Growth and Transformation Plan (GTP2) outlines projects which will bring the country's total installed capacity to 17,000 MW by 2020. This figure includes new hydropower facilities, alongside thermal, wind, solar PV, biomass and geothermal projects. Within the GTP2 period, Ethiopia plans to commission a further 3,900 MW of new hydropower, including the 254 MW Genale Dawa 3 in 2016, and Geba I and II 385 MW in 2018. Further developments include Gibe IV and Gibe V (2,000 MW and 600 MW, respectively), as well as the Upper Dabus (326 MW) and Halele Werabesa (436 MW). Ethiopia also plans to begin construction on a further 7,500 MW spread across ten projects by 2020.

POPULATION **96,959,000**	GDP **USD 56 BILLION**	INSTALLED HYDROPOWER CAPACITY **2,552 MW**	HYDROPOWER GENERATION **9,000 GWh**

AFRICA
GUINEA

Home to the sources of the Niger, Gambia and Senegal Rivers, Guinea boasts one of the highest hydropower potentials in West Africa. However, the country currently utilises less than 5 per cent of its technically exploitable potential, which is estimated at 6,100 MW. In 2014, Guinea had only 125.4 MW of installed hydropower capacity from five stations, which accounted for roughly 30 per cent of the total electricity mix; the remainder was provided by thermal generation.

Despite the country's vast mineral resources, three-quarters of the population (around 9 million people) currently lack access to electricity, with that figure rising to 90 per cent in rural areas.

It is difficult for countries in the region to achieve national self-sufficiency in electricity supply due to the high costs associated with establishing new generation and transmission infrastructure. Guinea is a member of a number of regional power interconnection and river basin management initiatives. It joined the Gambia River Basin Development Authority (OMVG) in 1981, the Senegal River Basin Development Authority (OMVS) in 1963 (re-joining in 2006) and the West African Power Pool (WAPP) of the Economic Community of West African States (ECOWAS) in 2000. All of these initiatives seek to establish reliable interstate power grids and shared electricity markets.

Guinea reached a milestone in 2015 when it commissioned the 240 MW Kaleta project on the Konkouré River, about 135 km from the capital city of Conakry. The three-turbine generating station almost triples the country's total installed hydropower capacity from 125 MW to 368 MW. The station was built with support from OMVG and in cooperation with China International Water and Electric Corporation (CWE), a wholly owned subsidiary of the China Three Gorges Corporation.

Power generated from the station will play a significant role in providing reliable power for Conakry's 1.7 million residents as well as Guinea's bauxite mines, which account for 31 per cent of power consumption in the country. Guinea possesses an estimated 25 per cent of the world's bauxite reserves, and the mining sector represents about a fifth of domestic GDP. Additionally, roughly 30 per cent of Kaleta's output will contribute power to the shared grid of OMVG.

2015 also saw the Souapiti hydropower project enter the construction phase. Located approximately 6 km upstream of Kaleta, this 515 MW dam and power station is also being built by CWE. The project, which is expected to be completed in five years, will advance Guinea's strategic goal to become a net power exporter.

2015 also saw ECOWAS member states approve a new directive for the better consideration of economic, environmental and social considerations of cross-border hydropower infrastructure projects to ensure the sustainable management of water resources. The directive, if implemented, will provide a strong policy foundation for further hydropower projects in the region.

An example is the Fomi dam, a proposed project to provide water storage, irrigation and electricity to countries in the Niger River basin. This 90 MW hydropower station would be a transboundary project between Mali and Guinea, used for irrigation and to maintain dry-season flows, in addition to power generation.

Further development is expected in Guinea. As stated in the country's intended national determined contribution (INDC) to the United Nations Framework Convention on Climate Change (UNFCCC), Guinea has ambitions to commission a further 1,410 MW of hydropower capacity by 2030.

POPULATION
12,276,000

GDP
USD 7 BN

INSTALLED HYDROPOWER CAPACITY
368 MW

HYDROPOWER GENERATION
500 GWh

AFRICA
MOZAMBIQUE

Estimated at around 12,500 MW, Mozambique's hydropower potential is among the largest in sub-Saharan Africa. More than 80 per cent of that potential is located in the Zambezi Valley, which includes the existing 2,075 MW Cahora Bassa project. Mozambique boasts 13 major river basins, and there is the potential for both strategic grid expansions via large-scale projects, and smaller-scale developments servicing off-grid population centres.

Access to energy has been made a national priority in Mozambique's development agenda, where it is viewed as a key driver for economic growth and poverty alleviation. In 2011, the Strategy for New and Renewable Energy Development (2011–25) was adopted. This policy aims to spur the sustainable development of Mozambique's renewable energy resources, using both on-grid and off-grid applications. The electrification rate was 39 per cent in 2015; however, around 15 million people still lack access to electricity, especially in rural areas and in the north of the country.

The development of hydropower and other water management infrastructure in Mozambique will also be driven by the National Climate Change Adaptation and Mitigation Strategy (NCCAMS), which includes a strategic action to "improve the capacity for integrated water resources management including building climate resilient hydraulic infrastructures". This policy, highlighted in Mozambique's INDC submission to the UNFCCC, also includes actions related to the protection of floodplains and water for agriculture, livestock and fisheries.

Mozambique is already a net exporter of electricity to the South African Development Community (SADC) countries via the Southern African Power Pool (SAPP). Around 73 per cent of the electricity generated at the Cahora Bassa plant is exported to the SAPP, an important source of foreign revenue. Exports are expected to increase significantly, especially to South Africa, which has identified Mozambique as a key strategic supplier of power; in one scenario, the South African government envisages an additional 2,135 MW in new hydropower capacity available to import from Mozambique.

Currently, six hydropower stations supply the national grid in Mozambique, namely the Cahora Bassa plant, operated by Hidroélectrica de Cahora Bassa, an independent power producer, and five plants operated by the privatised national utility, Electricidade de Moçambique: Mavuzi (52 MW), Chicamba (38.4 MW), Corumana (16.6 MW), Cuamba (1.9 MW) and Lichinga (0.73 MW).

Major projects in the pipeline include Mphanda Nkuwa (1,500 MW) and the north bank expansion of the Cahora Bassa plant (1,245 MW).

These projects are driving strategic grid expansion via the Regional Transmission Backbone Project (CESUL), a double transmission line which will connect the Tete province in central Mozambique to the capital Maputo, in the south, and to the SAPP.

Mozambique also has high potential for smaller-scale hydroelectric projects that can bring electricity to off-grid population centres via localised mini-grids. Policy support exists in the form of a renewable energy feed-in tariffs programme, which includes power purchase agreements for plants under 10 MW in capacity.

POPULATION
27,216,000

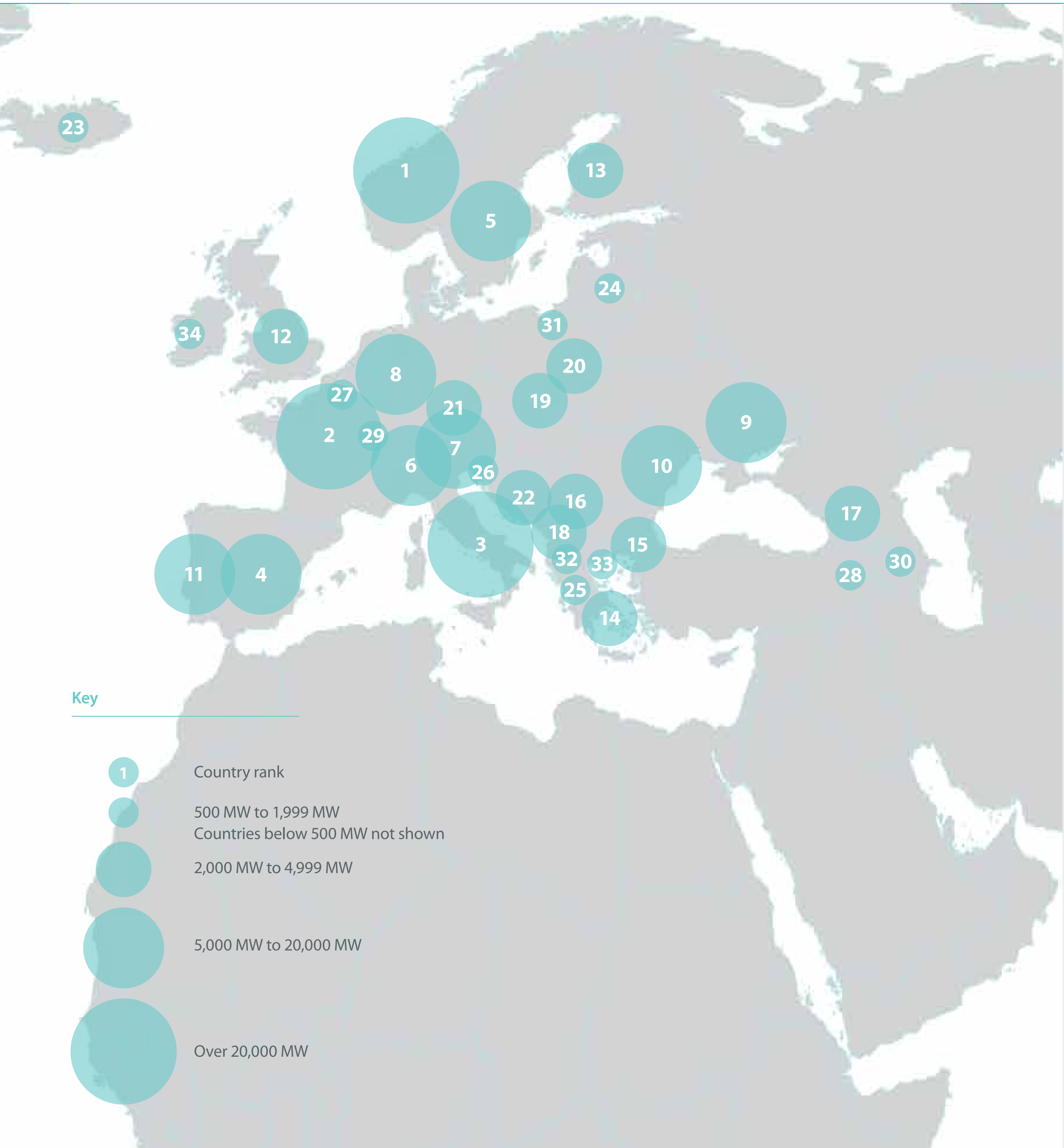
GDP
USD 16 BN

INSTALLED HYDROPOWER CAPACITY
2,187 MW

HYDROPOWER GENERATION
12,000 GWh

EUROPE
REGION MAP

TOP SIX COUNTRIES BY INSTALLED HYDROPOWER CAPACITY (MW)*					
OTHERS: 89,945 | **TOTAL:** 218,404					
1	2	3	4	5	6
NORWAY 30,566	FRANCE 25,397	ITALY 21,880	SPAIN 18,561	SWEDEN 16,419	SWITZERLAND 15,635



EUROPE
CAPACITY BY COUNTRY

Rank	Country	Installed hydropower capacity (MW)*
1	**Norway**	30,566
2	**France**	25,397
3	**Italy**	21,880
4	**Spain**	18,561
5	**Sweden**	16,419
6	**Switzerland**	15,635
7	**Austria**	13,178
8	**Germany**	11,258
9	**Ukraine**	6,785
10	**Romania**	6,705
11	**Portugal**	5,902
12	**United Kingdom**	4,443
13	**Finland**	3,198
14	**Greece**	3,396
15	**Bulgaria**	3,129
16	**Serbia**	2,835
17	**Georgia**	2,727
18	**Bosnia and Herzegovina**	2,504
19	**Slovakia**	2,522
20	**Poland**	2,351
21	**Czech Republic**	2,212
22	**Croatia**	2,141
23	**Iceland**	1,986
24	**Latvia**	1,576
25	**Albania**	1,527
26	**Slovenia**	1,479
27	**Belgium**	1,427
28	**Armenia**	1,249
29	**Luxembourg**	1,134
30	**Azerbaijan**	1,116

Rank	Country	Installed hydropower capacity (MW)
31	**Lithuania**	876
32	**Montenegro**	658
33	**Macedonia**	674
34	**Ireland**	529
35	**Greenland**	90
36	**Moldova**	76
37	**Hungary**	56
38	**Andorra**	45
39	**Faroe Islands**	39
40	**Netherlands**	37
41	**Kosovo**	36
42	**Belarus**	33
43	**Denmark**	9
44	**Estonia**	8

* includes pumped storage

EUROPE
OVERVIEW

Hydropower is poised to play a major role in meeting Europe's ambitious climate and energy goals. In particular, hydropower will complement the increased penetration of variable renewables into the European power grid. The continent's future energy systems, with large deployments of wind and solar capacity, will require sufficient flexibility, firm capacity and the ability to balance volatile generation over time horizons ranging from hours to several months.

Pumped storage hydropower remains the only form of electricity storage that is available on a large scale and at competitive costs. Moreover, all storage hydropower projects offer ancillary energy services, and European markets will need to adequately reward operators for these services to enable the increased penetration of variable renewables across the region.

To date, there is an estimated 218 GW of installed hydropower capacity in Europe, of which more than 150 GW is provided by storage and pumped storage stations. Currently, most of the installed hydropower capacity is located in Scandinavia and the Alpine countries, while the unexploited hydropower potential is concentrated in eastern Europe.

Western and northern Europe already have highly developed hydropower markets. Investment there is primarily focused on pumped storage projects, as well as refurbishment and modernisation projects to increase the lifespan and efficiency of existing plants and to minimise ecological impacts. Typically, new stations in these countries are limited to small, run-of-river facilities.

In Salzburg, Austria, the Bärenwerk project was successfully refurbished after three years of work, increasing the installed capacity from 11.6 MW to 15 MW. The project also included measures to reduce the project's ecological impacts. A new 5.4 MW run-of-river scheme was also commissioned in the state. The new power house is located in the same compound as the existing 18 MW Kreuzbergmaut station.

Currently, 1,730 MW of pumped storage capacity is under construction in Austria. Both the Reisseck II (430 MW) and Obervermuntwerk II (360 MW) pumped storage projects are designed to operate in conjunction with existing storage hydropower stations, so as to minimise further environmental impacts in the region. The Reisseck II station is scheduled to come online in early 2016, after experiencing some challenges due to a discovered leak in the headrace tunnel. Construction work on the Obervermuntwerk II project began in 2014, and is expected to be completed by 2019. In 2015, the engineering contract for the 940 MW Koralm pumped storage station was awarded to Andritz, an Austrian engineering group. Upon completion, it will be the largest hydroelectric plant in the country.

Modernisation works were completed at the Hagneck run-of-river facility in Switzerland, one of the world's oldest hydropower stations. The refurbishment increased capacity from 12 MW to 20 MW, and included the addition of a nature-mimicking fish-pass and an alluvial forest at the site.

In Switzerland, more than 3,000 MW of pumped storage capacity is currently under construction, including the Linthal 2015 project, a 1,000 MW expansion of the Linth–Limmern system of dams and reservoirs. The project will include an expansion of both the upper and lower reservoirs, and will also regulate inflows for power stations further down the valley. Other pumped storage stations in the pipeline include the 900 MW Lago Bianco, scheduled for 2019; the 900 MW Nant de Drance, scheduled for 2018; and 660 MW Grimsel 3, scheduled for 2019.

In Portugal, 104 MW of new capacity was installed in 2015. The 30 MW lower station in the Baixo Sabor system was commissioned in early 2015, and the 140 MW upper station is expected to come online during 2016. The 74 MW Ribeiradio-Ermida was also commissioned in 2015. Moving forward, Portugal is expecting to commission two new pumped storage plants in 2016. The Salamonde II pumped storage station will use water at the existing Salamonde dam. It will be able to generate 231 MW and use 204 MW when pumping. In addition, the 746 MW Venda Nova III pumped storage station will be the country's largest hydropower station when it is completed in 2016.

In Iceland, a 100 MW expansion of the Búrfell hydropower project was tendered with commissioning expected in April 2018. The new underground power house will be located about 2 km from the existing 288 MW Búrfell power station.

HYDROPOWER TARGETS

Country	Target
Armenia	265 MW additional hydropower by 2025
Austria	1,000 MW to be added 2010–20
Bulgaria	522 MW new capacity by 2018
Finland	14,600 MW hydropower by 2020
Italy	42,000 GWh/year from 17,800 MW by 2020
Lithuania	14 MW by 2020
Macedonia	216 GWh/year small-scale hydropower by 2020
Portugal	400 MW small-scale hydropower by 2020
Spain	13,900 MW by 2020 (2.9 per cent of final energy mix) 8,800 MW pumped storage by 2020
Switzerland	37,400 GWh/year by 2035

POLICIES

Armenia
Feed-in tariffs for small hydropower stations guaranteed for 15 years, rates differentiated by type, including AMD 21.168/kWh for natural water streams.

Austria
Tax incentives and feed-in tariffs for small hydropower, for example maximum 10 per cent of the investment for up to 10 MW capacity, up to EUR 400/kWh.

Belarus
Law on Renewable Energy Sources (2011) includes feed-in tariff for hydropower plants at rate of USD 1.3/kWh for first ten years, then USD 0.85/kWh for next ten years.

Bosnia and Herzegovina
Feed-in tariffs and power purchase agreements for hydropower plants up to 10 MW capacity in the Republika Srpska.

Bulgaria
Energy from Renewable Sources Act 2011 includes feed-in tariff for hydropower plants up to 10 MW capacity at rate of BGN 93.69–236.92/MWh.

Estonia
Electricity Market Act 2007 includes feed-in tariff for hydropower with premium at EUR 0.0537/kWh.

Finland
Tax subsidies for small hydropower (below 1 MVA).

France
Feed-in tariff for hydropower at rate of EUR 0.0607/kWh, plus bonuses for small installations and regular production during winter, with contracts of 20 years.

Germany
Renewable Energy Sources Act (EEG) includes targets for 35 per cent renewables by 2020, and 50 per cent by 2030, and feed-in tariff at different rates including EUR 0.042/kWh for up to 50 MW capacity, all for 20 years with tariffs decreasing by one per cent each year.

Greece
Feed-in tariff for hydropower units up to 15 MW capacity, rate at EUR 73/MWh in mainland grid and EUR 84.6/MWh in islands not connected to main grid.

Ireland
Feed-in tariff for hydropower units of less than 5 MW capacity at rate of EUR 0.07/kWh, and for wave and tidal power at EUR 22/kWh.

POLICIES

Italy
Feed-in tariff for hydro streams up to 250 kW capacity, tenders for hydropower above 10 MW capacity.

Lithuania
Feed-in tariffs for hydropower, LTL 0.27/kWh for <10 kW capacity, LTL 0.24/kWh for 10 kW–1 MW capacity, and LTL 0.22/kWh for > 1 MW capacity, all granted for a period of 12 years.

Luxembourg
Feed-in tariffs for hydropower plants up to 6 MW, including rate of EUR 85/MWh for 1–6 MW capacity, reduced by 0.25 per cent each year, guaranteed for a period of 15 years.

Macedonia
Feed-in tariffs for hydropower units up to 10 MW capacity.

Montenegro
Feed-in tariffs for hydropower at EUR 0.104/kWh for plants with annual generation up to 3 GWh, EUR 0.0744/kWh for plants with annual generation between 3 and 15 GWh, and EUR 0.0504/kWh for plants with annual generation above 15 GWh.

Norway
Hydropower plants of less than 5 MW capacity exempt from natural resource and ground rent taxes.

Poland
Obligation for suppliers to purchase certain quota of power from renewable sources, with the quota set at 14 per cent in 2015, and rising to 20 per cent in 2021.

Slovakia
Feed-in tariffs for hydropower in various bands including EUR 105.15/MWh for 500 kW – 1 MW capacity and EUR 97.98/MWh for 1–5 MW capacity, all for a period of 15 years. Hydro is also exempted from electricity excise tax.

Switzerland
Energy Law 2008 includes feed-in tariff for hydropower plants up to 10 MW capacity.

Ukraine
Green Tariff policy includes feed-in tariff for hydropower plants up to 10 MW capacity at a rate of EUR 104.7/MWh, until 2030.

United Kingdom
Renewables Obligation (RO) sets renewable quotas on electricity suppliers, which rise annually. Feed-in tariff for small scale renewables including hydropower up to 5 MW, for a period of 20 years, at a rate of GBP 0.11/kWh for 2–5 MW capacity.

EUROPE
WESTERN BALKANS

The Western Balkan region has the largest remaining unexploited hydropower potential in Europe as its river catchments have remained largely undeveloped. Up to 30 per cent of rivers remain in near-natural or pristine states and have a very high conservation value. The region has an estimated 80,000 GWh technical potential, which is concentrated in the mountainous regions of Montenegro and Albania.

The region has experienced significant political and economic changes over the past 25 years. The breakup of Yugoslavia in the early 1990s and associated military conflicts resulted in the fragmentation of a once unified and integrated power system within the region and the loss of the interconnection with the Western European grid in 1992.

The main domestic sources of electricity generation in the region are coal and hydropower. Albania derives 98 per cent of its domestically produced electricity from hydropower, Bosnia and Herzegovina 41 per cent, Serbia 30 per cent and Montenegro 31 per cent. One of the major obstacles facing the Western Balkan countries in joining the EU is the adoption of environmental and climate policies. Nonetheless, meeting these standards will provide an opportunity for power system reform.

As the region tries to limit greenhouse-gas emissions in line with EU goals, it could see the increased co-generation of biomass and gas with coal, while also promoting the development of renewable energies, mainly focusing on hydropower.

The EU has sent strong signals towards fostering regional integration to increase energy trade for a more efficient power market. By expanding the total market size, new interconnections would improve reliability, reduce costs and decrease the risk of unsustainable infrastructure damaging already-fragile ecosystems. An integrated market allows for the possibility of thermal and hydropower technologies to complement each other, as well as lowering the required reserve capacity and overall balancing costs.

In 2015, the EU announced that it would invest in a number of transmission projects across the region, especially between Albania and Macedonia, as well as works to improve the Serbian and Montenegrin grids.

Despite the high unexploited potential in the Balkan region, the development of new hydropower projects has stalled primarily due to environmental concerns and a lack of financing. While there are many potential projects in the planning stage, it is expected that the majority will not come to fruition. Many of the developments in the region are small (less than 10 MW in capacity) or include the modernisation or retrofitting of existing infrastructure.

Serbia has the highest installed hydropower capacity in the region, with some 2,835 MW currently operational. Over two-thirds of this capacity is concentrated near to the border with Romania, which hosts the Iron Gate 1 and 2 stations (2,116 MW and 540 MW respectively), which are shared equally with Romania. The country boasts an undeveloped potential of 7,000 GWh, focused on the Drina and Danube rivers.

With financial assistance from the European Bank for Reconstruction and Development (EBRD), Serbia announced plans to install new hydropower plants and two existing dams, and to rehabilitate a further 15 existing power plants totalling around 30 MW. With increased projected solar PV and wind penetration, Serbia has identified the essential need for a further pumped storage station, potentially the 680 MW Bistrica or 1200 MW Iron Gate 3.

Bosnia and Herzegovina has a hydropower potential of more than 6,000 MW, of which only 2,504 MW is currently exploited. In 2015, the country commissioned a 5.2 MW hydropower plant in Rogatica in the Republika Srpska region. The Republika Srpska also signed a memorandum of understanding (MOU) with the China International Water & Electric Corporation (CWE) for the development of the 160 MW Dabar project in the south. This project is expected to improve generation at downstream stations, and provide flood protection and irrigation services. However, the project has met strong opposition due to the water transfer away from the Neretva catchment and associated ecosystem damages. The country, in its in its intended nationally determined contribution (INDC), also announced plans to commission a further 120 MW of small-hydro plants (<10 MW) by 2030.

Macedonia has a technical hydropower potential of 5,500 GWh, of which only about 1,500 GWh is currently utilised, representing a total installed capacity of 674 MW. Most of its currently operational stations are located in the mountainous north-west, near to the Albanian border.

EUROPE
WESTERN BALKANS

The country officially opened five small hydro plants in 2015 located in Kavardarci in the Tikveš region. The project includes an irrigation system on the Bosava River. The five power plants of the Kolektor cascade range in capacity from 1.4–2.8 MW and total 10.9 MW.

Kosovo currently relies almost exclusively on two coal power plants for over 97 per cent of its power generation, and the system is marred by high technical and commercial losses. With the planned closure of one of the coal power plants in 2017, the country faces peak capacity gaps, which are required to be met through expensive imports. There are plans, however, to augment power supply through the construction of an aggregated 63 MW of small-scale, run-of-river projects across the country, while the Energy Regulatory Office of Kosovo plans some 140 MW by 2020. Kosovo's long-term energy strategy also includes the 305 MW Zhur station which will provide peaking support to accommodate variability in the grid.

Montenegro has abundant water resources, despite its relatively small size. Two large hydropower plants, Perućica (307 MW) and Piva (363 MW) provide for approximately three-quarters of domestic power supply, but account for only 18 per cent of total hydropower potential. There are currently 27 projects being implemented on some 25 water courses, totalling 83 MW. The country also signed an MOU with Norinco International Corporation Ltd, a Chinese Company, to explore the possibility of developing four hydropower plants on the river Morača with a combined installed capacity of 238 MW.

Country	Albania	Bosnia and Herzegovina	Kosovo	Macedonia	Montenegro	Serbia
Installed hydropower capacity (MW)	1,527	2,504	36	674	658	2,835
of which pumped storage (MW)		420				614
Hydropower generation (GWh)	4,000	6,500	126	1,200	1,800	11,500

EUROPE
GEORGIA

The Georgian government is currently pursuing further development of its hydropower sector as a pathway to increase energy security and reduce reliance on fossil fuel imports. Following the collapse of the Soviet Union in 1991, Georgia was plunged into a deep recession; however, extensive economic reforms, beginning in 1995, resulted in dramatic improvements to the country's power sector.

The first phase of these reforms lasted until 2004, establishing the Georgian National Energy and Water Supply Regulatory Commission (GNERC), and bringing about systematic change under the principles of ownership unbundling, commercialisation and privatisation.

The second phase of reforms, beginning in 2004, ushered in further deregulation and privatisation of the power industry. This allowed for generators, distributors, customers and exporters to enter into direct contracts. In addition, the Electricity System Commercial Operator (ESCO) now buys and sells balancing power and reserve capacity, and has the authority to negotiate power purchase agreements.

Today, hydropower accounts for more than 80 per cent of Georgia's generating capacity and between 75 to 90 per cent of power generation, based on average hydrologic conditions. By the end of 2015, Georgia had installed more than 70 operational hydropower stations, totalling 2,727 MW in capacity. Two stations alone provide roughly 45 per cent of the domestic electricity supply: the Inguri dam (1,300 MW) and its downstream sister-station, Vardhili HPP (210 MW).

The country's dependence on hydropower means that the reliability of supply is threatened in the winter months when power demand is high and hydropower capacity is reduced due to depleted storage in reservoirs. Much of the power deficit is made up through domestic thermal generation using imported natural gas or imported power from neighbouring Russia and Azerbaijan. Georgia exports power in the summer months, but relies on neighbouring countries for power trade. In 2015, 63 per cent of exports were traded with Turkey, and 77 per cent of imports were traded with Russia. Georgia also exports excess hydropower to other neighbouring countries in the summer.

The completion of the Black Sea transmission interconnection in 2013, which runs between east and west Georgia and the north-east of Turkey, has attracted significant multilateral support in 2015 with the view to encourage cross-border energy trading in the region.

Most recently, the country commissioned the 87 MW Paravani station, which is located just 25 km from the Turkish border in the south-west. This project was financed through loans from the European Bank for Reconstruction and Development (USD 52 million), the International Finance Corporation (USD 40.5 million) and Turkish Bank TSKB (USD 23 million), and owned by the Turkish Anadolu Group. The project is connected to both the Georgian and Turkish power grid. The power generated here will be used in Georgia during the winter months and sold to the Turkish grid during the rest of the year.

The 187 MW Shuakhevi hydropower scheme in south-western Georgia has also been spurred on by international support, and is expected to begin commercial operations in 2016. The project has received financing from the IFC, ADB and EBRD, and is being built as a joint venture between India's Tata Power and Norway's Clean Energy Invest. The Clean Development Mechanism (CDM) accredited power station is part of a cascade complex that also includes plans for the 150 MW Koromkheti, 65 MW Khertvisi and 10 MW Skhalta stations.

Another project nearing completion is the 108 MW Dariali run-of-river project in north east Georgia, close to the Russian border. The project is the first infrastructure scheme to be structured as a public-private partnership in the country. 2015 also witnessed the announcement of a number of significant projects with international support, including the 51 MW Kheledula 3 project, which is being developed by the Turkish Anadolu group, as well as the 280 MW Nenskra, which is receiving support from Korea's K-water, the EBRD, ADB, IFC, the Korean Development Bank, and the European Investment Bank.

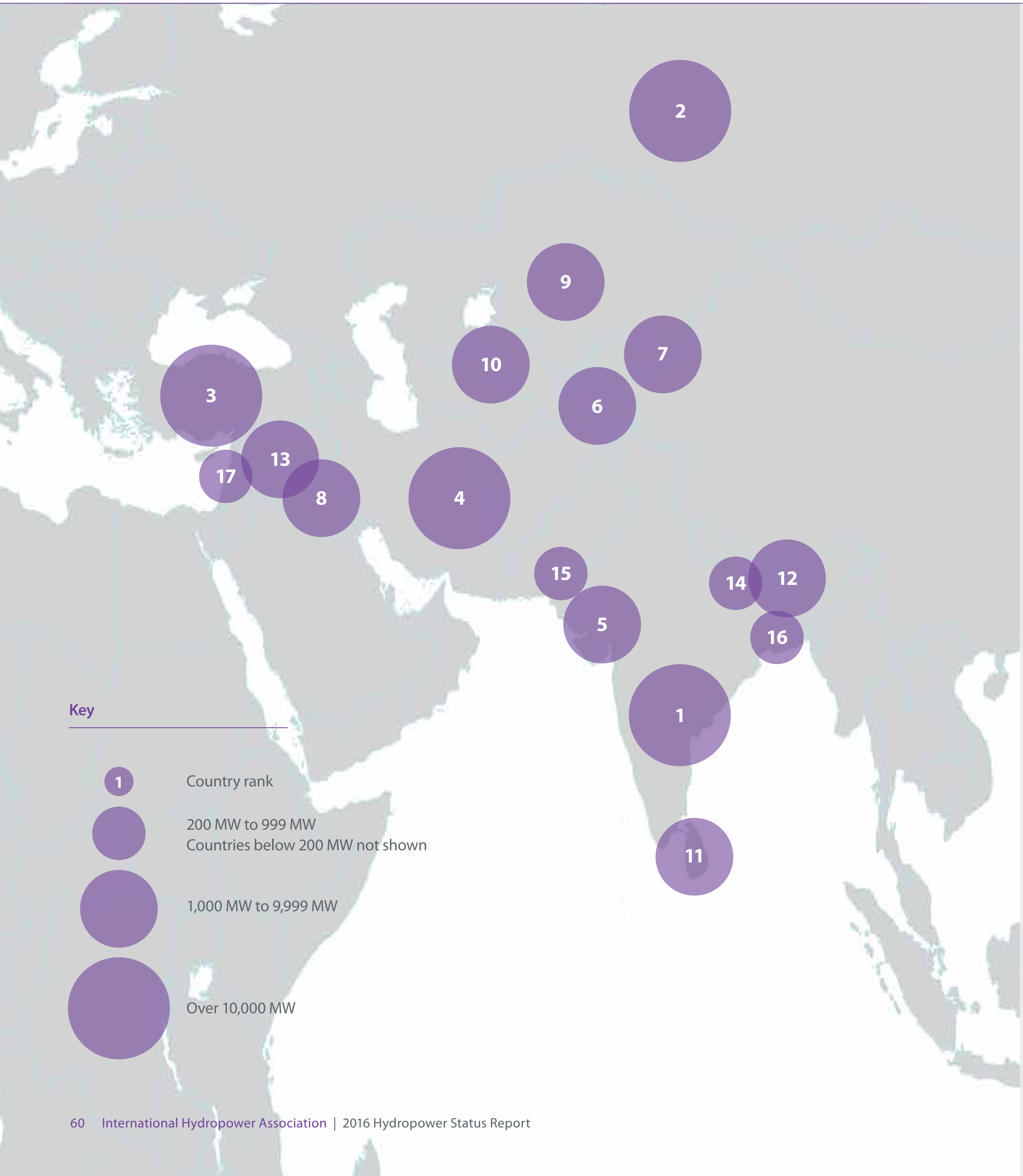
POPULATION
3,727,000

GDP
USD 17 BN

INSTALLED HYDROPOWER CAPACITY
2,727 MW

HYDROPOWER GENERATION
8,807 GWh

SOUTH AND CENTRAL ASIA **REGION MAP**



TOP SIX COUNTRIES BY INSTALLED HYDROPOWER CAPACITY (MW)* | **OTHERS:** 16,203 | **TOTAL:** 167,856

1	2	3	4	5	6
INDIA 51,494	RUSSIA 50,624	TURKEY 25,886	IRAN 11,196	PAKISTAN 7,264	TAJIKISTAN 5,190

SOUTH AND CENTRAL ASIA
CAPACITY BY COUNTRY

Rank	Country	Installed hydropower capacity (MW)*
1	**India**	51,494
2	**Russia**	50,624
3	**Turkey**	25,886
4	**Iran**	11,196
5	**Pakistan**	7,264
6	**Tajikistan**	5,190
7	**Kyrgyzstan**	3,091
8	**Iraq**	2,753
9	**Kazakhstan**	2,260
10	**Uzbekistan**	1,731
11	**Sri Lanka**	1,624
12	**Bhutan**	1,615
13	**Syria**	1,505
14	**Nepal**	753
15	**Afghanistan**	400
16	**Bangladesh**	230
17	**Lebanon**	221
18	**Jordan**	12
19	**Israel**	7
20	**Turkmenistan**	1

*includes pumped storage

SOUTH AND CENTRAL ASIA **OVERVIEW**

The South and Central Asian region includes a number of hubs for hydropower development, notably Turkey, which has recently announced 101 new projects totalling more than 2,000 MW; Tajikistan and Kyrgyzstan, which are expected to export hydropower to neighbouring countries when the CASA-1000 transmission lines are completed; and the Himalayan region, where considerable hydropower potential is concentrated in Nepal, Bhutan and India's northernmost states.

Across the region, we are witnessing increased private sector involvement, with a number of notable public-private partnerships showcasing the new opportunities for independent power producers. Dagacchu, a 126 MW run-of-river scheme in Bhutan which began commercial operation in 2015, marks the first public–private partnership in infrastructure investment in the country. Tata Power, an Indian utility, owns 26 per cent of the project, and has signed a power purchase agreement to import electricity generated at the site to India.

In another milestone for the private sector, India has for the first time granted approval for project preparatory works to a 100 per cent foreign-owned company, REG-Velcan SA, an independent power producer, in preparation for three hydropower projects totalling 571 MW: Heo (240 MW), Tato-1 (186 MW) and Pauk (145 MW). This cascading hydropower scheme received final environmental clearance from the Indian government in December 2015. The approval came with a number of now-standard conditions, which include a plan of social and economic benefits for local people, as well as measures to protect biodiversity and a commitment to undertake compensatory reforestation.

The three projects will have a relatively low environmental impact due to their small land use, which will not require any human resettlements.

The Indian-based independent power producer and hydropower developer DANS Group also commissioned the 96 MW run-of-river Jorethang Loop project in Sikkim. The power station marks the terminal project in a cascade development of five projects on the Rangit River (Rangit Stages I to IV). Rangit III (60 MW) was completed in 2000, while Rangit II and Rangit IV are currently under construction.

Meanwhile, Pakistan broke ground on a number of private power projects in 2015, including the 720 MW Karot and 102 MW Gulpur hydropower plants, owned by Mira Power Ltd and Karot Power Company Pvt Ltd respectively. The 147 MW Patrind hydropower project is also under construction. This project is being managed by Star Hydro Ltd., a subsidiary of K-water, under a build-own-operate-transfer basis with an operation period of 30 years. The project is expected to commence commercial operation in 2017.

In Turkey, a number of state-owned generation assets are being transferred to the private sector, including hydroelectric facilities. Turkey's Privatisation Administration (ÖİB) announced tenders for the privatisation of ten hydropower plants in July 2015. The country has seen a gradual transfer of generation assets owned by state-owned generation company EÜAŞ to the private sector since the energy market was liberalised in 2003.

Turkey added 2,225 MW of new hydropower capacity in 2015, including the 582 MW Beyhan 1 plant. The plant consists of three 186 MW Francis units and one 25 MW unit; the three main Francis turbines are among the largest of their type ever installed in the country. Other notable Turkish projects commissioned in 2015 include the Bagistas Dam (141 MW), and the Pembelik (128 MW) and Kargı (102 MW) projects.

In Russia, JSC Sulak Hydrocascade, a wholly owned subsidiary of RusHydro, announced the commissioning of the 100 MW Gotsatlinskaya hydropower plant in the province of Dagestan. RusHydro also continued to progress its ambitious modernisation programme, which will see the company replace all units with expired service life by 2025, adding a total of 29 MW of installed capacity at the Volzhskaya (10.5 MW), Zhigulevskaya (10.5 MW), Novosibirskaya (5 MW) and Kamskaya plants (3 MW).

India commissioned 1,909 MW in 2015, continuing the strong growth trend in the country's hydropower sector. Large deployments included the 800 MW Koldam run-of-river plant in Himachal Pradesh. This marks the first hydropower project developed and commissioned by NTPC, a state-owned utility, which has previously focused on thermal installations. The four 200 MW Francis turbines were designed by Toshiba Corporation, while BHEL of India manufactured, installed and commissioned the units. BHEL was also involved in a project In Uttarakhand, where the 330 MW Alaknanda (formerly Srinagar) station was commissioned. The run-of-river project will reduce dependence on fossil fuels for power production in the northern region.

The second 450 MW stage of the run-of-river Baglihar power project was completed in November 2015, bringing the total capacity to 900 MW at the site in Jammu and Kashmir, India. The station is located on the Chenab River in the Chanderkote area of Ramban district and was developed by the Jammu and Kashmir Power Development Corporation. The three 150 MW turbines add to the 450 MW Baglihar stage-1 which was commissioned in 2008; 40 per cent of the power generated will go to the state power development department to meet demand requirements, while the remaining 60 per cent will be sent outside the province to generate revenue to clear loans for the project.

POLICIES

India
2014–19 feed-in tariffs for hydropower in Uttar Pradesh, INR 5.65–6.47/kWh for <5 MW capacity and INR 4.98–5.68/kWh for 5–25 MW capacity, both with power purchase agreements for 20 years.

Iran
Renewable Energy Development Fund, tax levied on consumer bills at a rate of IRR 30/kWh, except rural households. The fund goes towards maintenance of rural grids and the development of renewables.

Nepal
Capital subsidies of NPR/KW 60,000 to 90,000 for pico hydropower installations up to 10 KW, and NPR/KW 70,000 to 120,000 for community/cooperative mini hydropower installations from 100 kW to 1 MW.

Russia
EBRD loan of EUR 185 million to support modernisation of nine power stations on the Volga–Kama cascade.

Turkey
Renewable Energy Law 2010 includes feed-in tariff for hydropower (all sizes) at a rate of USD 0.073/kWh for a period of ten years, and renewable producers receive 85 per cent discount on transmission costs for ten years.

HYDROPOWER TARGETS

Country	Target
India	2.1 GW small-scale hydropower to be added 2012–17
Kazakhstan	170 MW new capacity by 2020
Turkey	36 GW by 2023

SOUTH AND CENTRAL ASIA

BHUTAN AND NEPAL

South Asia's considerable hydropower potential is concentrated in the Himalayan region, spanning Nepal, Bhutan and India's northernmost states: Arunachal Pradesh, Sikkim, Uttarakhand, and Himachal Pradesh. Tapping the vast hydropower resources of Nepal and Bhutan, in particular, will be critical in order to meet the region's rapidly growing demand in a cost-effective and environmentally sustainable manner.

In particular, Indian demand for clean and affordable electricity will be a major driver for hydropower development across South Asia. Much of the new hydropower capacity in Nepal and Bhutan will be built with a view to export electricity to meet growing demand for electricity in northern India, offsetting greenhouse-gas emissions by reducing the proportion of coal-burning stations in the electricity portfolio. The Indian prime minister, Narendra Modi, made landmark visits to both Bhutan and Nepal in 2014, cementing India's bilateral energy agreements with these countries.

Bhutan boasts a very high hydropower potential, estimated at around 30,000 MW, of which 23,760 MW has been identified as economically feasible. A total of 1,615 MW of hydropower capacity has been installed in the country to date. Bhutan's domestic demand for electricity is relatively low, but power exports to India are already an important source of revenue; hydropower contributes over 27 per cent of government revenue and 14 per cent of Bhutan's GDP. India's investment in Bhutan's programme of hydropower development is also contributing to economic growth and development on both sides of the border.

Bhutan already exports a large amount of power to India. In the fiscal year 2013–14, the annual net power transfer from Bhutan to India was 4,992 GWh, a figure which is likely to grow as further hydropower development takes place in Bhutan. The government's National Transmission Master Plan has projected 11,000 MW of power transfer capacity between the two countries by 2020, and identifies the necessary projects to improve interconnection infrastructure. The Bhutanese government envisions 10,000 MW of installed hydropower capacity in the country by 2020, which it will develop in close collaboration with the Indian government and private sector.

There are five major hydropower projects currently operational in Bhutan, all of which are run-of-river schemes: Tala (1,020 MW), Chhukha (336 MW), Dagacchu (126 MW), Basochhu (64 MW) and Kurichu (60 MW). The Dagachhu run-of-river scheme, which began commercial operation in 2015, is a milestone project in many ways.

The project is the first in Bhutan to export power exclusively to India; Tata Power has signed a power purchase agreement for 25 years, and will export all electricity generated at the site to India. Dagachhu was also the first cross-border project registered under the UN Clean Development Mechanism (CDM).

Dagachhu also marks the first public–private partnership in infrastructure investment in Bhutan. Druk Green Power Corporation, the state-owned utility, owns 59 per cent equity in the project, Tata Power Company of India owns 26 per cent, and the remaining 15 per cent is held by the Pension and Provident Fund of Bhutan. The Asian Development Bank supported the project with a USD 80 million loan; the total project cost was around USD 200 million.

Nepal is also expected to become a net exporter to the Indian market, but Nepal currently suffers energy shortages and frequent blackouts. For example, the shortfall in electricity supply to meet domestic load requirements was about 410 MW in late 2013, when peak demand reached 1,202 MW. This led to blackouts of up to 14 hours a day.

Nonetheless, Nepal is blessed with significant hydropower resources. Nepal's theoretical hydropower potential has been estimated to be around 84,000 MW, of which 43,000 MW has been identified as economically viable. Currently, Nepal's installed hydropower capacity is 753 MW.

Although Nepal suffers from regular energy shortages, the available hydropower resources could provide a large surplus if strategically developed with a view to foster regional energy trade. Therefore, Nepal will follow a similar path to Bhutan, with the view of becoming a net exporter to the Indian market, as well as Bangladesh.

The first large-capacity interconnection between India and Nepal (1,000 MW) was completed in February 2016, and is now importing 80 MW at 132 kV. The Nepal Electricity Authority (NEA) plans to charge the capacity of the line to 220 kV in the next five to six months, and the line is expected to be charged at its full capacity of 400 kV by September 2017. The project is being supported by the World Bank, which has committed USD 138 million in financing.

2015 saw Nepal connect over 45 MW of hydropower to the national grid, including the Mai Khola hydropower (22 MW), Nau Gad Khola (8.5 MW), Upper Hugdi Khola (5MW), Andhi Khola (4.3 MW; capacity addition), Jiri Khola (2.4 MW), Upper Puwa 1 (3 MW) and Belkhu Khola (0.5 MW). This project will provide relief from load-shedding in the eastern region of the country. The Nepal Electricity Authority (NEA) is also developing the 7 MW Mai cascade hydropower project, which is nearing completion. The Mai Khola plant will discharge into the intake of the Mai cascade hydropower project, which ultimately discharges back into the Mai Khola River.

A further seven projects in Nepal are scheduled to be completed in the first half of 2016. Many of these projects were expected to come online in 2015, but were delayed due to the April–May earthquakes in the country. The delays were further exacerbated due to the border blockade and Madhesi movement, which is limiting much-needed fuel to complete construction works. The projects expected to be completed are: Upper Marsyangdi (50 MW), Chameliya (32 MW), Upper Made (19 MW), Kulekhani III (14 MW), Hewa Khola (14 MW), Thapa Khola (11 MW) and the Pikhuwa Khola (2 MW).

In February 2016, Nepal's government declared 2016–26 the "national energy crisis reduction and electricity development decade", with ambitious targets to end the current power shortages within three years and to spearhead further development in the hydropower sector.

BHUTAN

POPULATION
765,000

GDP
USD 2 BN

INSTALLED HYDROPOWER CAPACITY
1,615 MW

HYDROPOWER GENERATION
7,780 GWh

NEPAL

POPULATION
28,175,000

GDP
USD 20 BN

INSTALLED HYDROPOWER CAPACITY
753 MW

HYDROPOWER GENERATION
3,635 GWh

SOUTH AND CENTRAL ASIA
IRAN

Iran is endowed with the world's fourth-largest proven crude oil reserves and the world's second-largest natural gas reserves. The country has relied heavily on its rich fossil fuel resources to supply domestic energy consumption. In 2013, Iran's total primary energy consumption consisted of 60 per cent natural gas, 38 per cent petroleum and 1 per cent hydropower. The remaining share was provided by coal, nuclear and other renewable sources, each of which accounted for less than 1 per cent of the mix.

The Iranian government has signalled its intention to move towards a more balanced energy mix while improving energy efficiency. Recent reforms have curbed subsidies on domestic petroleum, natural gas and electricity with the intention to raise consumer prices. The goal is to limit domestic demand growth. Iran's primary energy consumption has almost doubled since 2004, with growth concentrated in rapidly urbanising areas. These reforms were initiated in 2010, and the second phase began in 2014. The recent lifting of international economic sanctions will likely boost production and exports of petroleum, which may have a moderating effect on any further energy price reforms.

The Iranian government also implemented the Renewable Energy Development Fund in 2013. This policy obliges the ministry of energy to include a duty of IRR 30/kWh on energy bills, which will be payable by all customers with the exception of rural householders. The fund will be maintained by Tavanir, the state-owned utility, and will contribute financing for the expansion and maintenance of rural electricity grids as well as the development of new renewable energy capacity in the country.

Most large-scale hydropower projects are managed by the Iran Water and Power Resources Development Company (IWPCO). There are also a number of well-known developers active in the country, such as Farab, a contractor, and Mahab Ghodss, an engineering consultancy. Hydropower is the country's largest renewable resource by generational capacity, and Iranian companies have considerable experience and expertise in hydropower development. They are also increasingly active on the international stage. For example, Iran has long-standing agreements in place with Tajikistan, and is supporting development of the Uma Oya multipurpose project (134 MW) in Sri Lanka.

There has also been steady progress on development within Iran. The 1,040 MW Siah Bishe pumped-storage plant, which commissioned its first 260 MW generating turbine in 2013, entered full commercial operation in September 2015 when the fourth and final pump-turbine was commissioned. This station generates electricity during periods of high energy demand and consumes 940 MW of electrical power for pumping operation during periods of low demand. It is intended to meet peak electricity demand in the capital city, Tehran, which is 125 km to the south.

The first of three 160 MW turbines at the 480 MW Seimare dam was also commissioned in 2013. Studies for the dam were carried out in the mid to late 1970s and construction began on the diversion works in 1997. In 2006, concrete placement began, and on 19 May 2011, the dam began to impound the river. Looking forward, two major projects are expected to be completed in 2016: Khersan 3 (400 MW) and Rudbar Lorestan (450 MW). The 1,500 MW Bakhtiari project is also currently under construction.

There are 14 large-scale projects totalling 5,831 MW seeking investments in the country, including the 1,000 MW Ilam pumped-storage plant, the 712 MW Karun 2, and the 584 MW Khersan 1. A further 28 potential large projects are being studied, totalling almost 13 GW in capacity.

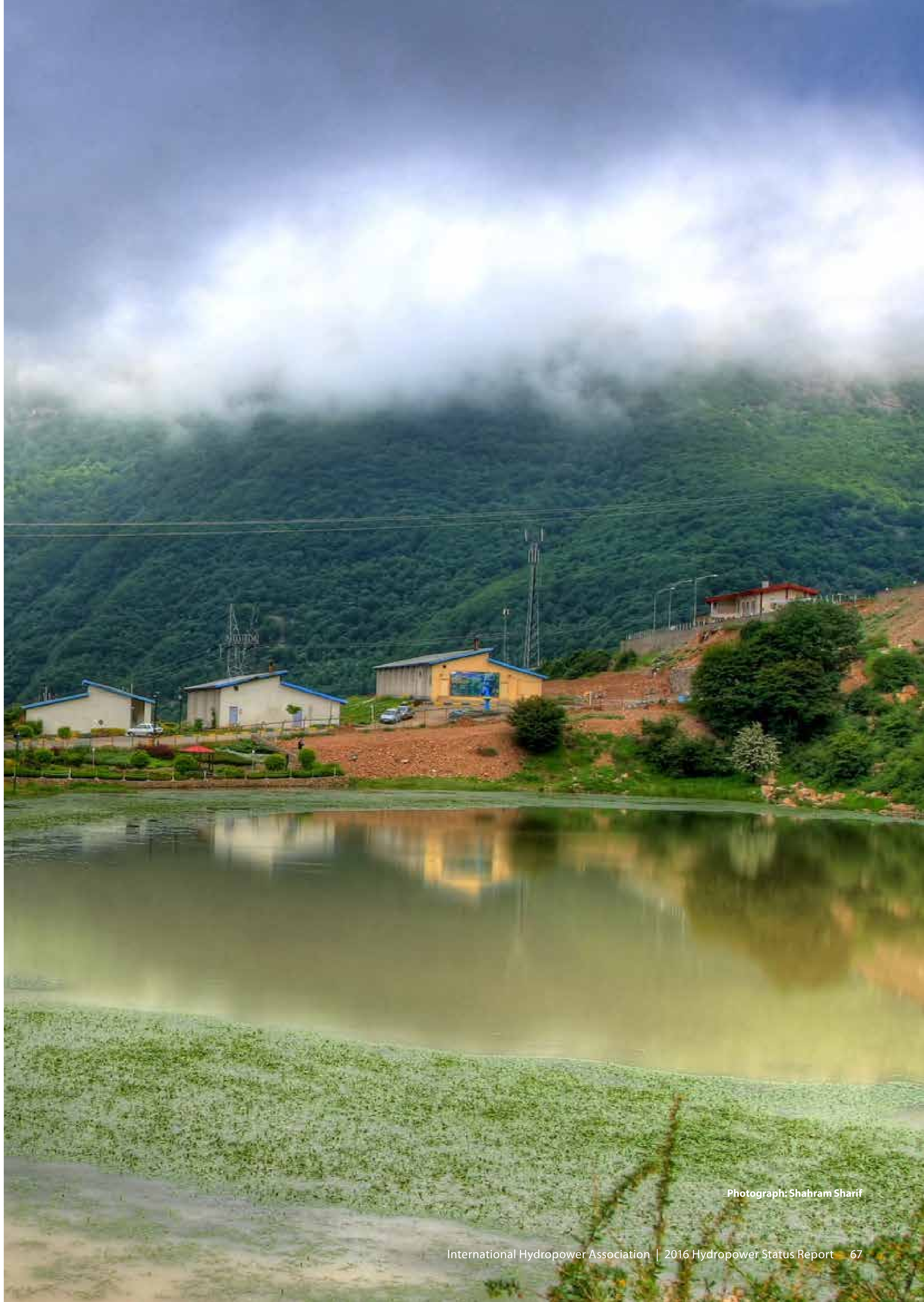
There are also a number of small and medium-sized projects at various stages of development in the country. 14 small and medium-sized projects are ready for investment, representing a total of 430 MW in capacity.

POPULATION
78,144,000

GDP
USD 425 BN

INSTALLED HYDROPOWER CAPACITY
11,196 MW

HYDROPOWER GENERATION
13,785 GWh



Photograph: Shahram Sharif

EAST ASIA AND PACIFIC **REGION MAP**

TOP SIX COUNTRIES BY INSTALLED HYDROPOWER CAPACITY (MW)* — **OTHERS:** 38,012 | **TOTAL:** 443,207

1	2	3	4	5	6
CHINA	JAPAN	VIETNAM	AUSTRALIA	SOUTH KOREA	MALAYSIA
319,370	49,905	15,211	8,790	6,447	5,472

EAST ASIA AND PACIFIC CAPACITY BY COUNTRY

Rank	Country	Installed hydropower capacity (MW)*
1	China	319,370
2	Japan	49,905
3	Vietnam	15,211
4	Australia	8,790
5	South Korea	6,447
6	Malaysia	5,472
7	Indonesia	5,258
8	New Zealand	5,254
9	North Korea	5,000
10	Chinese Taipei	4,683
11	Thailand	4,510
12	Philippines	4,235
13	Laos	4,168
14	Myanmar	3,140
15	Cambodia	1,267
16	Papua New Guinea	234
17	Fiji	125
18	New Caledonia	78
19	French Polynesia	47
20	Samoa	12

* includes pumped storage

EAST ASIA AND PACIFIC **OVERVIEW**

The East Asia and Pacific region accounts for the largest share of global installed hydropower capacity out of all six regions. China alone accounts for almost one-third of global hydropower capacity. Approximately 19.4 GW of new capacity was added there in 2015 – more than the rest of the world's additions combined – bringing the country's total installed hydropower capacity to an estimated 319 GW. Excluding China, an estimated 2,717 MW were added in the East Asia and Pacific region in 2015.

Vietnam commissioned four hydropower stations totalling 1,030 MW in 2015, affirming the country's commitment to further hydropower development in the country in order to meet rising demand. Both turbines were commissioned at the 150 MW Dong Nai 5 station, which is expected to generate 616 GWh per year. Vietnam also commissioned the first turbines at the 1,200 MW Lai Châu station, where 400 MW were commissioned, and the 520 MW Huoi Quang station, where 260 MW were commissioned. These projects are expected to be completed during 2016. The 220 MW Ben Chat project was also completed last year.

The Vietnamese government approved, in December, the new Renewable Energy Development Strategy to 2030 with an outlook to 2050, which builds upon the 7th Power Master Plan and gives priority to renewable energies. The strategy plans an increase in hydropower generation from 56 TWh in 2015, to 90 TWh in 2020 (which corresponds to 21,000 MW total installed hydropower capacity), and 96 TWh in 2030.

Myanmar commissioned the 140 MW Upper Paunglaung project in December 2015, a significant milestone towards the country's target of achieving a 50 per cent electrification rate by 2020. The station is expected to produce approximately 450 GWh per year. In addition, the project will regulate river flows to improve power generation at the existing 280 MW Lower Paunglang station downstream.

Myanmar has also announced plans for several new hydropower projects that will be developed in cooperation with European and North American companies. Previously, agreements had been signed mostly with Chinese, Thai and Indian companies, but some of these projects were cancelled due to incomplete environmental and social impact assessments. The Shweli 3 project is to be built by a firm from the United Kingdom and France, while the Middle Yeywa and Bawgata projects will be built by Norwegian firms, and the Middle Paunglaung project will be handled by Austrian or British developers. Toshiba's Chinese subsidiary, Hangzhou, was awarded the contract to supply four 77 MW turbines for the 308 MW Upper Yeywa project, which is expected to come online in 2018.

Malaysia installed the remaining three 236 MW turbines at the 944 MW Murum power station in the state of Sarawak on the island of Borneo. The first turbine was connected to the grid in December 2014, and the final turbine was connected in June 2015. The dam is located on the Murum River. It is part of a planned four-station cascade, which also includes the 2,400 MW Bakun station, located 70 km downstream. The state is also expecting to begin construction on the 1,285 MW Baleh project in 2016.

In Japan, Toshiba installed the second 200 MW unit at the Kyogoku pumped storage power plant in Hokkaido, about 35 km south-west of Sapporo. The first turbine was commissioned in October of 2014. The two turbines of the Kyogoku station use variable-speed technology which allows for the station to provide both peak-power supply capability as well as the ability to suppress fluctuations in frequency in the grid. It is worth noting that innovative control-system technology allows each pump-turbine unit to be controlled separately, further increasing flexibility to balance power frequency fluctuations.

Meanwhile the Philippines added 29 MW of hydropower capacity in 2015: 14 MW at the Sabangan project and a further 15 MW in upgrading the 125 MW Binga plant to 140 MW.

POLICIES

Chinese Taipei
Feed-in tariff for run-of-river hydropower (all sizes) at rate of EUR 0.184/kWh.

Indonesia
Feed-in tariffs for hydropower plants up to 10 MW capacity, IDR 656/kWh for medium voltage and IDR 1,004/kWh for low voltage, power purchase agreements with the state electricity company.

Japan
Feed-in tariffs for hydropower at JPY 35.70/kWh for <200 kW capacity, JPY 30.45/kWh for 200 kW – 1 MW capacity, and JPY 25.20/kWh for 1–3 MW capacity, all for 20 years.

Malaysia
Renewable Energy Act 2011 includes feed-in tariff for small hydropower plants for a period of 21 years.

Philippines
Feed-in tariff for run-of-river hydropower at PHP 5.90/kWh for at least twelve years, with an installation target of 250 MW by 2015.

Thailand
Small hydropower supported by small power producer purchase agreements.

TARGETS

Country	Target
China	330 GW total by 2017
Chinese Taipei	2,500 MW total installed capacity hydro by 2030 (not including pumped storage)
Indonesia	2,000 MW by 2025
	3,000 MW pumped storage by 2025
South Korea	13,016 GWh/year by 2030
	1,926 GWh/year small-scale hydropower by 2030
	6,159 GWh/year ocean power by 2030
Vietnam	17,400 MW by 2020
	1,800 MW pumped storage by 2020, 5,700 MW pumped storage by 2030
Philippines	8,724 MW by 2030
Thailand	5,100 MW by 2021
	2 MW ocean power by 2021

EAST ASIA AND PACIFIC
CHINA

For the tenth consecutive year, China added more new installed hydropower capacity than the rest of the world combined, cementing the country's leading role in global hydropower development. In 2015, China added 19,370 MW of new hydropower capacity*, including 1,230 MW of pumped storage, bringing the total installed capacity in the country to 320 GW. The country remains the world's leading producer of renewable energy. China is also a world leader in clean energy investments, which now exceed total investments in fossil fuels and nuclear power combined.

In its intended nationally determined contribution (INDC) to the United Nations Framework Convention on Climate Change (UNFCCC), China reaffirmed the terms of its bilateral agreement with the USA, pledging to reach peak total emissions by 2030, or earlier, and to reduce power sector emissions by 60 per cent before 2020. China has also shown a determined effort to combat urban air pollution by reducing coal consumption and bolstering the carbon efficiency of transport and industry.

In order to achieve these ambitious goals, China is rapidly expanding low-carbon generation technologies, including nuclear, wind and solar power. The flexible characteristics of hydropower, including pumped storage, facilitate the increased grid penetration of wind and solar. Pumped-storage hydropower is also complementing the growing nuclear power capacity in the country. In 2015, China produced over 1,126 TWh of hydroelectric energy, a 5 per cent increase from 2014, while fossil fuel production dropped by almost 3 per cent. Hydropower accounts for 20 per cent of the country's total power production.

China has largely met the ambitious goals for hydropower development set out in its twelfth five–year plan (2011–15). However, it has not developed pumped storage capacity at such a rapid rate as conventional hydropower. Installed pumped-storage capacity reached 23 GW in 2015, which is far from the plan's 41 GW target.

Nearly one-fifth of China's installed wind power output was curtailed in 2014, i.e. electricity that could have been generated by wind farms was not accepted, due to excess power in the system. Some of this curtailment can be attributed to the lack of pumped-storage capacity. This situation also reflects the need for improved transmission and distribution interconnections.

The slower rate of pumped storage development can be attributed in part to the lack of fair remuneration for grid services by the market. The Chinese government has now reformed policies to encourage further pumped storage development. New policy instruments include a two-part feed-in tariff, which is specific to pumped-storage plants. This mechanism reflects the value of pumped storage's ancillary energy services, and acknowledges the technology's important role in providing reserve capacity. Further policies put the onus on the two Chinese grid companies, China State Grid and China Southern Grid, to construct and manage new pumped-storage stations.

An estimated 27 GW of pumped storage capacity is currently in development across the country. Notable pumped storage projects include the 3,600 MW Fengning plant in Hebei province, which is currently under construction. When completed in 2021, it is expected to be the largest pumped storage station in the world. Pumped storage projects that are expected to commission turbines in 2016 include Tianchi (1,200 MW) and Jixi (1,800 MW).

Notable capacity additions in 2015 include the addition of the first two 650 MW turbines at the Dagangshan hydropower station on the Dadu River in Sichuan. When fully commissioned in 2016, this project will have a total installed capacity of 2,600 MW. The Guanyinyan project (3,000 MW) on the Jinsha River added three more 600 MW turbines in 2015; one remains to be installed before the project is completed.

In the Tibet Autonomous Region, the 510 MW run-of-river Zangmu station was fully commissioned, having added its first two 85 MW turbines in late 2014. Zangmu, located some 140 km away from Lhasa, will be the largest hydropower station in the region. The 120 MW Niyang station, also in Tibet, close to the Indian border with Arunachal Pradesh, was fully commissioned.

Elsewhere, the 558 MW Mamaya hydropower station, situated on the Beipangjiang River, a tributary of the Pearl River, in Guizhou province, was connected to the grid. It will supply power through newly constructed transmission lines to Guangdong provinces.

POPULATION
1,356,000,000

GDP
USD 9,240 BN

INSTALLED HYDROPOWER CAPACITY
319,370 MW, INCLUDING 23,060 PUMPED STORAGE

HYDROPOWER GENERATION
1,126,000 GWh

* Due to uncertainty about full station commissioning dates falling between 2014 and 2015, IHA's Hydropower Status Report is reporting 19 GW added in 2015, and REN21's Global Status Report is reporting 16 GW

EAST ASIA AND PACIFIC
INDONESIA

Indonesia's technical hydropower potential is estimated at around 75,000 MW, with untapped resources concentrated on the islands of Sumatra, Java and Sulawesi. It is estimated that there is currently about 8 GW of undeveloped hydropower potential, which would provide almost 33 TWh of electricity per year. Nonetheless, the development of renewable technologies, including hydropower, remains stalled in the country. The Indonesian government's current strategy is to emphasise coal and gas in the energy supply mix to focus on reducing both the cost of electricity production and the country's current reliance on subsidised oil.

The electricity sector in Indonesia is dominated by the state-owned utility, PT Perusahaan Listrik Negara (PLN), which controls 74 per cent of the country's 46 GW of installed electricity capacity, as well as the transmission and distribution infrastructure. The involvement of independent power producers is regulated in accordance with the 2009 Electricity Law, which maintains PLN's exclusive rights over the transmission, distribution and selling of electricity.

Total energy demand in Indonesia is expected to increase by 8.7 per cent each year up to 2024. According to PLN's strategic plan (RUPTL), new capacity in the country will be delivered largely through new coal-fired stations (7.23 GW), gas installations (4 GW) and combined-cycle plant (6.3 GW). The plan also includes a proposed 1 GW of new hydropower capacity.

Hydropower development will be driven in part by the government's target to increase the share of renewables in the country's total energy use to 23 per cent by 2025; the figure is around 5.87 per cent for 2015. Nonetheless, investment in renewable technologies has been deterred by both subsidised fuel prices and a complex, rapidly changing legal and regulatory environment.

Despite these challenges, seven hydropower stations totalling 1,559 MW are currently under construction in the country. A further ten projects totalling 1,819 MW are subject to power purchase agreement (PPA) negotiations, while 19 projects totalling 2,131 MW are in the study or design phase.

The largest project currently under construction is the 1,040 MW Upper Cisokan plant, a pumped storage project located in western Java. The project is being built by South Korea's Daelim and Italy's Astaldi Group, in a joint venture with an Indonesian firm, Wika. The total project cost is estimated at USD 800 million, and will be supported by a USD 640 million specific investment loan from the World Bank. According to the World Bank, the goal of this project is to increase the peaking capacity of the Java-Bali grid in an environmentally and socially sustainable way, while strengthening PLN's institutional capacity to oversee hydropower planning, development and operations.

Indonesia is also now importing hydropower to the West Kalimantan province in Borneo, from the neighbouring state of Sarawak in Malaysia. A 275 kV transmission connection linking the two countries' grids in Borneo was completed in January 2016, and imports from Malaysia are expected to reach 50 MW by the end of March 2016. 2015 saw Sarawak Energy Berhad commission the final three turbines at the 944 MW Murum dam.

POPULATION	GDP	INSTALLED HYDROPOWER CAPACITY	HYDROPOWER GENERATION
254,455,000	**USD 889 BN**	**5,258 MW**	**13,741 GWh**

EAST ASIA AND PACIFIC
LAOS

With a theoretical hydropower potential of 26.5 GW, the Lao People's Democratic Republic (PDR) is among the richest countries in south-east Asia in terms of hydropower resources. Due to high average annual precipitation, hilly terrain and a low population density that limits the need for human resettlements, 18 GW of the theoretical potential are technically exploitable. Lao PDR's geographic region includes a significant part of the Mekong River basin and its tributaries, which contribute an estimated 35 per cent of the Mekong's total inflows.

Hydropower is now seen as a cost-effective energy supply option in Laos. However there were only four operational hydropower stations, totalling 206 MW installed capacity, before the Laotian government opened the power sector to foreign investment in 1993. Since then, the country has experienced a rapid growth in installed hydropower capacity, bringing more than 3.5 GW online during the past 20 years. Growth in the Laotian hydropower sector has been driven by demand for electricity exports to neighbouring Thailand and, to a lesser extent, Vietnam; consequently these neighbouring countries have supported the development of projects in Laos.

Laos currently exports an estimated two-thirds of its hydropower. Revenues from power exports make a significant contribution to economic growth and poverty alleviation in the country. Electricity accounts for roughly 30 per cent of all Laotian exports. In 1993, Laos and Thailand signed their first memorandum of understanding (MOU), which outlined a plan for Laos to supply 1,500 MW of power to Thailand. This MOU has since been extended several times in response to rising demand in Thailand. The most recent power purchase scheme states that Laos will supply some 7,000 MW of electricity to Thailand by 2020. Laos has also entered into similar bilateral agreements with both Vietnam (5,000 MW) and Cambodia (200 MW). Under these agreements, approved independent power producer (IPP) projects that export energy are required to reserve a minimum of 10 per cent of their total installed capacity for domestic markets.

Investment from neighbouring countries has contributed to a significant increase in the country's electrification rate over the last 20 years. The Laotian electrification rate increased from 15 per cent in 1995 to close to 90 per cent in 2015, though the remaining unserved areas are remote and difficult to reach.

Laos added 599 MW of installed hydropower capacity in 2015, bringing its total installed capacity to 4,168 MW. In its intended nationally determined contribution (INDC) to the United Nations Framework Convention on Climate Change (UNFCCC), Laos outlined continued plans for hydropower development, projecting a total hydropower installed capacity of 5,500 MW by 2020 and further 20,000 MW planned after 2020. In total, there are more than 50 hydropower sites in the country which are expected to be operational by 2025.

The 130 MW Nam Khan 2 project, located in the northern Luang Prabang province, was completed in cooperation with the China Power Construction Corporation and Sinohydro. This station will mainly supply domestic power demand, but is also a milestone project for cooperation between Laos and China; Nam Khan 2 will also provide power for the construction and operation of the upcoming China-Laos railway to be completed by 2021.

After four years of construction, Nam Ngiep 2 in Xieng Khuang province was connected to the national grid. The 180 MW generating station was constructed by the China International Water & Electric Corporation (90 per cent ownership) in partnership with Electricite du Laos (10 per cent) under a build-own-operate-transfer (BOOT) scheme. The power supplied from Nam Ngiep 2 will contribute towards meeting local demand.

The first station of a seven-stage cascade project was completed on the Nam Ou River in late 2015. Nam Ou 2 (120 MW) is part of the first phase of the cascade development and is located upstream of Nam Ou 5 (240 MW) and Nam Ou 6 (180 MW), which are expected to come online in 2016 and 2017, respectively.

Other stations commissioned in 2015 include Houay Lampien (88 MW) in the south, Nam San 3B (45 MW) in central Laos, and Nam Beng (36 MW) in the north.

POPULATION	GDP	INSTALLED HYDROPOWER CAPACITY	HYDROPOWER GENERATION
6,689,000	**USD 12 BN**	**4,168 MW**	**18,700 GWh**

world hydropower congress

While about two-thirds of the hydropower potential is currently unutilised, especially in the developing world, the total installed capacity of hydropower is now significant, at 1,211 GW. This is enough low-carbon electricity to supply more than a billion people.

Hydropower can be developed over a wide range of scales, from kW to GW, and from isolated projects to regionally interconnected systems. It has an exceptional level of efficiency and operational flexibility, and can provide both storage and backup for other sources of generation; in particular, other forms of renewable energy.

Hydropower can also contribute to multiple freshwater services, including water supply, irrigation, navigation, flood control, drought mitigation and tourism.

However, hydropower's contribution to modern energy and water systems remains often suboptimal. Past experience and good practice are not always well known, and opportunities for better outcomes have been missed.

Hydropower's role in a changing world is a dynamic that calls for an integrated approach, with a strongly connected sector, and a high level of open-mindedness. With the right commitment, it can form an integral part of sustainable development, and play a key role in delivering modern energy and water services in a climate-constrained world.

The World Hydropower Congress will bring together a diversity of perspectives and examine how initiatives from governments, businesses, finance and civil society can converge to help deliver better hydro, and ultimately better development for all.

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WORLD HYDROPOWER INSTALLED CAPACITY AND GENERATION 2015

AFRICA

Country	Total installed capacity including pumped storage (MW)	Pumped storage (MW)	Generation (TWh)
Algeria	228	-	0.32
Angola	766	-	4.27
Benin	1	-	-
Botswana	-	-	-
Burkina Faso	32	-	0.10
Burundi	54	-	0.21
Cameroon	741	-	4.41
Cape Verde	-	-	-
Central African Republic	25	-	0.14
Chad	-	-	-
Comoros	1	-	-
Congo	209	-	1.06
Côte d'Ivoire	604	-	2.49
Democratic Republic of the Congo	2,495	-	8.52
Djibouti	-	-	-
Egypt	2,800	-	13.70
Equatorial Guinea	127	-	0.01
Eritrea	-	-	-
Ethiopia	2,552	-	9.00
Gabon	170	-	0.80
Gambia	-	-	-
Ghana	1,584	-	8.67
Guinea	368	-	0.50
Guinea-Bissau	-	-	-
Kenya	818	-	3.44
Lesotho	80	-	0.69
Liberia	-	-	-
Libya	-	-	-
Madagascar	164	-	0.86
Malawi	364	-	2.14
Maldives	-	-	-
Mali	157	-	0.29
Mauritania	97	-	0.12
Mauritius	60	-	0.08
Morocco	1,770	464	2.52
Mozambique	2,187	-	12.00
Namibia	341	-	1.79
Niger	-	-	-
Nigeria	2,040	-	5.90
Réunion	121	-	0.50
Rwanda	99	-	0.18
São Tomé and Príncipe	4	-	0.01
Senegal	-	-	-
Seychelles	-	-	-
Sierra Leone	54	-	0.11
Somalia	-	-	-
South Africa	2,251	1,580	1.06
South Sudan	-	-	-
Sudan	2,250	-	6.31
Swaziland	60	-	0.27
Tanzania	562	-	2.56
Togo	65	-	0.10
Tunisia	66	-	0.05
Uganda	706	-	1.48
Western Sahara	-	-	-
Yemen	-	-	-
Zambia	2,272	-	13.93
Zimbabwe	765	-	5.50
TOTAL	**30,111**	**2,044**	**116**

SOUTH AND CENTRAL ASIA

Country	Total installed capacity including pumped storage (MW)	Pumped storage (MW)	Generation (TWh)
Afghanistan	400	-	0.91
Bahrain	-	-	-
Bangladesh	230	-	1.49
Bhutan	1,615	-	7.78
India	51,494	4,786	124.65
Iran	11,196	1,040	13.79
Iraq	2,753	240	4.40
Israel	7	-	0.03
Jordan	12	-	0.06
Kazakhstan	2,260	-	7.33
Kuwait	-	-	-
Kyrgyzstan	3,091	-	13.81
Lebanon	221	-	0.66
Nepal	753	-	3.64
Oman	-	-	-
Pakistan	7,264	-	31.18
Qatar	-	-	-
Russia	50,624	1,360	160.17
Saudi Arabia	-	-	-
Sri Lanka	1,624	-	5.12
Syria	1,505	-	2.77
Tajikistan	5,190	-	17.73
Turkey	25,886	-	66.90
Turkmenistan	1	-	-
United Arab Emirates	-	-	-
Uzbekistan	1,731	-	10.31
TOTAL	**167,856**	**7,426**	**473**

EAST ASIA AND PACIFIC

American Samoa	-	-	-
Australia	8,790	740	13.63
Brunei	-	-	-
Cambodia	1,267	-	1.85
China	319,370	23,060	1,126.40
Chinese Taipei	4,683	2,602	4.19
Cook Islands	-	-	-
Fiji	125	-	0.30
French Polynesia	47	-	0.29
Indonesia	5,258	-	13.74
Japan	49,905	27,637	91.27
Kiribati	-	-	-
Laos	4,168	-	18.70
Malaysia	5,472	-	11.98
Marshall Islands	-	-	-
Micronesia, Federated States Of	-	-	-
Mongolia	-	-	-
Myanmar	3,140	-	5.78
Nauru	-	-	-
New Caledonia	78	-	0.33
New Zealand	5,254	-	24.29
Niue	-	-	-
North Korea	5,000	-	13.14
Papua New Guinea	234	-	0.86
Philippines	4,235	685	9.95
Samoa	12	-	0.05
Singapore	-	-	-
Solomon Islands	-	-	-
South Korea	6,447	4,700	5.86
Thailand	4,510	1,000	11.68
Timor-leste	-	-	-
Tonga	-	-	-
Tuvalu	-	-	-
Vanuatu	-	-	-
Vietnam	15,211	-	62.63
Wallis And Futuna	-	-	-
TOTAL	**443,207**	**60,424**	**1,417**

EUROPE

Country	Total installed capacity including pumped storage (MW)	Pumped storage (MW)	Generation (TWh)
Åland Islands	-	-	-
Albania	1,527	-	4.01
Andorra	45	-	0.10
Armenia	1,249	-	2.74
Austria	13,178	5,200	39.53
Azerbaijan	1,116	-	2.44
Belarus	33	-	0.11
Belgium	1,427	1,307	0.34
Bosnia and Herzegovina	2,504	420	6.50
Bulgaria	3,129	864	3.97
Croatia	2,141	293	6.31
Cyprus	-	-	-
Czech Republic	2,212	1,147	3.06
Denmark	9	-	0.02
Estonia	8	-	0.03
Faroe Islands	39	-	0.12
Finland	3,198	-	16.54
France	25,397	6,985	57.30
Georgia	2,727	-	8.40
Germany	11,258	6,806	24.49
Gibraltar	-	-	-
Greece	3,396	699	5.59
Greenland	90	-	0.35
Hungary	56	-	0.23
Iceland	1,986	-	13.65
Ireland	529	292	1.08
Italy	21,880	7,555	44.75
Kosovo	36	-	0.13
Latvia	1,576	-	3.18
Liechtenstein	-	-	-
Lithuania	876	760	0.51
Luxembourg	1,134	1,100	0.09
Macedonia	674	-	1.19
Malta	-	-	-
Moldova	76	-	0.37
Montenegro	658	-	1.80
Netherlands	37	-	0.09
Norway	30,566	1,351	139.00
Poland	2,351	1,782	2.36
Portugal	5,902	1,343	9.78
Romania	6,705	92	14.48
San Marino	-	-	-
Serbia	2,835	614	11.50
Slovakia	2,522	916	3.79
Slovenia	1,479	180	4.11
Spain	18,561	5,268	32.01
Sweden	16,419	99	73.93
Switzerland	15,635	1,817	39.00
Ukraine	6,785	1,315	11.02
United Kingdom	4,443	2,744	8.65
TOTAL	**218,404**	**50,949**	**599**

NORTH AND CENTRAL AMERICA

Country	Total installed capacity including pumped storage (MW)	Pumped storage (MW)	Generation (TWh)
Antigua and Barbuda	-	-	-
Bahamas	-	-	-
Barbados	-	-	-
Belize	53	-	0.21
Bermuda	-	-	-
Canada	79,202	177	375.63
Costa Rica	1,800	-	7.41
Cuba	64	-	0.10
Dominica	6	-	0.03
Dominican Republic	543	-	1.43
El Salvador	472	-	1.90
Grenada	-	-	-
Guadeloupe	10	-	-
Guatemala	991	-	3.99
Haiti	61	-	0.15
Honduras	558	-	2.98
Jamaica	23	-	0.12
Martinique	-	-	-
Mexico	12,435	-	30.13
Montserrat	-	-	-
Nicaragua	123	-	0.55
Panama	1,655	-	5.07
Puerto Rico	100	-	0.10
Saint Kitts and Nevis	-	-	-
Saint Lucia	-	-	-
Saint Pierre and Miquelon	-	-	-
Saint Vincent and the Grenadines	7	-	0.03
Trinidad and Tobago	-	-	-
United States	101,755	22,441	250.15
TOTAL	**199,857**	**22,618**	**680**

SOUTH AMERICA

Argentina	10,118	974	41.46
Bolivia	494	-	2.34
Brazil	91,650	30	382.06
Chile	6,622	-	24.57
Colombia	11,392	-	49.00
Ecuador	2,297	-	11.87
French Guiana	119	-	0.73
Guyana	1	-	-
Paraguay	8,810	-	59.43
Peru	4,190	-	26.06
Suriname	189	-	0.73
Uruguay	1,538	-	7.54
Venezuela	15,393	-	79.56
TOTAL	**152,813**	**1,004**	**684**

The International Hydropower Association (IHA) is a non-profit organisation that works with a vibrant network of members and partners active in more than 100 countries.

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