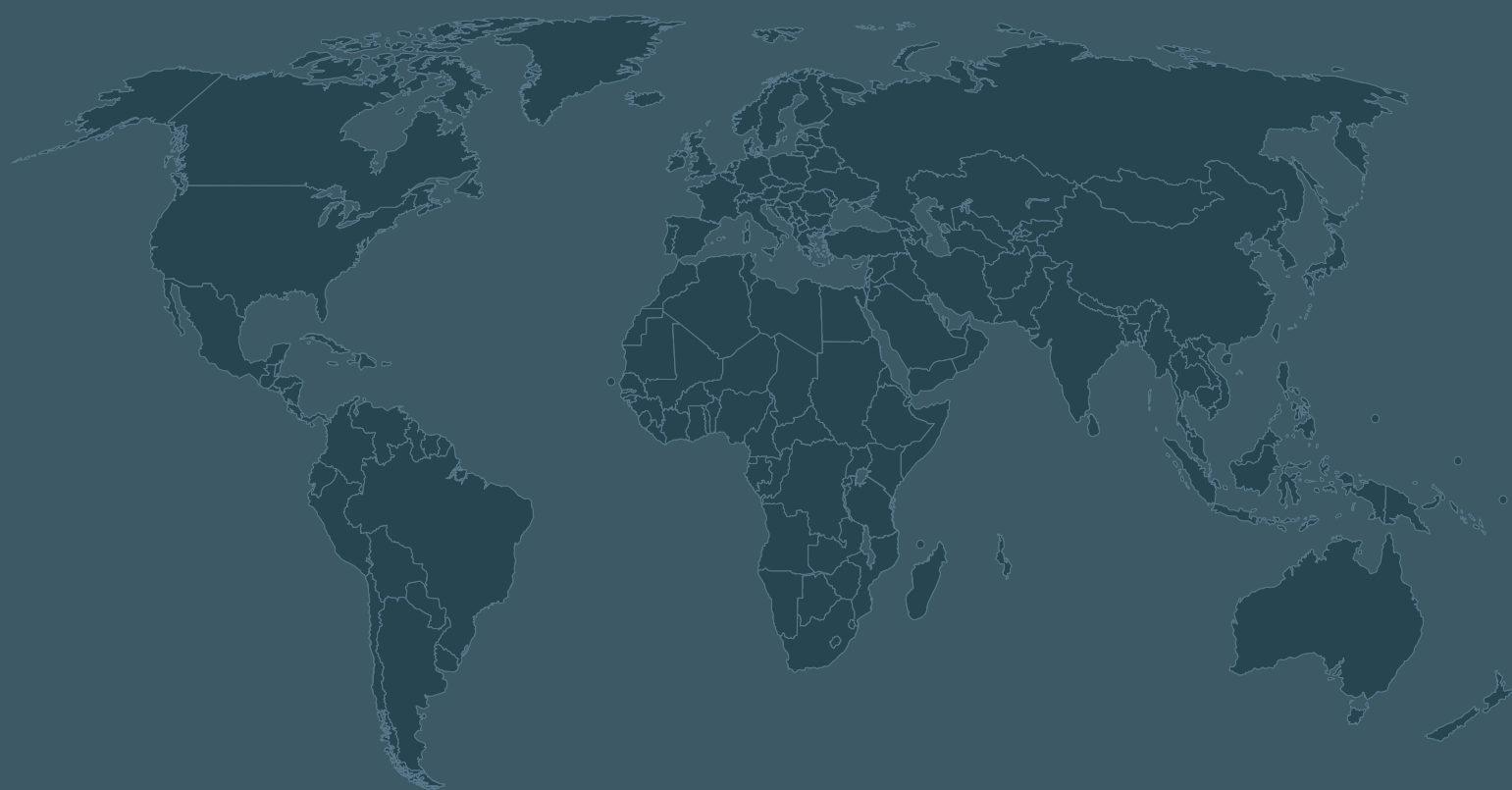


WORLD SMALL HYDROPOWER DEVELOPMENT REPORT 2013

Executive Summary

www.smallhydroworld.org



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Foreword

CHEN Lei

Minister of Water Resources, People's Republic of China and Honorary Chairman, INSHP

Hydropower, as the largest clean and renewable energy source, has played an essential role in the global energy mix. Against the backdrop of rapid social-economic development and global warming, the development of renewable energy has gained increased attention among the global community. The manifold benefits of small hydropower - the relatively low investment capital, small engineering work, simplistic maintenance and operation, minimal environmental impacts, suitability for scattered development in rural and remote areas - have attracted special attention from the global community. Small hydropower has seen rapid development in many countries, making important contribution to meeting daily electricity demand, reducing poverty and advancing socio-economic improvement.

The Chinese Government attaches top priority to the development and utilization of hydropower as well as other renewable energy sources. After many years of efforts, China has an installed hydropower capacity of 249 GW, ranked first in the world. Among which, small hydropower is significant, with 45,000 stations nationwide and 65 GW installed capacity and an annual output of, accounting for 27 per cent and 25 per cent of the nation's hydropower installed capacity and electricity output respectively. In particular, several national programmes have been implemented in recent years, such as the Small Hydropower Replacing Fuel Wood Program, New Rural Hydropower Electrification Program and the Capacity Expansion and Efficiency Improvement of Rural Hydropower Program. As a result, electricity has been provided to those people who have no access to electricity, the wellbeing of the rural residents has been

improved, the local environment has been protected and rural economic progress has been promoted. Significant contribution has been made to energy saving, emission reduction and energy security. Half of the world's small hydropower installed capacities are located in China. The country has accumulated abundant experiences in small hydropower equipment manufacturing, planning and design, technology development, operation and management as well as enabling policy framework. China's successful approaches in small hydropower development have been applauded by international organizations such as the United Nations, and attracted the attention from the international community, all of which paved the way for the establishment of the first China-based international organization - the International Network on Small Hydro Power (INSHP).

In different parts of the world, the availability of water resources, socio-economic conditions, small hydropower technology sophistication and management standard vary greatly from country to country. Developed countries boast of advanced small hydropower technologies and up-to-date equipment as well as managerial expertise, accumulating rich experiences in constructing environment-friendly hydropower projects, which are of great reference value to developing countries. In the process of socio-economic development, developing countries have urgent need for energy and electricity. Blessed with huge hydro potentials yet hindered by low level of development, developing countries still face a huge gap in terms of hydropower technology and equipment manufacturing. Therefore, it is important and imperative to regularly publish reliable official information on small hydropower

development worldwide and promote modern concepts, updated technologies and latest approaches and experiences about small hydropower, in order to create opportunities for bilateral and multilateral cooperation, while highlighting it as a green and clean renewable energy to serve world development.

As the hosting country of INSHP, the Chinese Government actively supports initiatives by the INSHP and International Center on Small Hydro Power (ICSHP) to work closely with other international organizations, including United Nations Industrial Development Organization (UNIDO), and independent experts and scholars, with a view of promoting the worldwide development of small hydropower. After a three-year effort, under the auspices of INSHP and UNIDO, the compilation of the world's baseline data on small hydropower from 152 countries, territories and regions has finally been completed and contained in the *World Small Hydropower Development Report 2013 (WSHPDR 2013)*, with contributions from over 60 experts worldwide. The *WSHPDR 2013* began with a global vision of small hydropower development, providing regional and international institutions as well as countries concerned with baseline information and strategic outlook on renewable energy planning and integrated water resources management. With the *WSHPDR 2013*, the experiences and lessons of small hydropower development could be shared among countries and more opportunities provided for the technical innovation, technology transfer and expertise services in those untapped small hydropower markets.

The Chinese Government welcomes the in-depth exchange and practical cooperation in small hydropower development with the rest of the world. Meanwhile, I sincerely hope that the publishing of *WSHPDR 2013* serves to build a global knowledge platform on small hydropower; one that will play an active role in expanding cooperation and exchange among countries around the world in the development, management, technology, marketing, investment and finance of small hydropower; one that will expedite the sound development of small hydropower and contribute to the creation of a beautiful life for humankind.



CHEN Lei
Minister of Water Resources
People's Republic of China
Honorary Chairman
International Network on Small Hydro Power



Foreword

LI Yong

Director General, UNIDO

Since the industrial revolution and the introduction of steam power, energy has been at the forefront of boosting industrialization and economic growth. The availability of fossil fuels led to increased production, employment and technological innovation, which improved living standards around the world. Environmental challenges, energy security, and volatile fuel prices associated with conventional fossil fuels, have shifted the focus to renewable energies as a basis for low-carbon and sustainable development. Access to reliable low-cost energy based on locally available renewable resources for productive use is a pre-condition for industrial competitiveness, increased productivity, job creation, and income generation, which provide opportunities for social inclusion. Renewable energies are also key success factors in reducing the environmental footprint (e.g. CO₂-emissions per unit of output) of industrial production.

Small hydropower is one of the most suitable renewable energy solutions for productive use and rural electrification. Small hydropower is a mature technology that can be easily constructed, operated and maintained locally. A great share of the small hydropower value chain benefits local economies. It has the lowest electricity generation prices of all off-grid technologies, and has the flexibility to be adapted to various geographical and infrastructural circumstances. Increased small hydropower development will showcase the use of renewable energy in industries, and small and micro enterprises, being an ideal technology option to mainstream renewable energy use to improve productivity, boost industrialization and reduce geographic inequality in industrial production.

As a leading United Nation agency in the provision of renewable energy solutions for inclusive sustainable development, UNIDO is collaborating with the International Center on Small Hydro Power (ICSHP), based in China, to develop a small hydropower knowledge platform www.smallhydroworld.org and to publish the *World*

Small Hydropower Development Report 2013. This flagship initiative of UNIDO is a world-first compilation of global small hydropower data, and will be a crucial policy and investment guide for renewable energy provision through small hydropower. It aims at identifying the world's small hydropower development status and its potential in different countries and regions by engaging with stakeholders to share information. The initiative reinforces UNIDO's continuous commitment to accelerating sustainable development and enhancing productive capacities.

To date, much of the world's small hydropower potential remains untapped. The first step to promote small hydropower is through dissemination of reliable data for policy development and energy planning, as well as through guiding investors in entering renewable energy markets. UNIDO and ICSHP are proud to facilitate this collective effort based on the contribution of more than 60 different authors and organizations from all over the world. We would like to thank all contributing authors and organizations for their work. We are proud to jointly promote small hydropower development for productive use and sustainable industrialization further, and invite interested organizations and experts to participate. UNIDO will continue to play a special role in promoting a system of international dialogue and engaging small hydropower stakeholders from across the world to make this initiative a hub for all small hydropower related information.

LI Yong
Director General
UNIDO

Introduction

A world-first assessment on the global status of small hydropower

As a leading UN agency in the provision of renewable energy solutions for inclusive sustainable industrial development, UNIDO is collaborating with the International Center on Small Hydro Power (ICSHP), based in China, to develop a small hydropower knowledge portal www.smallhydroworld.org and to publish the *World Small Hydropower Development Report 2013 (WSHPDR 2013)*. This flagship assessment of UNIDO is a world-first compilation of global small hydropower data, and will be a crucial policy and investment guide for renewable energy provision through small hydropower. It aims at identifying the world's small hydropower development status and its potential in different countries and regions by engaging with stakeholders to share information.

Small hydropower is one of the most suitable energy solutions for fostering inclusive sustainable development and industrialization.

Small hydropower is a mature technology that can be easily operated and maintained. It has the lowest electricity generation prices of all off-grid technologies, and has the flexibility to be adapted to various geographical and infrastructural circumstances.

Information is the first essential step for policy and investment decisions.

Much of the world's small hydropower potential remains untapped. First step to remedying the situation is through dissemination of reliable data that can inform policy development and energy planning, as well as guide investors in entering renewable energy markets.

This Executive Summary provides the key findings of the report. The complete assessment can be accessed at: www.smallhydroworld.org

Global data on small hydropower by region and country is provided.

The assessment is based on the contribution of more than 60 different authors or organizations. It contains 20 regional overviews and 149 country-level reports, which are available to the public. The report includes:

- an overview of the global status of small hydropower with a focus on the untapped potentials of small hydropower.
- an overview of small hydropower development status and potential for 20 geographical regions.
- country-level analysis for 149 countries with an overview of the power and electricity sector of the country, installed small hydropower capacity, and institutional climate for small hydropower development.

The report will be updated biennially to provide current and relevant data.

To ensure that the data and information provided by the report is up-to-date, UNIDO and ICSHP will collaborate with national institutions to facilitate continuous monitoring and collection of small hydropower data. The changes will be reflected regularly on the website while a consolidated print version is planned to be available biennially.

Join us!

UNIDO has the vision to play a special role in promoting a system of international dialogue and engaging small hydropower stakeholders from across the world to make this initiative a hub for all small hydropower related information. UNIDO and ICSHP are actively reaching out to more stakeholders and partners to provide relevant information in order to keep the website up-to date. This shall be a collaborative effort – you are invited to participate in extending the world's small hydropower knowledge base.

Contact us: renewables@unido.org or report@icshp.org to find out more.

Executive Summary

Comprehensive information regarding global small hydropower potential and development has not been available so far. For many years, information on small hydropower has had to be sourced at the local or regional level, with a great variety in depth, availability and reliability of data, even lacking a universal small hydropower definition. A comprehensive reference publication for decision makers, stakeholders and potential investors is clearly needed to more effectively promote small hydropower as a renewable and rural energy source for sustainable development and to overcome the existing development barriers. This, the first *World Small Hydropower Development Report 2013 (WSHPDR 2013)* aims to identify the development status and resource potential of different countries, territories and regions in the world by engaging with experts and those working at the ground level to compile and share existing information, experiences and challenges in one comprehensive report.

Energy is one of the most critical economic, environmental and sustainable development issues concerning people worldwide. According to the *World Energy Outlook 2012*, 1.3 billion people still lack the access to electricity while 2.7 billion must rely solely on traditional biomass to meet their energy needs. The United Nations estimated that among those with access to electricity, 1 billion people have poor quality electricity or can only obtain it intermittently from unreliable grid networks. Electrification is an important prerequisite of development, yet the fact remains that hundreds of millions remain trapped in a cycle of energy poverty. Albeit inefficient, many resort to traditional sources of energy, while their production and utilization have been shown to be detrimental to health and the environment.

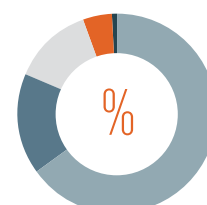
Small hydropower is a well-developed small-scale renewable energy technology, which can contribute to the improvement of electricity access in rural areas and be part of the solution for socially inclusive sustainable industrial development as per the mandate of the United Nations Industrial Development Organization (UNIDO). One of the main challenges of implementing hydropower is capital cost. However, this disadvantage is weighed against the long term as small hydropower is a locally available renewable energy resource that can be used for electrification both on- and off-grid in a clean, efficient and secure manner. It has a high tariff payback ratio while serving to mobilize financial resources locally. Such economic benefits may contribute to the long term socio-economic development of populations that are small in group, dispersed and geographically isolated, combating their vulnerable status with autonomous electricity generation and a resilient micro grid network.

Many countries including several small island states rely on diesel for electricity generation. Soon they will be impacted by increasing petroleum prices and growing trade deficits. The switch to renewable energy, including small hydropower, may provide greater energy independence and economic stability, as well as contributing to climate change mitigation. Even in countries that are fully electrified, small hydropower may contribute to achieve renewable energy targets, energy diversification and energy independence.

Overview of small hydropower worldwide

Currently, small hydropower plants with a capacity of 10 MW exist in 148 countries or territories worldwide. Four other countries have been identified with resource potential.

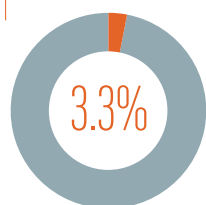
Global distribution of small hydropower resource potential up to a capacity of 10 MW



Asia	65.18%
Europe	16.28%
Americas	13.26%
Africa	4.57%
Oceania	0.72%

The findings of *WSHPDR 2013* show that small hydropower potential globally is approximated at almost 173 GW. The figure is arrived by totalling data from a wide range of sources with potential compromise of data integrity to varying degrees. For example, research data on economically feasible potential were more readily available in developed countries than those in the least developed or developing countries. More than half of the world's known hydropower potential is located in Asia, around one third can be found in Europe and the Americas. In the future it is possible that more small hydropower potential might be identified both on the African and American continents. The installed small hydropower capacity (up to 10 MW) is estimated to be 75 GW in 2011/2012.

Region's small
hydropower installed
capacity and potential in
MW (10 MW definition)



209 MW installed capacity
6,262 MW potential

Countries and territories
with small hydropower

Burundi, Ethiopia,
Kenya, Madagascar,
Malawi, Mauritius,
Mozambique, Réunion,
Rwanda, South Sudan*,
Uganda, United Republic
of Tanzania, Zambia,
Zimbabwe

* potential only

Africa

Eastern Africa

Thirteen of the twenty countries in Eastern Africa use small hydropower to supplement their existing electrification efforts. Eastern Africa has an estimated small hydropower potential of 6,262 MW (up to 10 MW), of which 209 MW has been developed. Among these, countries with the highest potential are Kenya (3,000 MW), Ethiopia (1,500 MW) and Mozambique (1,000 MW). Most of the other countries do not have an official small hydropower definition, and Mozambique defines it as up to 15 MW.

Most of the countries in Eastern Africa have national energy policies (e.g. Malawi, Rwanda) or rural electrification policies (e.g. Madagascar, United Republic of Tanzania) in place to support the use of renewable energy. In Uganda, the renewable energy policy has a target that includes mini- and micro-hydropower and value-added tax exemption for hydropower investors. Micro hydropower and isolated mini-grids are explicitly mentioned in the national energy policy of Rwanda. Kenya possesses a revised feed-in tariff (FIT) policy for small hydropower. Several countries such as Madagascar, Mauritius, Rwanda and Réunion already use FITs. Rwanda also uses other forms of incentives such as tax exemption and direct subsidies. Both Ethiopia and Zambia are preparing to introduce renewable energy FITs.

Barriers to small hydropower development are manifold, ranging from lack of hydrological data in Burundi, Réunion and the United Republic of Tanzania, to inadequate awareness of small hydropower in the United Republic of Tanzania. Some data need to be updated, such as Burundi's small hydropower master plan and Malawi's resource potential due to environmental degradation. Difficult site access due to lacking road infrastructure in remote areas pose barriers in Mauritius, Madagascar and Zambia, as these barriers mean higher transport costs while energy consumers either live far away from the power generation sites or have low income (e.g. Rwanda). Another barrier is the lack of investment from foreign investors, private companies. Banks in particular, are reluctant to lend the start-up capital upfront. In addition, human resource capacity, especially technical know-how, needs to be improved in view of the poor maintenance and management of small hydropower plants i.e. in Kenyan communities. South Sudan's meteorological and hydrological data collection network were destroyed post-conflict, water resources management also does not receive priority, on top of that there is a lack of technical capacity.

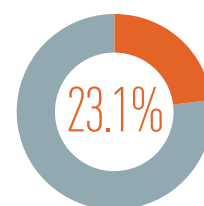
Water is a very scarce resource in both Ethiopia and Mauritius. Effects of climate change, deforestation and degradation of water in catchment areas were reported for Kenya and Malawi. Seasonal fluctuation of water flow in Mauritius and climatic variations in Réunion pose challenges and concerns to small hydropower development.

Middle Africa

Five out of nine countries in Middle Africa use small hydropower to some degree or have the potential to do so. Middle Africa has an estimated small hydropower potential of about 328 MW (for plants up to 10 MW), of which 76 MW has been developed. It should be noted that none of the countries have had their full small hydropower resources assessed and the estimated potential is based on individual, probably non-comprehensive country lists of sites that may be inaccurate or out of date at the time of this writing.

No specific renewable energy policy exists in any of the Middle African countries mentioned. Legislation for renewable energy sector in Angola is underway and small hydropower endorsement can be found in poverty reduction and rural electrification strategies. In Cameroon, the development objectives up till 2035 include renewable energy for economic development. The energy policy of the Central African Republic favours renewable energy and energy diversification. It aims to reduce poverty based on expanded rural electrification, building micro-hydropower plants and electrifying villages using photovoltaic systems and biomass energy.

Financial and administrative barriers as well as difficulty of access to technology were reported in Cameroon. However, a comprehensive barrier analysis is needed for the whole region.



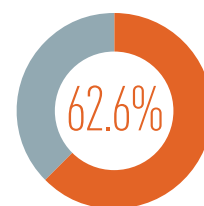
76 MW installed capacity
328 MW potential

Angola, Cameroon,
Central African Republic,
Democratic Republic
of the Congo,
São Tomé and Príncipe

Northern Africa

Five out of seven countries in Northern Africa use small hydropower. Northern Africa has an estimated small hydropower potential of about 184 MW (for plants up to 10 MW), of which 115 MW has been developed. There has been little interest in assessing and harnessing small hydropower as energy source due to the region's characteristics such as its arid climate, desert landscape, very high solar reception and a high electrification rate of up to 99 per cent. Drought in Morocco and water scarcity and over-exploitation of groundwater resources in Tunisia are issues of concern.

Energy subsidies and the lack of suitable hydro sites further hinder small hydropower development in Egypt. Public awareness on the benefits of small hydropower is low in Sudan. Furthermore, a clear policy is lacking and institutional capacity is low.



115 MW installed capacity
184 MW potential

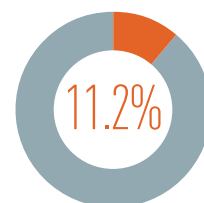
Algeria, Egypt, Morocco,
Sudan, Tunisia

Southern Africa

Four out of the five countries in Southern Africa use small hydropower. Southern Africa has an estimated small hydropower potential of about 383.5 MW (for plants up to 10 MW), of which 43 MW has been developed. In South Africa, a governmental programme supports only hydropower up to a capacity of 10 MW. Lesotho defines small hydropower with a capacity of up to 15 MW. The other two countries, Namibia and Swaziland, do not have their own official definition of small hydropower.

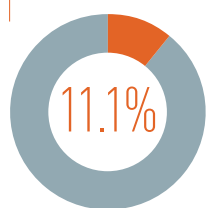
South Africa has a renewable energy policy. In Lesotho, rural electrification is used to increase electricity access while renewable energy is used to replace fossil fuel use. Namibia, South Africa and Swaziland have programmes and action plans in place to support renewable energy.

Known barriers, range from difficulty in accessing sites to the lack of equipment spare parts (e.g. Lesotho) and the lack of knowledge on plants that need refurbishment (e.g. Swaziland). Namibia's desert climate is not suitable for hydropower development. A comprehensive barrier analysis is still needed for the region.



43 MW installed capacity
383.5 MW potential

Lesotho, Namibia,
South Africa, Swaziland



82 MW installed capacity
742.5 MW potential

Benin, Burkina Faso,
Côte d'Ivoire, Ghana*,
Guinea, Liberia,
Mali, Niger*, Nigeria,
Sierra Leone, Togo

* potential only

Western Africa

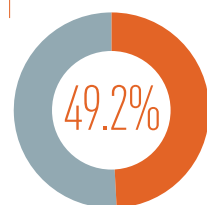
Nine out of the seventeen countries in Western Africa use small hydropower. Western Africa has an estimated small hydropower potential of about 742.5 MW (for plants up to 10 MW), of which 82 MW has been developed. The countries with the highest known potential are Togo (144 MW) and Burkina Faso (139 MW). It should be noted that not all countries have small hydropower potential due to unsuitable climate and topography.

Until recently, most of the countries in Western Africa did not have a renewable energy policy. Electricity access is still a major issue, thus Ghana, Nigeria and Liberia are all in the process of establishing rural electrification agencies. Ghana has a renewable energy law and is about to announce its FIT for small hydropower. Nigeria has a renewable energy master plan (at the time of writing it is in its final draft) and a trust fund to support renewable technologies including small hydropower. Mali has a national renewable energy strategy and takes part in the Scaling-Up Renewable Energy Program in Low Income Countries (SREP) by the African Development Bank. It has an investment plan which integrates the main principles of the Growth and Poverty Reduction Strategy and the National Climate Change Strategy. The establishments of the UNIDO-Regional Center for Small Hydropower in Nigeria and the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) in Cabo Verde are key steps to support the up-scaling of small hydropower and renewable energy in the region through technical trainings, information exchange and identifying financing mechanisms.

Lack of hydrological data in the countries mentioned makes it difficult to give a comprehensive and updated summary. To date, inventories established decades ago have not been updated. Resource assessments in the 1970s to 1990s were conducted by foreign consultants; therefore, regional expertise in hydro resource assessments is relatively poor. Financial barriers include little or no incentives to attract investors to small hydropower projects and inadequate financing of civil engineering works. To varying degrees, there is limited technical expertise for equipment manufacturing, construction, operation and maintenance. There is need to improve institutional, regulatory and legal frameworks for the development and use of renewable energy sources including small hydropower. Some climatic factors also limit the suitability of small hydropower development, such as irregular or seasonal rainfall, low flow and drying up of rivers and in some countries a highly variable and arid climate.

Americas

Caribbean



124 MW installed capacity
252 MW potential

Nine out of the twenty-eight countries or territories, use small hydropower. The Caribbean has an estimated small hydropower potential of about 252 MW (for plants up to 10 MW), of which 124 MW has been developed. The countries with the highest known potential are Jamaica (63 MW), Cuba (62 MW), followed by Guadeloupe (46 MW) and Puerto Rico (45 MW).

The topic of renewable energy is discussed at a political level because one of the region's priorities is securing energy supply and becoming increasingly independent from fuel imports. Several countries have individually passed energy policies with mixed outcomes. The renewable energy policy draft of Jamaica includes a premium for renewable plants while the Dominican Republic grants an exemption on all import taxes of equipment and machinery necessary for renewable energy production. At a regional level, there are several initiatives that promote the

use of renewable energy, especially the Caribbean Renewable Energy Development Programme (CREDP), which is an initiative of the Caribbean Community (CARICOM).

The hydropower potential of Cuba needs to be re-assessed. In Jamaica, easier access to information on potential sites is needed, as well as a corresponding institutional framework and regulatory platform that facilitates and attracts private investment. Private sector financing of renewable projects is non-existent in Haiti, as recurring natural disasters have diverted the attention of international community to emergency issues such as food security. A comprehensive barrier analysis is needed for the Caribbean region.

Cuba, Dominican Republic, Guadeloupe, Haiti, Jamaica, Puerto Rico, Dominica, Saint Lucia, Grenada*, Saint Vincent and the Grenadines

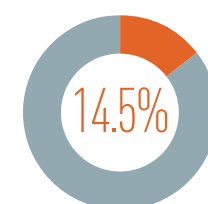
* potential only

Central America

All eight countries, Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama, in Central America use small hydropower. Central America has an estimated small hydropower potential of about 4,116 MW (for plants up to 10 MW), of which 599 MW has been developed. The country with the highest potential is Mexico (with a gross estimate of 3,250 MW). All countries need nationwide studies on their small hydropower potential.

Many of the countries in Central America have legislation that promotes renewable energy generation and many offer tax-based incentives such as exemption from income and on imported equipment and machinery. Preferential measures for mini- and small-hydropower plants in Panama include direct sales contracts with the electricity distribution company, with exemption from distribution and transmission costs for the first 10-year of commercial operation.

In many countries, domestic financing for small hydropower projects is difficult to obtain and/or the terms of commercial credit are not favourable. Major investments into interconnections are required in Mexico due to the lack of grid coverage and capacity in areas with high small hydropower potential. Incentives for the purchase of power generated from small hydropower plants are still missing on a wider-scale. Technical barriers include the lack of detailed and reliable national small hydropower potential inventory in natural and artificial streams (e.g. Mexico) or out-of date nationwide data (e.g. El Salvador). This is linked to a lack of adequate and/or affordable hydrological data in these countries. Social and community concerns about large and small hydropower projects in general prevail in Mexico, and land-issues and concerns about private sector involvement in natural resource management exist in Guatemala. Both institutional and administrative barriers to small hydropower development can be found in Costa Rica and El Salvador.

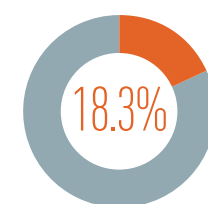


599 MW installed capacity
4,116 MW potential

Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama

South America

Nine out of the fourteen countries in South America use small hydropower. The region has an estimated small hydropower potential of about 9,465 MW (for plants up to 10 MW), of which 1,735 MW has been developed. The country with the highest estimated potential is Chile (7,000 MW). Some countries define small hydropower as below 10 MW, however Argentina has an upper limit of 15 MW, Chile of 20 MW and Brazil of 30 MW. There have been difficulties in data compilation because not all countries have separate data available for capacity up to 10 MW. For example, the small hydropower potential in Brazil is 22,500 MW (for plants up to 30 MW) and Chile is 17,000 (for plants up to 20 MW).

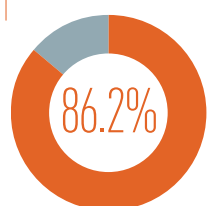


1,735 MW installed capacity
9,465 MW potential

Argentina, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Ecuador, French Guiana, Peru, Uruguay

Not all countries have renewable energy policies in place at the moment, especially where electricity access poses a challenge. Bolivia (Plurinational State of), Chile and Peru have decrees, laws or programmes to support rural electrification. Uruguay has a high electrification rate and sees small hydropower as an opportunity to promote rural development and to achieve 100 per cent electrification rate. Argentina has a FIT to guarantee power purchase agreements while Peru uses a premium price for electricity from renewable energy sources including small hydropower. Most countries use tax-based incentives. In Brazil, small hydropower producers sell their energy directly to the consumers via the grid at half price for grid use. Small hydropower action plans in Argentina and Colombia have yet to determine their national potential. Bolivia (Plurinational State of) has a hydropower programme that has successfully built small hydropower plants.

All countries report financial barriers due to a range of reasons: a weak micro-financing sector, access to appropriate loans from banks, lack of incentives for private investors, inadequate metering of energy sold, over-reliance on governmental support and financial disadvantage in comparison to other types of renewable technologies, in particular wind (e.g. Brazil). Other barriers include governmental predisposition in Bolivia (Plurinational State of) to support projects that can be connected to the central electricity grid, in the case Ecuador, preference was given to large power projects. The topography of Colombia, Uruguay as well as French Guiana makes them suitable only for low head installations which are technically and economically more challenging to build. In Chile, it is difficult and costly for small hydropower plants to be connected to the secondary grids because of the lack of transportation capacity on existing lines.



7,843 MW installed capacity
9,099 MW potential

Canada, Greenland,
United States of America

Northern America

Three out of five countries use small hydropower. Their potential of small hydropower (for plants up to 10 MW) is not fully known. It is estimated that about 7,843 MW has been developed. Greenland only introduced hydropower in 1993. The small hydropower potential in Canada is 15,000 MW (for plants up to 50 MW) which does not include a high refurbishment potential (1,000 MW).

The United States established the Renewable Portfolio Standard in many of its states, and the governmental programmes focus on different aspects of small hydropower, such as low-impact, adding capacity to non-powered dams and increasing efficiency. In Canada, incentives to develop clean, renewable or green power take one or more of the following forms: tax incentives, special requests for proposal, standard offer programmes, net-metering and/or FITs.

In Canada and the United States, the investment of time and money necessary to obtain a licence for small hydro plants has become a significant burden. Concerns about environmental impacts caused by small hydropower projects are common.

Asia

Central Asia

All five countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan) in Central Asia use small hydropower. Central Asia has an estimated small hydropower potential of about 4,880 MW (for plants up to 10 MW), of which 183.5 MW has been developed so far. The countries with the highest potential are Kazakhstan (2,707 MW) and Uzbekistan (1,760 MW).

Legislations on renewable energy exist in Kazakhstan, Kyrgyzstan and Tajikistan, while Turkmenistan's Renewable Energy Development Strategy includes plans to develop renewable energy frameworks. Only Kyrgyzstan has a special FIT for small hydropower. However, accompanying by-laws and regulations are yet to be developed or adopted. The region has a large reservoir of small hydropower sites, but its potential is hampered by in-country disadvantages. Both Turkmenistan and Uzbekistan do not have a related policy in place to promote renewable energy. Even where such legislations exist, the uncertainty in the legal and regulatory framework for private sector participation is high (e.g. Kyrgyzstan and Tajikistan).

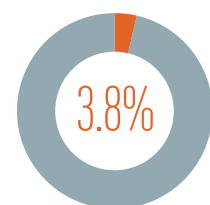
The local technical capacity for construction, maintenance and equipment or spare parts required for small hydropower projects need to be improved in Kyrgyzstan or built up in the case of Tajikistan. There is a need in Tajikistan to attract financing and managing resources from donors or state-funded support for decentralized renewable development. In Kyrgyzstan, private investors face unfavourable economic conditions, also low stream flow reduces operation hours during winter time, when power and heat are greatest in demand and the central grids are unable to compensate. Additionally, most communities are grid-connected, thus during summer the demand for additional off-grid power is low.

Eastern Asia

Five out of seven countries/regions in Eastern Asia use small hydropower. Eastern Asia has the largest estimated small hydropower potential worldwide. The potential is estimated at 75,312 MW (for plants up to 10 MW), of which 40,485 MW has been developed. The country with the highest potential is China (63,492 MW) followed by Japan (7,062 MW). China is the only country in the region with a small hydropower definition of up to 50 MW. China's small hydropower potential (for plants up to 50 MW) is 128,000 MW, of which 65,680 MW has been developed.

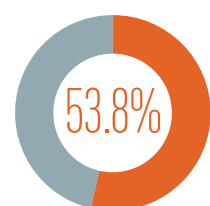
The importance of renewable energy is widely acknowledged throughout the region. The Republic of Korea has legislation on alternative energy with the aim of reaching a renewable energy supply share of 6.1 per cent by 2030. China plans to achieve a 30-per cent non-fossil capacity in its national installed capacity by 2030. The local governments in China are encouraged to develop small hydropower; value-added tax (VAT) for small hydropower is subsidized. In Japan, a FIT system was established in 2012 under an Act that promotes renewable energy usage. Some laws in Japan simplify the process for renewable energy producers to sell electricity to the electric utility. The policy orientation of Democratic People's Republic of Korea inclines towards non-fossil fuel options, solving the issues of ageing infrastructure and of the transmission and distribution networks. Its policy is favourable to the development of small hydropower. However, small hydropower information about this country is scarce. Mongolia has a renewable energy programme that aims to achieve a renewable energy share of 25 per cent in its electricity system by 2020.

The main barrier to small hydropower development is of a financial nature, such as the access to funding and generation equipment in the Democratic People's Republic of Korea. In the Republic of Korea, topographical conditions are not suitable for small hydropower, thus the economic feasibility of small hydropower projects is limited. In Japan the potential is being reassessed to include less conventional sites from existing infrastructure facilities, such as dams, weirs, irrigation channels, water supply and sewerage systems, in order to avoid environmental impacts.



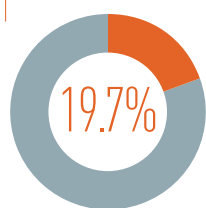
183.5 MW installed capacity
4,880 MW potential

Kazakhstan, Kyrgyzstan,
Tajikistan, Turkmenistan,
Uzbekistan



40,485 MW installed capacity
75,312 MW potential

China, Japan,
Democratic People's
Republic of Korea,
Republic of Korea,
Mongolia



3,563 MW installed capacity
18,077 MW potential

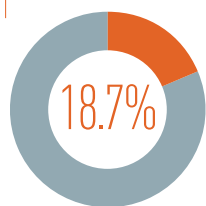
Afghanistan, Bangladesh,
Bhutan, India, Iran (Islamic
Republic of),
Nepal, Pakistan,
Sri Lanka

Southern Asia

Eight out of the nine countries in Southern Asia use small hydropower. The region has the second largest small hydropower potential estimated at 18,077 MW (for plants up to 10 MW), of which 3,563 MW has been developed. Afghanistan has a known potential of (1,200 MW). The small hydropower potential in India for plants up to 10 MW is not known, and it is 15,000 MW for plants up to 25 MW. Some countries define small hydropower as below 10 MW, however Bangladesh has an upper limit of 15 MW. Bhutan and India apply a threshold of 25 MW and Pakistan of 50 MW.

Most countries have a renewable energy policy (e.g. Bangladesh, Bhutan, Pakistan) and a renewable energy target, or a hydropower policy (e.g. Bhutan, India, Nepal). Afghanistan has a Rural Renewable Energy Strategy Action Plan up to 2014. Renewable energy is seen as an opportunity to boost rural electrification (e.g. India, Afghanistan) and an option to be less dependent on imported fossil fuels (e.g. Pakistan). In India, subsidies for the development of small hydropower through the private sector are in place, but vary from state to state and may include power wheeling, power banking, buy-back of power and/or facilities for third party sales. Some states also provide concessions such as leasing of land, exemption from electricity duty and entry tax on power generation equipment. The Iranian Government purchases electricity produced by private sector renewable energy plants at a tariff three times higher than those paid by the consumers. In Nepal, there are several incentives available, such as VAT exemption, custom duty reductions for imported small hydropower related machinery or equipment and income tax exemptions for the first 10 years from the date of plant commissioning, thereafter 50 per cent for the next five years.

A range of barriers exist in Southern Asia, such as the remote location of potential sites and the need for road access and long-distance transmission lines (e.g. Bangladesh, Pakistan). Related to this is the uncertainty of grid extension, as it may not be economically feasible in rural areas where power demand is low (e.g. Nepal, Bhutan). Financial barriers include economic feasibility due to terrain and topographical conditions (e.g. Bhutan) and the lack of understanding by the local banks on financing needs of project developers (e.g. Bangladesh). In short, the lack of/ low interest from the private sector to develop small hydropower plants is because there is no proper tariff structure and/or electricity market system (e.g. Pakistan, Bhutan) in place. Administrative complexity and long waiting times delay small hydropower development in Bangladesh, India and Nepal. The seasonality of rain, with low output during the dry season poses a barrier for Bangladesh and Bhutan, and in countries like Bhutan it is a big concern due to the country-specific conservative environmental laws. Other specific barriers reported for each country concerned human resources capacity, technical knowledge and institutional capacity.



1,252 MW installed capacity
6,682.5 MW potential

South-Eastern Asia

Nine out of eleven countries in South-Eastern Asia use small hydropower. The region has an estimated small hydropower potential of about 6,682.5 MW (for plants up to 10 MW), of which 1,252 MW has been developed. The country with the highest known potential is Viet Nam (2,205 MW), followed by the Philippines (1,876 MW) and Indonesia (1,267 MW). The upper limit of small hydropower varies. In Malaysia and Indonesia it is 10 MW, in Lao People's Democratic Republic (PDR) and Thailand it is 15 MW and in Viet Nam 30 MW. In the Philippines and Cambodia the upper limit of mini-hydropower is 10 MW, while no definition is available for Myanmar and Timor-Leste.

Most South-Eastern Asian countries have a national renewable energy action plan that sets renewable energy target in the national power generation mix. Lao PDR has a draft Renewable Energy Development Strategy that promotes small hydropower of up to 15 MW. Thailand also has a small hydropower target of 0.04 per cent of the total generation mix by 2015. Viet Nam has an avoided cost tariff specifically for small hydropower, and the Philippines has mini-hydropower projects auctions as well as a FIT. In Indonesia, the electricity is bought by the State at an agreed fixed price. In general the FIT system is not well developed in the region. Renewable energy policy limitations have been reported in Timor-Leste, Malaysia, Indonesia and the Philippines. For example there was a delay in the implementation of the Renewable Energy Act of the Philippines.

Cambodia, Indonesia,
Lao PDR, Malaysia,
Myanmar, Philippines,
Thailand, Timor-Leste,
Viet Nam

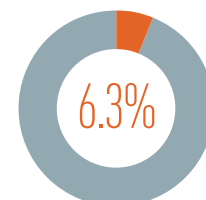
The lack of field expertise and technical skills is the largest barrier impeding the development of small hydropower and this has been reported in many countries. The second important barrier is of a financial nature, ranging from the lack of financial sources in Cambodia; to financial institutions that are unfamiliar with assessing risks for small hydropower projects in Malaysia and Thailand. High costs for the development of small hydropower are reported in Cambodia, Malaysia and Timor-Leste. More subsidies are available in Thailand for importing electricity to rural areas than for building small hydropower plants. In Lao PDR, only large hydropower projects attract foreign investors. Environmental or climatic barriers are reported as well, such as vulnerability to drought in Malaysia and Timor-Leste, and a reduction of maximum water flow from rivers that can be used for electricity generation in the Philippines have been reported.

Western Asia

Eight out of eighteen countries in Western Asia use small hydropower. Western Asia has an estimated small hydropower potential of about 7,754 MW (for plants up to 10 MW), of which 489 MW has been developed. The country with the highest known potential is Turkey (more than 6,500 MW). Not all countries in the region are suitable for small hydropower development due to climatic conditions, some even suffer from water stress.

Most countries consider renewable energy as an important resource. Armenia and Turkey have renewable energy laws, while other countries such as Azerbaijan, Georgia and Armenia have national renewable energy programmes. Armenia has a strategic hydropower development programme that includes small hydropower and international finance mechanisms to support its development. Azerbaijan does not have any customized laws for renewable energies, but producers of small hydropower plants with a capacity from 50 kW to 10 MW do receive subsidy that guarantees the unlimited purchase of their electricity based on a combination of applicable laws. In Georgia, the programme regulates and supports the construction of new renewable energy projects with a capacity up to 100 MW. It offers long-term purchasing agreements and favourable FITs and license-free electricity generation for power plants up to 10 MW.

Some countries such as Iraq, Jordan and Lebanon, do not have any policy for renewable energy, as renewable energy in general is not prevalent. Lebanon needs to evaluate the various demands on its water resources. Turkey's renewable energy law does not differentiate between small- and large-hydropower, thus the private sector's interest has moved towards large hydropower systems due to potentially higher profits. Many regulatory, legal and technical barriers need to be overcome in Armenia to fully develop the small hydropower potential, including its low FIT.

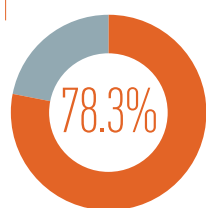


489 MW installed capacity
7,754 MW potential

Armenia, Azerbaijan,
Cyprus, Georgia, Iraq,
Jordan, Lebanon,
Turkey

Europe

Eastern Europe



2,735 MW installed capacity
3,495 MW potential

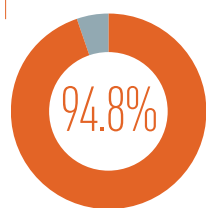
Belarus, Bulgaria,
Czech Republic,
Hungary, Republic
of Moldova,
Poland, Romania,
Russian Federation,
Slovakia, Ukraine

All ten countries, Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia (EU Member States) and Belarus, Republic of Moldova, the Russian Federation, and Ukraine in Eastern Europe use small hydropower. Eastern Europe has an estimated small hydropower potential of about 3,495 MW (for plants up to 10 MW), of which 2,735 MW has been developed. The countries with the highest potential are the Russian Federation (1,300 MW) and Romania (730 MW). Apart from the Russian Federation which has a definition of up to 30 MW, small hydropower is mostly defined as up to 10 MW in the region.

Most of these countries have policies for renewable energy as well as targets. A Renewable Energy Directive has been implemented within the European Union (EU). Thus all the Member States currently have a renewable energy policy and a target share from renewable sources in gross final consumption of energy by 2020. Tariffs for electricity from renewable energy sources including small hydropower exist in Belarus, Bulgaria, Czech Republic and Ukraine. Slovakia supports small hydropower through additional payments for electricity supplied from these plants for the first 15 years.

In both Belarus and the Czech Republic, the flat topography of the country seems to limit the small hydropower development to low head sites. However this is also seen as a change to apply small hydropower to waterworks in combination with other uses such as water regulation, supply and transport. The lack of involvement of private companies in small hydropower projects is mentioned as a barrier in Republic of Moldova and Belarus; the former is due to lack of funds available for private companies, the latter has an incomplete legal framework for independent power producers. Residual flow regulations exist in Czech Republic, Poland and Romania. Similar legislation is planned in Bulgaria, where an increased residual flow means an increase in operating costs.

Northern Europe



3,643 MW installed capacity
3,841 MW potential

Denmark, Estonia,
Finland, Iceland,
Ireland, Latvia,
Lithuania, Norway,
Sweden, United Kingdom
of Great Britain and
Northern Ireland

Ten out of eighteen countries or territories use small hydropower. Northern Europe has an estimated small hydropower potential of about 3,841 MW (for plants up to 10 MW), of which 3,643 MW has been developed. The upper limit of small hydropower is generally 10 MW. However, some have lower limits such as 5 MW in the United Kingdom, 1.5 MW in Sweden and 1 MW in Denmark and Iceland.

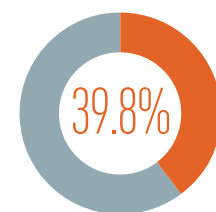
A Renewable Energy Directive has been implemented within the European Union (EU). Thus all the Member States now have a renewable energy policy and a target share from renewable sources in gross final consumption of energy by 2020. All countries except Iceland, have support systems for small hydropower. Seven countries have FITs applicable to small hydropower, while Finland discontinued its fixed production support but supports small hydropower developers with tax incentives. Norway uses a quota system and Sweden uses electricity certificates as a market-based support system for renewable electricity including small hydro. Residual flow is regulated in most countries except Iceland and Sweden. The EU Water Framework Directive applies to most countries, however, its full impact has yet to be determined. In the case of Estonia, this has led to a decrease in small hydropower potential.

Southern Europe

Eleven of the sixteen countries or territories use small hydropower. Southern Europe has a small hydropower potential estimated at 14,169 MW (for plants up to 10 MW), of which 5,640 MW has been developed. The countries with the highest potential are Italy (7,066 MW) and Spain (2,185 MW). Most countries use the 10 MW definition. However, in Italy, the upper limit of small hydropower is 3 MW, in Bosnia and Herzegovina 5 MW and in Greece 15 MW.

The Renewable Energy Directive has been implemented in the EU, five countries are not Member States (Albania, Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia and Montenegro). Most countries in Southern Europe have a national renewable energy action plan. Apart from Albania, the Former Yugoslav Republic of Macedonia and Bosnia and Herzegovina, all countries have a renewable energy target for 2020 or 2025, ranging from 17 per cent in Italy and Greece, to 60 per cent in Portugal. Albania is preparing a new power sector law and a new renewable energy law. The FIT system is used in eight of the eleven countries and is sometimes compiled with a market price and premium, as in the case of Spain.

The main barrier to the development of small hydropower is related to administrative procedures. Authorization of procedures and network connections are long and often complex, such as the case in Serbia, Italy, Slovenia or Spain. There is a lack of methodology for concession, licensing and permit delivery in Bosnia and Herzegovina and Portugal. Protection of culture or landscape and mountainous areas are noted barriers to small hydropower development in Croatia and Greece. The implementation of the EU Water Framework Directive decreases the potential of small hydropower as mitigation costs have risen in Greece and Italy.



5,640 MW installed capacity
14,169 MW potential

Albania, Bosnia and Herzegovina, Croatia
Greece, Italy, the Former Yugoslav Republic of Macedonia, Montenegro
Portugal, Serbia
Slovenia, Spain

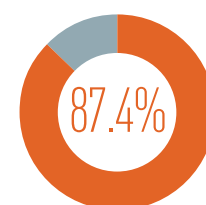
Western Europe

Seven out of nine countries or territories in Western Europe use small hydropower. Western Europe has an economic small hydropower potential estimated at 6,644 MW (for plants up to 10 MW), of which 5,809 MW has been developed. The countries with the highest potential are France (2,615) and Germany (1,830 MW). The limit of small scale of hydropower is 10 MW in most of the countries. However, in the Netherlands, the limit is 15 MW, 6 MW in Luxembourg, and Germany has several definitions: the limit differs from 1-5 MW.

The Renewable Energy Directive has been implemented in the EU. All countries, except Switzerland are part of the EU. All of its Member States have a renewable energy policy and a target share from renewable sources in gross final consumption of energy by 2020. The FIT system exists in five countries, whereas Belgium uses Green Certificates and the Netherlands uses subsidies and tax deduction to support small hydropower.

The barriers in Western Europe are aplenty. In particular, Austria, Belgium and Germany exists a strong opposition to small hydropower development by powerful administrations, non-governmental organizations and the fishing lobby, mainly due to ecological and fishing issues. The environmental impacts have led the German government to establish mitigation measures. The topography of the Netherlands is not very suitable to develop small hydropower plants and it is difficult to obtain permits.

Policy decisions sometimes have a negative impact on small hydropower. In Belgium, the new classification of plants could have a negative effect for very small operators. Environmental legislations such as those related to Natura 2000 and the EU Water Framework Directive increase mitigation costs and limit the economic small hydropower potential. In Austria there is a gap



5,809 MW installed capacity
6,644 MW potential

Austria, Belgium
France, Germany
Luxembourg, Netherlands
Switzerland

between the policy which encourages hydropower and the reality of granting procedures. The new policy regarding the FITs in Switzerland has led to an overload at planning offices and public authorities. Also, different procedures for each canton have created a challenge for investors. Financial barriers differ among countries. In Austria, budget for the support scheme is limited; in Switzerland profitability is low due to high demand for engineering services and high prices for hydropower equipment.

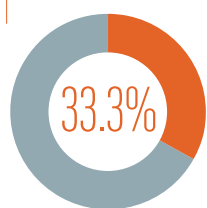
Oceania

Australia and New Zealand

Both Australia and New Zealand use small hydropower. Together they have a small hydropower potential estimated at 932 MW (for plants up to 10 MW), of which 310 MW has been developed.

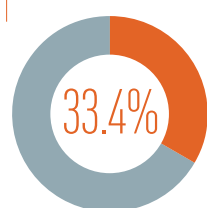
In Australia, renewable energy certificates provide incentives to upgrade and redevelop ageing hydropower plants. There is no governmental policy on small hydropower in New Zealand. However investigation for new sites is actively being pursued. Furthermore, a price for carbon aims to help the economic competitiveness of new renewable electricity.

Main barriers to small hydropower development are environmental protected areas and competing uses for water. Barriers specific to Australia are public acceptance, extreme variations in climate, remoteness of sites and overall high costs of generation and transmission. Barriers specific to New Zealand are administrative in nature (i.e. long and expensive consenting process) and high construction costs. Environmental and social issues also pose as a barrier to the widespread development of small hydropower. Incentives for renewable energy, in part to combat the potential effects of climate change, are focused primarily on wind energy and solar power which are considered to have greater potential.



310 MW installed capacity
932 MW potential

Australia.
New Zealand



102 MW installed capacity
306 MW potential

Fiji, New Caledonia,
Papua New Guinea,
Solomon Islands,
Vanuatu, Micronesia,
French, Polynesia,
Samoa

Pacific Island Countries and Territories

Eight out of the twenty-two countries or territories use small hydropower. The Pacific Island Countries and Territories (PICTs) have a small hydropower potential estimated at 306 MW (for plants up to 10 MW), of which 102 MW has been developed. Papua New Guinea has the highest potential among the countries (153 MW).

At the national level, Fiji is the only country with a specific renewable energy policy and a master plan for small hydropower. Most of the other countries have national energy policies that support the use of renewables and/or renewable energy programmes, however, the need for improved (rural) electrification is a key issue.

The Pacific Islands Energy Policy and an associated strategic action plan are critical at the regional level. Renewable energy is among the 10 areas of development addressed in this initiative, with the aim to increase the share of renewable energy resources in the energy mix. Similarly, the Framework for Action on Energy Security in the Pacific and its associated implementation plan (2011-2015), includes four key priorities, namely resource assessment, investment in renewable energy, capacity development and an increase in the share of renewable energy in the energy mix. International finance also plays a role in the small hydropower development in the Pacific region. The Asian Development Bank has been involved in the Town Electrification Programme of Papua New Guinea; the World Bank has a 10-year project Pacific Islands Sus-

tainable Energy Finance Project (2007-2017) which supports micro hydropower. Local financial institutions are incentivized to participate in sustainable energy finance in support of equipment purchase. However, apart from Fiji, little progress has been achieved in other participating countries.

In general, incentive mechanisms for small hydropower project development seem to be missing for most countries. Lack of funding for project execution is a barrier mentioned for the Solomon Islands and Papua New Guinea. Steep topography may lead to rapid runoff and landslides in Fiji, providing less suitable conditions for small hydropower. Outdated renewable energy assessments are a problem in Papua New Guinea. In Vanuatu, barriers to small hydropower are often those that are common for renewable energy, which include high capital costs, lack of political will, lack of in-country capacity and issues related to land ownership. Capacity for the construction of small hydropower in the PICTs exists, however external funding sources often bring their own experts. Investments made into various renewable energy technologies should consider climate change effects on the environment. In the case of small hydropower, this means the consideration of impacts on water availability particularly during the dry season.

Conclusion

The *World Small Hydropower Development Report 2013 (WSHPDR 2013)* contains data compiled on installed capacity and potential of small hydropower for 152 countries. The Secretariat has in phases of research and data collection, faced many obstacles, from linguistic, data accessibility to the different standards of reporting. There are cases where resource potential of a country is unclear, as there is no globally agreed small hydropower definition and many reports on small hydropower do not always indicate clearly the definition applied.

It can be concluded that small hydropower is a suitable renewable energy technology in the context of rural electrification efforts, energy diversification, industrial development and exploration of existing infrastructure. Rural electrification has significantly improved in China and in India thanks to small hydropower. At the national-level, small hydropower programmes in developing regions and at regional-level in Western Africa, have reflected the importance given by some governments to small hydropower as a energy solution for rural electrification and productive use.

Fossil-fuel dependent regions with high or relatively high electricity access have come to realize the importance of clean and renewable energy. Therefore many countries in Western and Central Asia are discovering or rediscovering small hydropower as an energy option and many are interested in refurbishing their old plants.

Small hydropower technology has gradually adapted to meet environmental concerns while technical innovators aim to explore the use of existing infrastructures.

The *WSHPDR 2013* proposes a more detailed policy and barrier analysis to identify critical capacity needs and identification of suitable financing mechanisms. The importance and advantages of small hydropower as the solution to rural electrification and inclusive sustainable industrial development has probably been underestimated, particularly in comparison to other small-scale renewable energies.

The following are some recommendations that aim at the national and regional/international level. They are served as a starting point and are in no way comprehensive.

Recommendations

National level

Resource assessment and water management

1. More hydrological data needs to be collected over a longer period of time. In order to achieve this goal, technical equipments such as a network of gauging stations are required along with human capacity building.
2. Small hydropower potential sites need to be reassessed due to the constantly changing hydrological and environmental conditions affecting the watershed. Environmental regulations and technological improvements should also be considered. When drafting master plans, it is important to balance the multiple demands and functions of water resources.
3. Screen small hydropower plants that need to be upgraded or refurbished in order to gain an overview. Investments should be promoted to reactivate old plants and increase their efficiency based on technical innovation.
4. Potential multi-purpose sites need to be identified. Across the world there are many water reservoirs and dams constructed for irrigation or as drinking water collection that do not yet produce electricity where small hydropower turbines could be installed and run concurrently.
5. Potential non-conventional sites based on technical innovation need to be identified. Existing infrastructure such as water pipes in buildings, or water channels with very low head could serve as potential small hydropower sites.
6. Implement regulations on the use of waterways to avoid conflict between agriculture, fishery, electricity generators and biodiversity.

Rural electrification

1. Improve the reporting of the impact of small hydropower on rural electrification by keeping track of on- and off-grid installed and potential small hydropower capacity.
2. The productive use of electricity from small hydropower plants in rural settings should be better developed and reported in order to share lessons learnt and improve inclusive sustainable industrial development.
3. New business models for sustainable small hydropower development for rural electrification need to be developed and promoted.

Planning, financing and implementation

1. Increase local capacities to conduct feasibility studies, for construction, operation and maintenance of small hydropower plants.
2. Build or improve local manufacturing capacity to produce components for small hydropower plants.

3. High initial costs need to be overcome with easier/improved access to finance for project developers. Awareness of small hydropower should be raised among local banking institutions or micro-finance institutions in order to improve the risk assessment and provide conducive loan conditions.
4. Improved electricity network planning will help to identify the need for investment into grid infrastructure. This will help to better inform the economic feasibility of potential sites. Small hydropower plants in remote areas are often not economically feasible because mini-grid or connections to the central grid need to be built.
5. Improve collaboration among agencies responsible for water resources, environment and electricity. Avoid overlapped mandates and conflicts and reduce duration needed for approval/authorization processes.
6. Simplify administrative procedures for small hydropower plants located in existing infrastructure such as irrigation channels, water supply systems, dams or wastewater treatment facilities, and for the rehabilitation of old schemes.
7. Improve timely land allocation by ensuring land records are clear and up-to-date to avoid conflict over land rights/ownership and concessions/permits.
8. Create a one-stop shop for small hydropower plants to streamline project implementation.

International and regional level

1. Develop a regional network of professional/mechanical workshops to satisfy local/regional equipment demand.
2. Remove linguistic barriers of knowledge exchange by providing information in several regional languages and create a knowledge platform.
3. Create a network of focal points (e.g. Ministry of Water Resources and/or Energy of one country in order to connect relevant stakeholders within the region.
4. Use existing international technical training resources to train trainers in their region.
5. South-South and triangular cooperation among developing countries, developed countries and international organizations (including international banks) for technology-transfer, capacity building and financing should help to facilitate the transition from individual pilot small hydropower projects towards the successful implementation of full-scale small hydropower programmes. International banking institutions can help to kick-start programmes and overcome funding barriers for countries in need.
6. Coordination, collaboration and knowledge sharing among regional and international organizations that include small-scale hydropower in their scope of work should continue and be expanded.
7. Promote the implementation of international projects aiming at the development of local small hydropower capacities, policies and investment.

Acknowledgements

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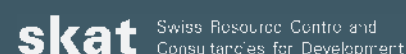
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Technical notes

Within the *World Small Hydropower Development Report 2013 (WSHPDR 2013)* small hydropower is defined as plants with a capacity of up to 10 MW per plant. This definition is also used for summary statistics at the regional level. On country level, the national definitions apply while, where possible, capacities and potentials up to 10 MW are also given. The term 'small hydropower' in this Report has a different meaning from country to country.

The information on small hydropower potential presented has been derived from various sources, often it was not clear from sources if gross, technical or economical potential was considered. Furthermore, not all of the countries have identified their small hydropower potential, in the case where data on small hydropower potential were not available, planned small hydropower potential was reported instead.

The *WSHPDR 2013* adheres to the geographical region and composition defined by the United Nations Statistics Division. Melanesia, Micronesia and Polynesia do not contain many

countries or territories that use small hydropower, therefore were combined under the regional heading of 'Pacific Island Countries and Territories (PICTs)'. This report was compiled for both 'countries' and 'territories'. Overseas territories have been included in the continent where they are geographically located in following the online M49 list of the United Nations Statistical Division. Countries that are not part of the United Nations were not considered in this report. For more details and a full list of countries or territories according to the UN regions, see <http://unstats.un.org/unsd/methods/m49/m49regin.htm>.

The *WSHPDR 2013* includes information on small hydropower of 152 countries/territories, however detailed reports are available for only 149 countries.

Please note that information presented was true up to end of December 2012, if not otherwise indicated.



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