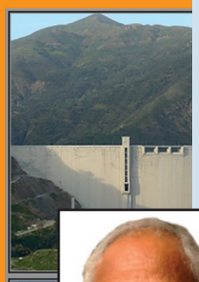



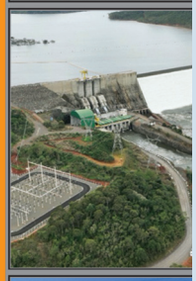
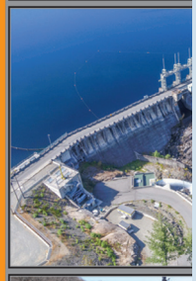
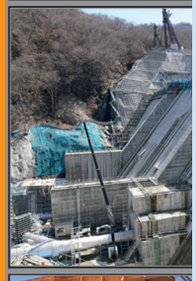
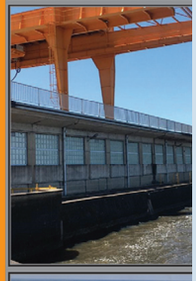
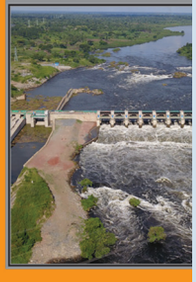

Assessing hydropower for the second quarter of the 21st century

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Historically, hydropower has been the oldest form of electricity generation, with countries like the UK and USA installing their first hydropower plants around the late 19th century. Accordingly, and not surprisingly, hydropower has been an important source of renewable electricity generation for more than a century. In 2020, it generated nearly 4500 TWh of electricity, accounting for nearly one-sixth of the global total. Only coal and natural gas generated more.

Currently, hydropower generates 50 per cent or more of electricity in 35 countries, of which 28 are emerging and developing economies, covering nearly 800 million people. In advanced economies such as Norway, Canada, Switzerland and Austria, hydropower has generated the greatest share of electricity for many decades. In fact, in Canada, hydropower has been so dominant that electricity bills are commonly known as 'hydro bills'.

Even though hydropower has proven to be a source of reliable energy, and hydro dams contribute to numerous benefits, when they are properly planned, constructed and operated, the 1995 to 2005 period proved to be mostly a lost decade for hydro development. This was as a result of strong anti-dam movements which were spearheaded by some single-cause activist NGOs, primarily from the Western World. Their media-savvy anti-dam campaigns were quite successful during this lost decade. As a direct result, major multilateral and bilateral funding institutions, including the World Bank and the Asian Development Bank, significantly curtailed their funding support to large dams during this period.

However, countries like China, Brazil, Turkey and India continued to construct dams during the lost decade. The pace of dam construction programmes accelerated after this period in much of the developing world. By 2020, China was by far the largest hydroelectricity generator in the world, followed by Brazil, Canada and the USA. These four countries alone accounted for 55 per cent of global hydropower generation in 2020.

During the past two decades, China not only constructed the most large hydropower dams within its borders, but also became the largest builder of dams all over the developing world, through construction contracts, financing them by providing the majority of funds through Chinese financial institutions, assuring funding as a part of larger financial groups, or by owning the projects directly. According to the estimates of the International Energy Agency, more than half of all new hydropower projects larger than 30 MW that are expected to be built in the Asia Pacific (excluding India), sub-Saharan Africa and the Latin America regions, during 2021-2030 period, would be built, financed, partially financed or owned by the Chinese state-owned enterprises. This is shown in Fig. 1.

Major Chinese dam construction companies like China Three Gorges Corporation and PowerChina have constructed numerous large dams within the country and outside, often under very different conditions. Accordingly, they have developed unique expertise and extensive experience to construct dams most cost-effectively and within shorter timeframes, than any other similar companies throughout the world.

According to IEA [2021[1]], during the period from 2021 to 2030, global hydropower capacity is likely to increase by 17 per cent or 230 GW. China alone would account for more than 42 per cent of this growth. India, Indonesia, Pakistan, Vietnam and Brazil together would account for another 21 per cent, that is, half of China's growth.

Policymakers have consistently under-appreciated the benefits of hydropower dams. We have argued consistently over the past three decades that the full benefits of these dams are seldom assessed in nearly all countries of the world. Thus, it is heartening to see that the International Energy Agency noted "Hydropower is the forgotten giant of low-carbon electricity" [IEA, 2021[1]]. Similarly, the International Renewable Energy Agency noted in 2023 that if the world is to "meet the climate goals set in the Paris Agreement, hydropower installed capacity, including pumped storage hydropower, should more than double by 2050" [IRENA, 2023[2]].

IEA [2021[1]] notes that if net-zero emissions are to be reached by 2050, "all governments need to raise their hydropower ambitions

dramatically." Since the public sector owned and operated 70 per cent of all installed hydropower capacity between the years 2000 and 2020, strong policy support for hydropower will be necessary if hydropower is to reach its full potential. Unfortunately, government policy support for hydropower is now limited to less than 30 countries [IEA, 2021[1]].

In addition to generating electricity, dams provide numerous other benefits as well, including energy storage, especially through pumped storage schemes, frequency control and black-start capabilities. In the coming decades, pumped storage is likely to play increasingly important roles in reaching net-zero within the next three to four decades. Some have estimated that potential future pumped storage hydropower developments could store as much as 23 TWh of electricity.

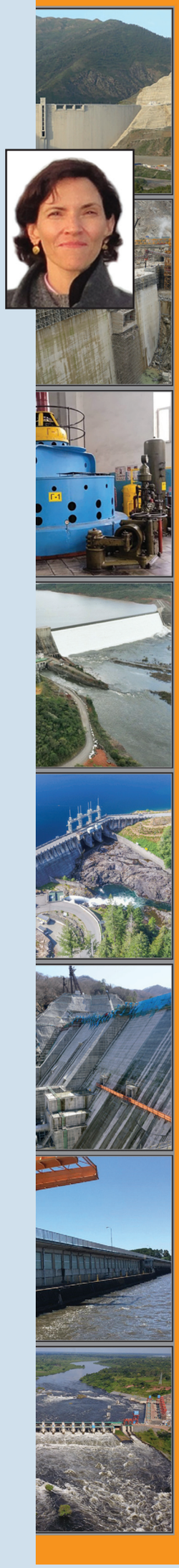
However, electricity generation is only one benefit stream from hydropower dams. Since hydropower is a non-consumptive use of water, the same water after generating electricity, can be used for many other purposes, including for drinking, industry and irrigation. The reservoirs can also be used effectively for managing extreme hydrological events like floods and droughts, which are now becoming more intense, frequent and long-lasting in many parts of the world as a result of climate change.

Reservoirs can and are also used effectively for developing aquaculture, tourism and recreation. Properly planned, reservoirs and rivers can be an effective means of inland navigation and intermodal transport. Unfortunately, all the economic and social benefits of dams have seldom been fully recognized or consistently assessed in the past. In addition, large dams have long economic lives, very often remaining economic for more than 500 years.

Large dams face many challenges which could hinder their construction. The planning and design lead times can be long and tortuous because of the lengthy and complex permitting processes, difficulties with conducting proper social and environmental impact assessments, and sometimes strong opposition from local communities.

These uncertainties and difficulties could impose higher financial costs and investment risks. The political process could be difficult [to navigate effectively. All these could discourage investors, both public and private, from giving hydropower the required impetus.

Given the global need for ensuring long-term energy, food and water security, and the urgency of reaching net-zero by 2050 or soon thereafter, moving hydropower higher up in energy and climate policy, globally and nationally, will be both necessary and desirable.



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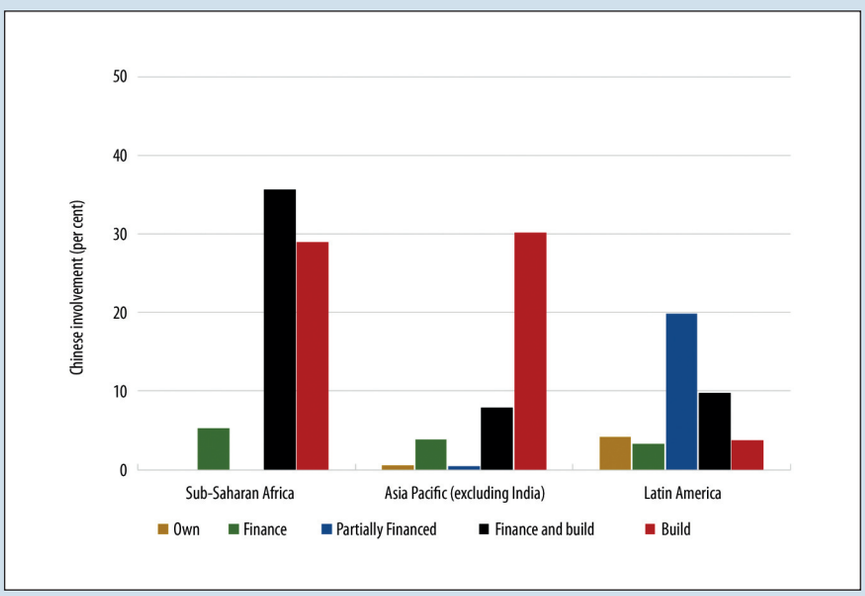

Fig. 1. China's role in owning, constructing, developing and financing hydropower project capacity, 2021-2030. Adapted from IEA [2021[1]].