



Yunnan's capacity grew over tenfold

# Let the rivers run: Asia's hydropower sector is at the brink of overproduction

Asia has been ramping up its renewables hydropower production following the Fukushima nuclear accident and the Paris Climate Change Agreement to the point of oversupply in the short to medium term.

If all the renewable sources were to stand on a podium ranked by their contributions in powering the world, hydropower will take the top spot, proudly ahead of wind and solar. Yet this dominance might become tenuous if Asian countries like China and India that are expected to lead hydropower growth in the next decades end up fumbling their potential. Analysts are sounding the alarm bells on possible overbuilding and underutilisation in China's hydropower-exporting Yunnan province, and on the glaring structural weaknesses that have put Indian hydropower projects on hold. Hydropower is the leading renewable source for electricity generation globally, with installed capacity of 1,064GW in 2016, supplying more than two-thirds of all renewable electricity and nearly one-sixth of the world's electricity from all sources, according to the World Energy Council. China is the undisputed hydropower leader with capacity of 319GW, while the United States is in second with 102GW and India notably in fourth with 52GW.

Governments have been keen to lower the share of nuclear and coal in their energy mix due to safety and pollution concerns, respectively, while promising to invest billions of dollars to grow their renewables sector. South Korea, for instance, has targeted to increase its share of renewables, including hydropower, fourfold to 20% from 5% by 2030 with support from its newly elected President Moon Jae-in. But even as most of Asia begins tapping into their hydropower potential, all eyes will be on the critical trifecta: China, India and Southeast Asia. How these countries with interconnected interests navigate the tricky rivers of hydropower – from overcoming huge upfront costs for new projects, mitigating price risks that threaten long-term profits, to

**Research shows installed hydropower far outstrips demand in China and Southeast Asia.**



planning for a regional energy market – will determine how large a role it continues to play in renewables.

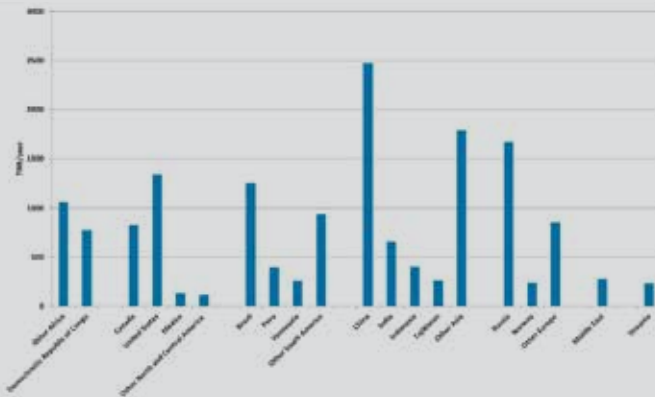
### **China's oversupply woes**

Overproduction will be a key concern for the Asian hydropower sector in the short to medium term, says **Darrin Magee**, associate professor of Environmental Studies at Hobart and William Smith Colleges, pointing to research that shows installed hydropower far outstrips demand in China and Southeast Asia. China's hydro boom has been concentrated on the southwest region where "steep rivers, narrow gorges, and heavy runoff combine to create a dam-builder's paradise." This has transformed Yunnan province into a "battery" that not only provides hydropower electricity to southern China but also for downstream neighbours like Vietnam, Laos, Cambodia and Thailand.

Yunnan's hydropower capacity has grown more than tenfold to 62GW between 2000 and 2016, surpassing that of entire countries like Russia and India (~49GW each) and nearing that of the US and Canada (~79GW each). Hydropower construction in Yunnan, a mountainous province, accelerated in the 1990s to 2000s in response to power shortages plaguing southern China and the subsequent rollout of supportive policies like "Send Yunnan Electricity Outward." Road improvements and the creation of long-distance transmission lines enabled hydropower produced Yunnan to be funneled eastward to electricity-hungry provinces like Guangdong.

In 2015, electricity production in Yunnan reached 262TWh, far exceeding the approximately 167TWh consumption within

World hydropower technical resource potential



Source: WEC

the province. Most of the surplus (93.5TWh) is exported to Guangdong province and a fraction (1.4TWh) is sent to downstream neighbours in Southeast Asia. Yunnan Power Grid has indicated an additional 95TWh were potentially available but not utilised, which Magee considers “a staggering amount of wasted electricity” comparable to the entire hydroelectric generation of 105TWh in mainland Southeast Asia.

For Magee, this then begs the questions: With installed capacity at such a high point already, why is there a continued push for large scale hydropower development in the region? And can excess hydropower be used to displace polluting coal plants and reduce pollution? **Thomas Hennig**, researcher in the faculty of geography at the University of Marburg in Germany says it is important to understand the regional hydropower boom in the broader context of energy portfolios in China and mainland Southeast Asia. “From a macro perspective, Thailand, Vietnam, and Yunnan all have comparable electricity consumption,” he says. “Yet while demand in Thailand and Vietnam is driven by a broader industrial development, Yunnan’s is mainly driven by electricity-intensive industries such as aluminium and silicon smelters.”

Hennig explains that Yunnan smelters that have built their fortunes on the rich non-ferrous metal deposits found in the province have a strong stake in hydropower, looking to take advantage of cheap electricity produced by plants during the rainy season. This has led to conflicting views on how to best utilise Yunnan’s hydropower potential. “Within Yunnan there is now a power struggle over the fate of its hydroelectricity,” says Magee. “Some actors, such as grid operators want to export power to other provinces and countries while others, such as local electricity-intensive smelters, want preferential access to it within the province.”

### Lower demand, higher production

On top of this conflict, the growth of Yunnan hydropower will likely be stunted by lower demand within China and Southeast Asia. Guangdong is planning to scale up its nuclear power, more than doubling from 6.3GW to 16.3GW by 2018, making hydropower a tougher sell due to the latter’s inherent flaws. “Given the high utilisation rate of nuclear power (capacity factor) and lack of seasonal fluctuations, it will likely be seen as more reliable and less risky than electricity from hydropower facilities up to 2000 kilometres away,” says Hennig. Yunnan can try to divert more of its hydroelectricity exports to Southeast Asian neighbours, but Hennig forecasts growth in this area to be modest compared to Guangdong.

“Those neighbours are developing their own hydropower sectors, often with investment and technical assistance from Chinese firms, both for domestic use and for export. Similarly, Chinese power companies such as Sinohydro and Huaneng are eyeing untapped hydropower resources in Bhutan, Myanmar



Darrin Magee



Asok Dasgupta

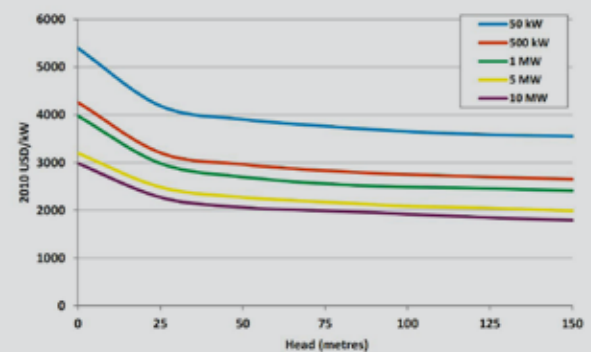


Aditya Valiathan Pillai,



Opangmeren Jamir

Investment costs as a function of installed capacity and turbine head



Source: Based on Kaldellis and Kondili

and Laos,” he says. But Hennig explains that Yunnan’s oversupply woes is part of China’s long play in hydropower: Exporting its hydropower planning expertise. “Plans for region-wide power grids linking Association of Southeast Asian Nation states will facilitate transmission of electricity across national borders, even if the financial arrangements for such transfers prove more complicated. And because hydropower output can be changed almost instantaneously it can effectively balance the increasing share of intermittent renewable electricity sources on grids,” he says.

### India’s slow flow

If overproduction is becoming a concern in China, then the reverse is the case in India where there is a desperate thirst for more hydropower. India’s economy is one of the fastest-growing in the world requiring an increasingly enormous amount of energy, which has led the government to start tapping into its rich hydropower potential, says **Asok Dasgupta**, president of the Independent Power Producers Association of India. Thermal sources still dominate India’s total installed power generation capacity with a 69 percent share, nearly five times the share of hydropower, which is at 14%. Non-hydro renewables is at 15%, while nuclear power is at %.

Dasgupta says the northeastern states of India will hold the key to India’s hydropower growth, particularly Arunachal Pradesh and Mizoram, which have abundant and still untapped potential at an estimated 50,000MW and 4,500MW, respectively. Unfortunately, hydropower projects have been slow to complete in both states. In Arunachal, Dasgupta says hydropower projects under construction have been shunned by several private companies. Meanwhile, in Mizoram, only 30MW – or less than 1% of its potential – of hydropower projects are currently in the planning and construction phase.

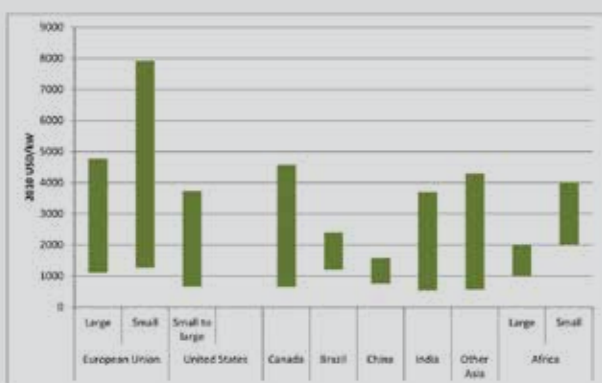
Hydropower projects in Arunachal have been riddled with challenges – namely, a poor transport infrastructure, a poor transmission system and local political gamesmanship – so most private power developers have chosen to sit in the sidelines. Other private power developers in Arunachal also cannot handle the heavy stress brought on by the projects to their balance sheets. This has placed the burden on completing the projects to the public sector.

**Aditya Valiathan Pillai**, program officer at The Asia Foundation says the high up-front construction costs of hydropower is one of the key reasons that has deterred private capital and put several government projects on hold. In India, new hydropower installations can cost between two and four times the price of thermal power depending on the projects, and solar is even cheaper. Long gestation periods and strong opposition have likewise driven up prices and risk of hydropower projects. But if India overcomes the growing pains in its hydropower sector, then it will be in great position to



# SECTOR REPORT: HYDROPOWER

Total installed hydropower costs rangers by country



Source: IRENA, IEA, Black & Veatch

benefit from its uniquely strategic role in the emerging regional cooperation on electricity trade. "India's geographic position at the center of the region makes this a vital effort in linking it to other South Asian countries, and linking South Asian countries like Nepal and Bangladesh to each other through India," says Pillai.

## Energy trade

Member countries of the South Asian Association for Regional Cooperation have already signed a landmark framework agreement for regional cooperation on electricity trade in 2014. This prompted India to release last year guidelines for cross-border electricity trade that it hoped would introduce "greater transparency, consistency, and predictability in regulatory approaches" in South Asia. "Though countries in South and Central Asia suffer from chronic mistrust, there is evidence of pragmatism in energy cooperation," says Pillai. "A gas pipeline connecting Turkmenistan, Afghanistan, India, and Pakistan, for example, has recently seen the benefits of political momentum at the highest levels, though beset by local security concerns. Recent moves in South Asia toward the creation of an energy market should be seen in this light."

"Energy trade creates interdependence, which is a somewhat reliable predictor of further openness in interstate relations. The intensity of interdependence is amplified by the fact that energy security is a crucial factor in state-citizen relations across South Asia." Pillai adds that the Paris agreement on climate change has played a significant role in pushing not only the West, but also emerging markets to prioritize carbon emissions mitigation. It is in this climate of accelerating momentum for countries to shift to a greener energy mix that regional electricity trade can flourish. "Hydropower from the Himalayas in Nepal and solar power from Rajasthan could meet demand in Bangladesh or Sri Lanka, reducing their dependence on coal and oil," says Pillai. "Seen through an economic lens, this injects an element of rationality to often costly investments in energy generation; electricity surpluses can be traded and deficits met across the geographic expanse of South Asia."

For Dasgupta, India's aspirations in establishing a transnational supply of electricity to neighboring countries will require the country to solve the domestic challenges in Arunachal Pradesh and Mizoram that have stalled more than a dozen hydropower projects currently under construction.

Five notable factors are keeping India, as well many developing countries such as Nepal, from realising the full potential of their hydro resources. Dasgupta says hydropower projects are more expensive, involve large logistics requirements, raise complex challenges in land acquisition and local population displacement, require new or upgrades of transmission line to evacuate power, and entail proponents to address critical environmental concerns.

## TORN BETWEEN RAPID DEVELOPMENT AND ENVIRONMENTAL OBLIGATION

Given these challenges, Dasgupta recommends India to start building suitable road and rail connections to the northeast for the transport of equipment and materials to build hydropower projects. It also needs to develop an adequate transmission network within India that can handle the additional electricity load in the future.

The government should also change the classification of "renewable source" as defined according to the Ministry of New and Renewable Energy. Dasgupta argues that, at present, renewable source only pertains to hydropower projects of up to 25MW capacity, so expanding the definition to include hydropower projects of all capacities will allow projects to take advantage of incentives and cheaper financing. "The provision of these incentives will serve to make hydropower projects more bankable for the private sector, and hence sprout greater private investment in the sector," says Dasgupta. "If India's central and state governments fail to take these steps, the full use of northeast India's hydropower potential will remain elusive."

## Balancing development and environment protection

The challenge for India will be in finding the right balance between the need for rapid development and the necessity of protecting the environment, says Opangmeren Jamir, research assistant at the Institute for Defence Studies and Analyses. India currently takes a haphazard approach to undertaking hydropower projects, which no less than the Comptroller and Auditor General of India had found to routinely bypass standard procedures, including for environmental impact assessments and public hearings, in a report it presented last March.

"Every stakeholder needs to contemplate the impact that hydropower dams would have on the environment, and also the potential impact of climate change on dams, both before and after their construction," he says. Jamir reckons that many countries have embraced hydropower as they attempt to mitigate climate change, lower airborne pollution as hydropower plants replace coal plants, and comply with global standards and agreements. But even though hydropower is indeed a clean source of energy, it can bring serious negative impacts on the climate that should not be overlooked.

He cites a research paper by Philip Fearnside that found hydropower dams located in tropical regions generate more methane than those located in temperate zones. Another study led by Bridget R. Deemer, on greenhouse gas (GHG) emissions from 267 large reservoirs around the world, more than 80 per cent of methane emissions come from water storage reservoirs created by dams, contributing almost three times more to global warming compared to carbon dioxide, although methane in the atmosphere stays for only a short while compared to carbon dioxide.

Asian nations will also need to start factoring in the impact of climate change in evaluating hydropower projects not merely as an environmental necessity, but also to determine financial feasibility. Jamir says climate change can alter river discharge, which in turn impacts the availability of water resources, water regularity and hydropower generation.

"Major rivers like the Indus, Ganga and Brahmaputra are fed by snow and glacier melt. But the retreat of glaciers in the Himalayas is likely to alter the pattern of river flow, resulting in the disruption of hydropower production. A one per cent reduction in the flow can reduce electricity output by roughly three per cent," he explains.

"Moreover, one cannot ignore the economic risks of investing in a hydropower project under the prevailing conditions of climate change. Bhutan, which boasts of a hydropower potential of around 30,000 MW, has invested enormous capital in the same in recent years, but is likely to face an economic risk on the returns in the years to come, apart from environmental risks. The social impact of large dams by way of population displacement and loss of income from farming and livestock should also not be overlooked."



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