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Accelerating hydropower development in India for sustainable energy security

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Foreword

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Hydropower can play a crucial role in India's sustainable development and energy security as it meets the criteria of sustainability, availability and reliability. It is an environmentally benign and non-polluting source of power and is most suitable for balancing renewables. Hydropower plants have the ability to run at zero load and thus, no outside source of power is needed to start the plants. This allows system operators to provide auxiliary power to other generation sources (e.g. thermal). Furthermore, hydropower provides transient stability to the grid. The quick start capability of hydropower plants helps quickly change the output to serve peak demand. The hydropower peak load factor is at 50% as against 16–20% in the case of solar and wind energy. Besides these capabilities, hydropower projects preserve soil fertility as sediment flow is regulated, thus helping to increase agricultural productivity and replenish ground water discharge. Hydropower projects maintain a sustained, adequate supply of water flow in river streams even during lean periods; this supply can be used by locals and for irrigation purposes.

The techno-economic viability of hydroelectric projects depends on geology, topography, hydrology and accessibility to project area. Land acquisition, clearance on environmental/forest aspects and judicial (NGT) litigations result in delays and consequent cost overruns. Besides, the lack of a compulsory hydropower purchase obligation impacts the signing of long-term PPAs and financial closure for projects. Government levies such as transmission charges, water cess and free power to state governments add to the cost and thus raise tariffs vis–à-vis other renewable energy sources. In order to create a competitive environment, the hydropower industry needs to have a level playing field with other renewable forms of energy.

I sincerely thank our knowledge partner, PwC, for their efforts in preparing this paper and suggesting a roadmap to accelerate hydropower development in the country. Industry recommendations have also been incorporated in this paper. We hope these will receive consideration from policymakers.

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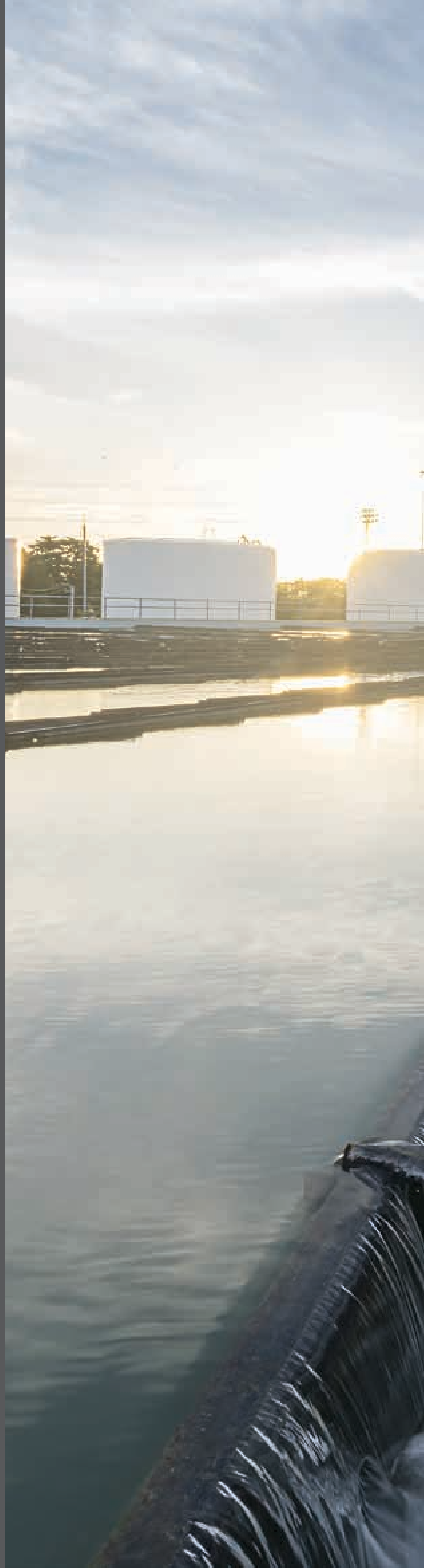


Introduction

Propelled by large-scale capacity additions in the past decade, India is likely to experience an energy surplus of 8.8% and a peak surplus of 6.8%.[1] While this achievement is a milestone in India's journey towards ensuring long-term energy security, it must be noted that the per capita energy consumption of India is still 1,075 kWh, which is well below the global average of 3,144 kWh.

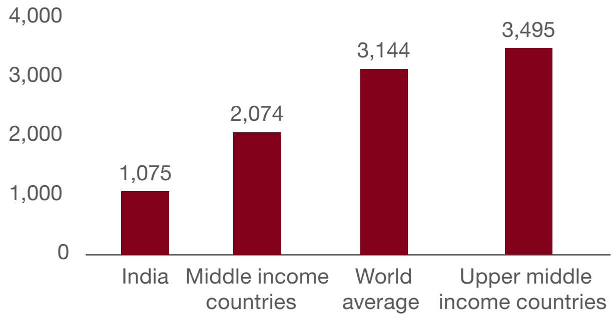
To ensure sustainable and equitable socio-economic development, the Government of India has launched the 'Power for All' programme with the objective of ensuring 24x7 power supply. This programme, India's increasing urbanisation and the rapid growth of the manufacturing sector are expected to be the three key factors that will drive power demand in the country.

In order to cater to this expected increase in power demand while fulfilling its climate change commitments as part of the 21st Conference of Parties (COP 21), the Government of India has set a renewable energy target of 175 GW by 2022, comprising mainly solar and wind capacity additions.

However, this large-scale renewable capacity addition, which is known for variable generation, may have large-scale implications on the reliability and stability of the Indian power system. Considering the government's firm resolve to achieve its renewable capacity addition targets by 2022, the power sector needs to be able to firmly support the variability and intermittency of the generation output of renewables through the provisioning of peaking support and ancillary services.

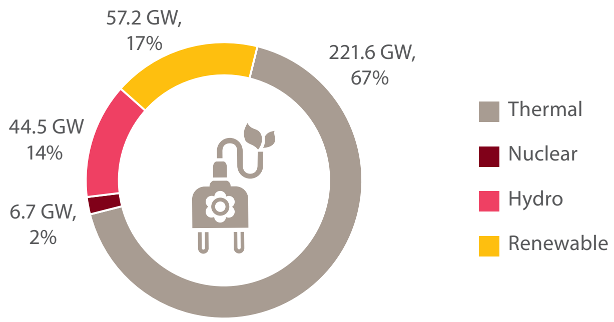
By design, hydropower is ideally suited to cater to the specific demands of the Indian power system. Thus, there is a need to focus on responsible and accelerated hydropower development, which will address the collective concerns of hydropower developers while ensuring sustainability and addressing socio-economic concerns around developing projects.

Per capita power consumption (kWh)

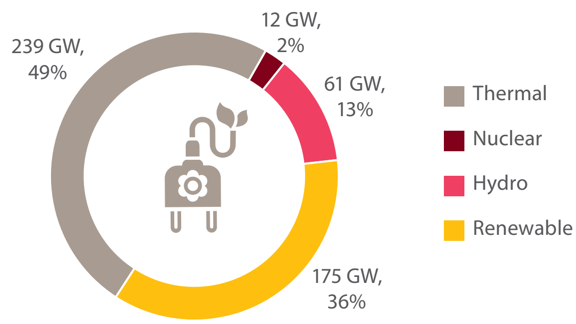


Source: World Bank

Total installed capacity = 330 GW (as of May 2017)



Tentative capacity in 2022 = 487 GW



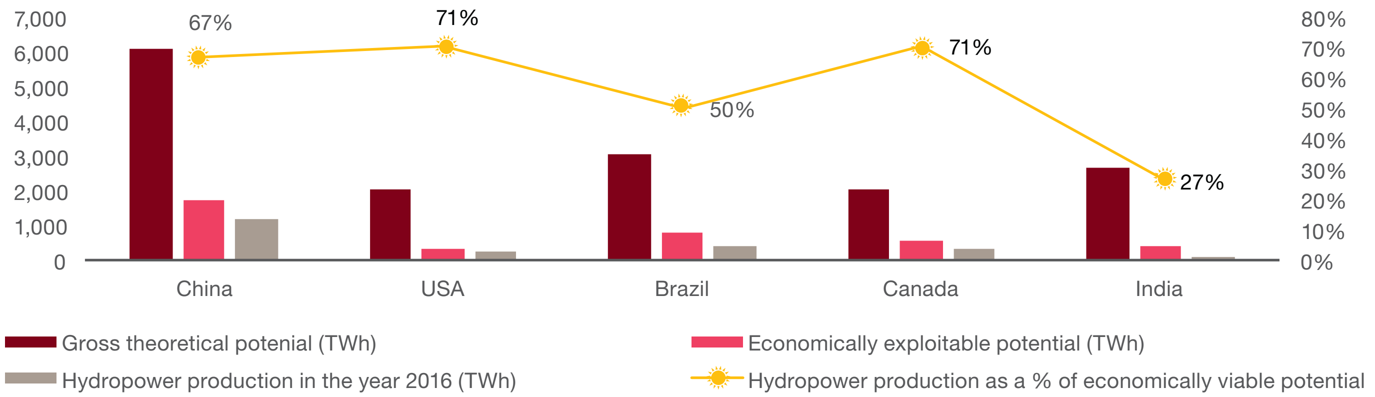
1. Central Electricity Authority, Government of India. (2017). Load Generation Balance Report, 2017–18. Retrieved from http://www.cea.nic.in/reports/annual/lgbr/lgbr-2017.pdf. (last accessed on 19 June 2017)

Status of hydropower development in India

India's hydro reserves and its current installed capacity

India is endowed with large hydropower reserves that are estimated to be capable of meeting a demand of around 85 GW at a 60% load factor, making it the fifth in the world in terms of usable hydropower potential.[2] However, in spite of the abundance of these reserves, the total installed capacity of large hydropower projects with a capacity greater than 25 MW till date is only 45 GW, representing only 30% of the total potential. A comparison with the global levels shows that the extent and overall pace of hydropower development in India are well behind those of other hydro-rich nations.

Global leaders in terms of hydropower potential



Source: International Renewable Energy Agency (IRENA) and International Hydropower Association (IHA) statistics, 2016

Moreover, the proportion of installed large hydropower capacity in relation to the total installed capacity in India has also seen a decline, with large hydropower accounting for only 14% of the total installed capacity (as of May 2017), down from 46% in the year 1966.

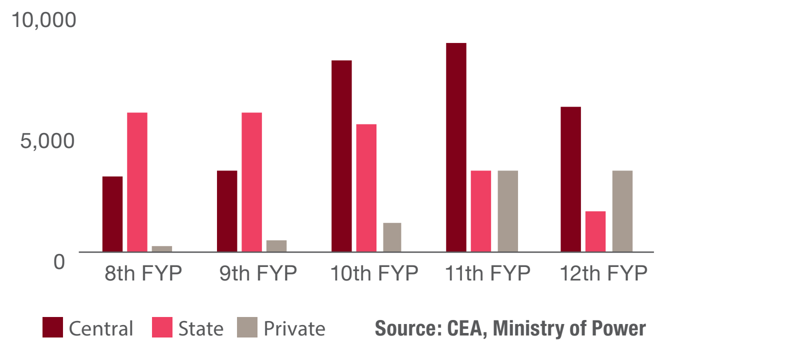
2. World Energy Council. (2016). World Energy Resources 2016. Retrieved from www.worldenergy.org/wp-content/uploads/2017/03/WEResources_Hydropower_2016.pdf (last accessed on 19 June 2017)

Private sector participation in the Indian hydro sector

From a historical perspective, with the electricity sector being categorised as a concurrent subject and water use as a state subject in the Constitution of India, hydropower development was primarily the responsibility of the central and state governments. However, in line with the economic liberalisation policy of the Government of India, the power sector, which includes hydropower, was opened to private sector participation in 1991. Subsequently, over the years, to facilitate projects through the public private participation (PPP)/joint venture (JV) mode, several states have nominated a state nodal agency with the option of equity investment by state governments.

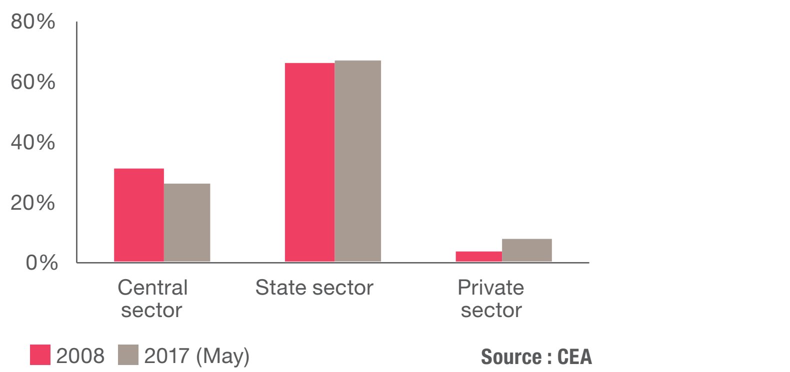
The New Hydro Power Policy introduced by the Government of India in 2008, which focuses on large hydro capacity additions, also provided a number of liberal provisions for inducing large-scale private investments in the hydropower sector. Subsequent five year plans of the Government of India had allocated an increased share of target hydro capacity additions to the private sector. Beyond the 12th Five Year Plan (FYP) as well, out of the total planned capacity additions of 6,500 MW, approximately 28% is expected to be developed by the private sector.

Target hydropower capacity additions across central and state governments and the private sector (MW)



Although these measures have resulted in increased participation of private developers in the hydropower sector, till date, only 3.2 GW has been commissioned through the private route. This constitutes only 7% of the total installed hydropower capacity as of May 2017.

Share of central and state governments and the private sector in hydropower capacity in 2008 and May 2017



Policy and regulatory initiatives for promoting hydropower development in India

Over the years, the Government of India has undertaken a number of policy and regulatory initiatives to promote hydropower development and facilitate investments in the sector. Some such measures are discussed below:

Legislation/act/ initiatives	Key features
Hydropower Development Policy, 1998	• Established a power development fund by levy of cess on electricity consumed • Transferred the subject of hydropower development up to 25 MW from the Ministry of Power to the Ministry of New and Renewable Energy
50,000-MW initiative, 2003	• Prepared a preliminary feasibility report and detailed project report of hydroelectric schemes in 16 states
National Electricity Policy, 2005	• Addressed the issues of long-term financing of hydel projects and provided guidelines for centre-state participation in the development of hydel projects • Emphasised the development of large-scale hydropower projects
Mega Power Projects Policy, 2008	• Awarded all hydel projects with a capacity above 500 MW the status of a 'mega power project' (qualification relaxed to 350 MW for projects in the northeast region) • Extended the benefit of a 10-year tax holiday to the projects identified in the policy , with no customs duty on imports of equipment, etc.
National Hydro Power Policy, 2008	• Replaced the Hydro Power Policy, 1998 • Provided impetus to hydropower development and emphasised the need for increased private sector participation in the hydropower sector • Aimed at quickly harnessing India's balance hydroelectric potential by ensuring improved financial viability of hydel projects
Central Electricity Regulatory Commission (CERC) (Ancillary Services Operation) Regulations, 2015	• To restore and maintain the frequency of electricity supply at desired levels by providing commercial incentives for both ramp up and backdown of ancillary services • Opened a new market for power generation, especially hydropower, given the ability of hydro schemes to provide ancillary support.
National Tariff Policy, 2016	• Underlined the norms for ancillary services and also gave rights to the CERC to introduce the norms and frameworks for ancillary services necessary to support grid operations, including the method of sharing of charges • Provided exemption to the hydropower sector from competitive bidding till 2022

Recent developments necessitating accelerated development of hydropower in India

India's strong climate change commitment through INDCs

Climate change is a major challenge for developing countries, particularly India, as it faces large-scale climate variability which can increase the impact of climate change. For instance, a substantial rise in temperature levels in India is likely to change rainfall patterns, significantly impacting agricultural produce and leading to more frequent droughts, as well as greater flooding in large parts of the country. Given India's dependence on fossil fuels to meet its growing demands from rapid urbanisation and industrialisation, the Government of India has made a commitment to curb CO2 emissions through its Intended Nationally Determined Contributions (INDC).

While the expected large-scale renewable capacity additions will help in meeting a substantial part of India's INDCs commitments, a recent committee report on 'Policy Interventions for Hydropower Development', Ministry of Power, estimates that hydro capacity to the tune of 65 GW would need to be developed by 2030. This would mean an addition of approximately 20 GW in the next 12–13 years.

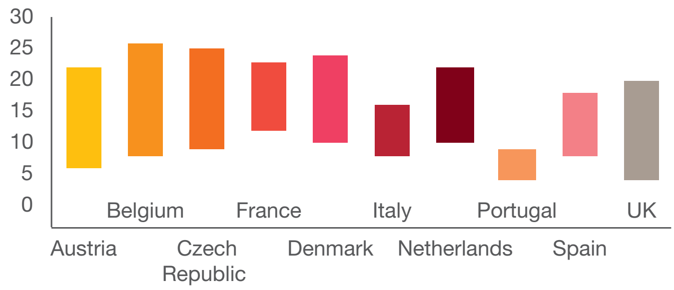
India's INDCs: Key commitments

- *To reduce the emissions intensity of its GDP by 33 to 35% by 2030 from the 2005 level*
- *To achieve about 40% cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030, with the help of transfer of technology and low-cost international finance, including from the Green Climate Fund (GCF)*
- *To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030*

Importance of hydropower in providing grid-balancing services and supporting large-scale renewable integration

While large-scale renewable capacity additions (mainly from solar and wind) are definitely a welcome step towards securing a green energy future for India, power from these sources is well known for its inherent variabilities. Apart from incurring system costs for integration of renewables in the grid (in terms of upgrade to the transmission and distribution networks), the need for additional firm balancing capacity has been observed in renewable-rich countries worldwide in the interest of ensuring grid reliability and stability.

Integration costs of solar photovoltaic (PV) (EUR/MWh) in select EU countries in the penetration range of 2%–18% (costs rise with increasing penetration).

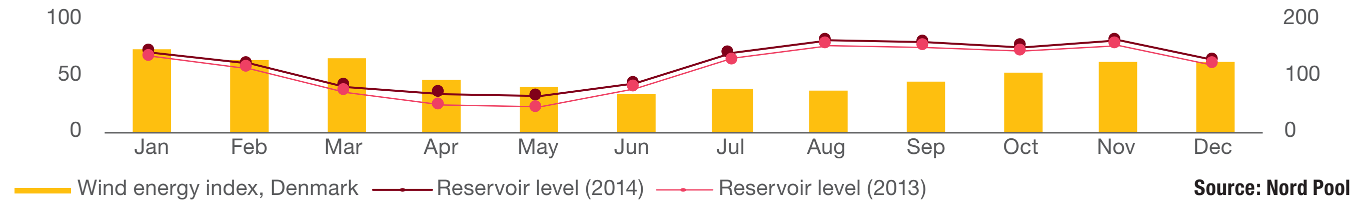


Source: Imperial College publications, 2013

Hydropower in Norway is supporting large-scale integration of wind power in Denmark.

Denmark, with its wind capacity of 5,227 MW contributing more than 40% of energy generation, observes a shortfall in wind generation in summer months due to seasonal variations. In order to balance the variable wind generation in the summer months, Denmark imports power from hydro reservoirs of Norway.

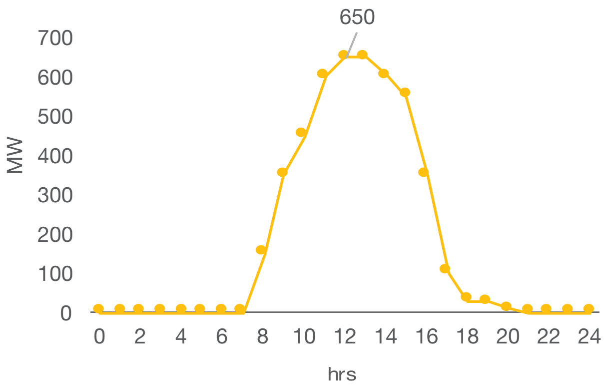
Reservoir water levels in the Nordic region vs wind energy index in Denmark



Source: Nord Pool

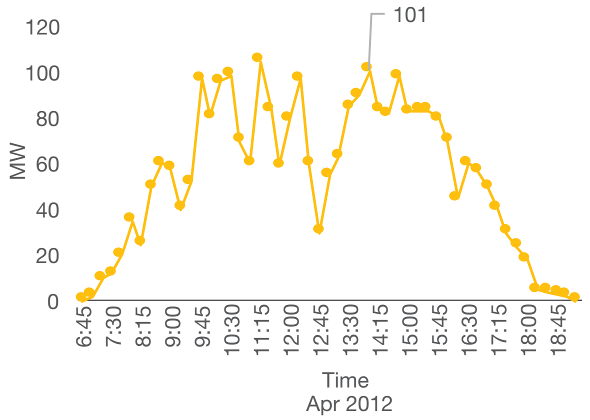
An example of the variabilities of power produced in the Indian context is presented below. At the Charanka Solar Park in Gujarat, the power output can go up to 650 MWp on a normal sunny day. On the other hand, on a cloudy day, the peak output may fall by as much as 85%.

Typical sunny day: Charanka Solar Park



Source: State Load Despatch Centre, Gujarat

Charanka solar generation on a cloudy day

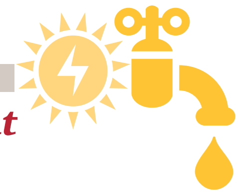


Such variabilities are leading to violations of voltage and frequency limits of the grid and are causing transient stability issues. Similarly, in the case of power generation through wind, in southern India, which has a significant installed wind capacity, there have been several instances of sudden falls in the operating frequency of the grid due to sudden drops in wind generation. Considering the total installed wind capacity of South India, wind generation drops from 2,000 MW to 200 MW over a duration of 1–1.5 hours, usually translating to a fall of approximately 1.5 Hz in system frequency.

Variable power generation from renewables impacts system stability not only in cases of reduced power output but also in cases of excessive power generation. In the past, the power production of several wind farms has been backed down by load despatch centres to maintain grid stability.

It is likely that these large variations in power generation through renewables may lead to large deviations in the power drawal commitments of states. While improved forecasting techniques of sunshine and wind velocity would definitely help in better planning for variations, complete accuracy of forecasts is often difficult to achieve. Nevertheless, forecasting alone will be insufficient to ensure seamless integration of renewables without impacting overall grid stability.

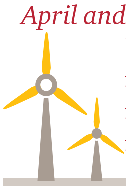
While thermal power generators are capable of providing flexible generation to overcome the variabilities of renewable power, they are polluting sources of power and are subject to limitations of fuel availability. An analysis of past data of ramping instructions issued to thermal stations shows that, in general, thermal stations are reluctant to back down their generation as per schedule to below 70% of their machine continuous rating due to increasing risks of 'wear' and 'tear' of generation assets. Gas turbine plants, although having quick ramp up/down capabilities, are relatively more expensive to operate due to high fuel costs. Moreover, it is observed that most plants usually operate at base load due to limited gas supplies.



Wind farm curtailment in Tamil Nadu

Wind Energy Generators (WEGs) in Tamil Nadu, such as Indian Wind Power and Green Infra, filed petitions with the Tamil Nadu Electricity Regulatory Commission in 2015. WEGs informed the commission that in spite of the 'must run' status given to wind power, the state load despatch centre, Tamil Nadu Transmission Corporation Limited (TANTRANSCO), was regularly issuing instructions to WEGs to switch off or back down generation.

The instructions were issued for a sizeable period, i.e. every day for as much as seven to 10 hours per day, particularly during the peak wind season between April and October, resulting in significant losses for WEGs. During the hearing, TANTRANSCO informed the commission that the instructions were being issued only in the interest of grid reliability and stability.



Hydropower, on the other hand, is the only clean renewable source capable of provisioning grid balancing and ancillary services.

Hydropower balancing and ancillary capabilities

Provisioning of peaking support

- Ability of hydropower projects to almost instantly ramp up to meet peak load requirements

Quick and black start capability

- Ability to quick-start in a matter of minutes as compared to 30 minutes or more for other sources
- Capability to run at zero load; ability to restore services more quickly than other sources

Frequency and voltage support

- Ability to maintain system frequency by continuous modulation of active power
- Control of system voltages through the supply of reactive power

Spinning reserves

- Provisioning of spinning reserves/ additional power supply to support system stability in case of unexpected load changes/blackout support

Barriers to hydropower development in India

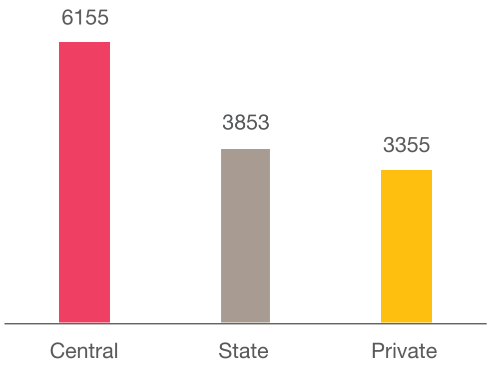
Despite significant hydropower potential, till now, only 30% of India's total economically feasible hydropower potential has been harnessed. Furthermore, several hydropower projects with a cumulative capacity of about 13,363 MW are stranded at various stages of project development, resulting in significant time and cost overruns.

Stranded hydro capacities in India as of December 2016

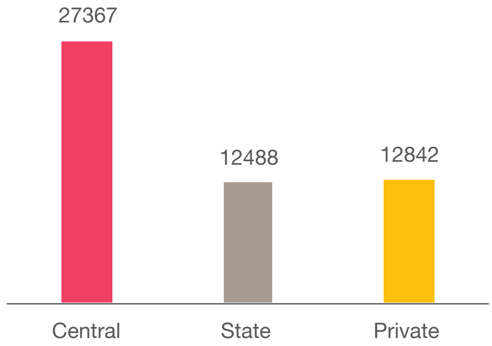
Total stranded capacity = ~13,363 MW

Total cost overruns = ~52,697 crore INR

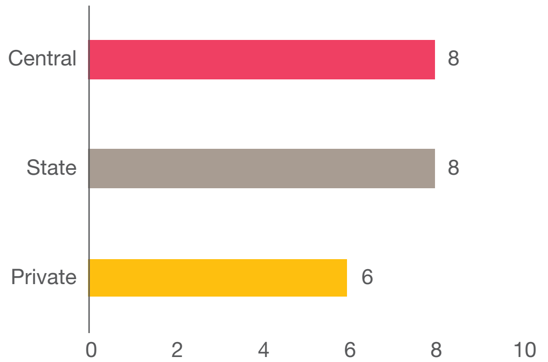
Stranded capacities across centre, state and private sector (MW)



Cost overruns across central, state and private schemes (crore INR)



Number of hydro schemes with time overrun of more than 5 years



Source: Hydropower quarterly review reports, CEA

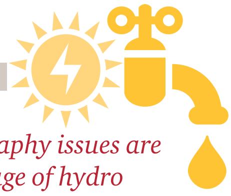
An assessment of the total stranded hydropower capacity in India shows that hydropower developers face some specific issues and challenges which affect their ability to ensure on-time/scheduled commissioning. The table below provides a snapshot of the major factors responsible for such delays.

- *Amongst the central schemes, Tuirial, which is being developed by North Eastern Electric Power Corporation Limited (NEEPCO) in Mizoram and had an original commissioning schedule of 2006–07, is still not commissioned due to local agitation.*
- *Similarly, Himachal Pradesh's scheme Uhl-III, which is being developed by Beas Valley Power Corporation Limited (BVPCL) is facing a time overrun of over 132 months due to land acquisition issues.*
- *Amongst the private sector schemes, the Maheshwar project in Madhya Pradesh, which is being developed by Shree Maheshwar Hydel Power Corporation Ltd (SMHPCL), has been delayed by over 17 years, mainly due to rehabilitation and resettlement (R&R) issues.*

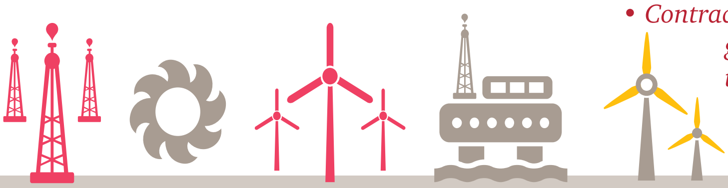
Major reasons for slippage in hydro capacity additions (as a percentage of total observed instances)							
	Geology, hydrology and topography	Critical electrical and mechanical works	Delays in clearances	Local issues, law and order problems	Contractual disputes	Enabling infrastructure	Land acquisition
Central hydro schemes	21%	8%	16%	24%	16%	11%	5%
State hydro schemes	8%	14%	14%	16%	35%	3%	11%
Private hydro schemes	35%	12%	12%	19%	8%	8%	8%

Source: Hydropower quarterly review reports, CEA; PwC analysis

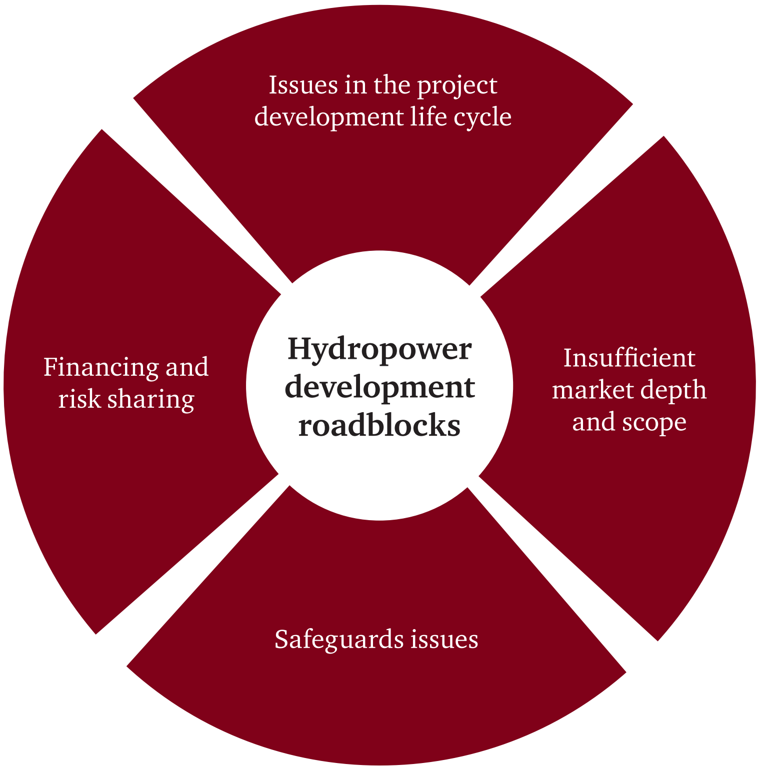
The above-mentioned reasons for delays in project commissioning and the current levels of investor/developer attractiveness of the hydropower sector, in general, can be traced to some underlying impediments and roadblocks. These roadblocks are categorised into four broad thematic areas as illustrated below.



- *While geology, hydrology and topography issues are some of the leading reasons for slippage of hydro projects, delays in clearance, local issues and law and order problems have also resulted in significant delays in project commissioning.*
- *Contractual disputes seem to affect central and state government schemes disproportionately more than private sector schemes.*



Barriers to hydropower development in India

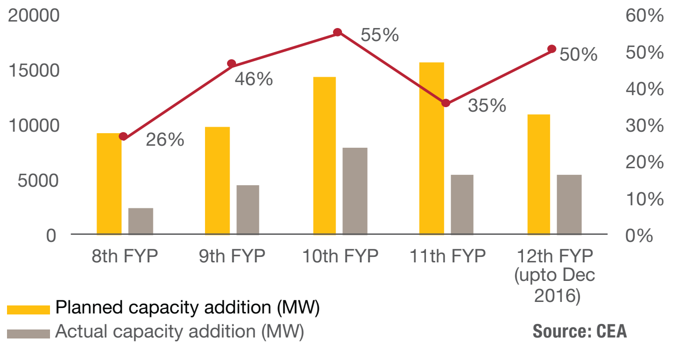


Issues in the project development life cycle

Hydropower planning and project allocations

Hydropower planning and subsequent project development in India are generally carried out on a case-to-case/individual project basis. Moreover, with water being categorised as a state subject, the consent of states impacted by the projects is required. As a result, a large number of hydropower projects with common river systems between adjoining states are delayed due to the lack of interstate agreements on water usage. Ongoing conflicts in Assam and Arunachal Pradesh over the utilisation of the Brahmaputra river, and the Mullaperiyar Dam conflict between Kerala and Tamil Nadu are some well-known instances. Furthermore, in the absence of an integrated river basin development plan, there is always the risk of multiple projects being developed on the same river, often leading to possible reductions in peaking capacities and additions of avoidable costs for siltation treatment.

Planned vs actual capacity addition



Source: CEA

Bidding norms for hydropower projects are also not standard across states, with varying minimum thresholds for royalty/free power, upfront premiums and free equity. Moreover, the bidding norms (particularly upfront premium and free equity) themselves lead to significant cash outflows even before the commissioning stage, impacting project financials and viability.

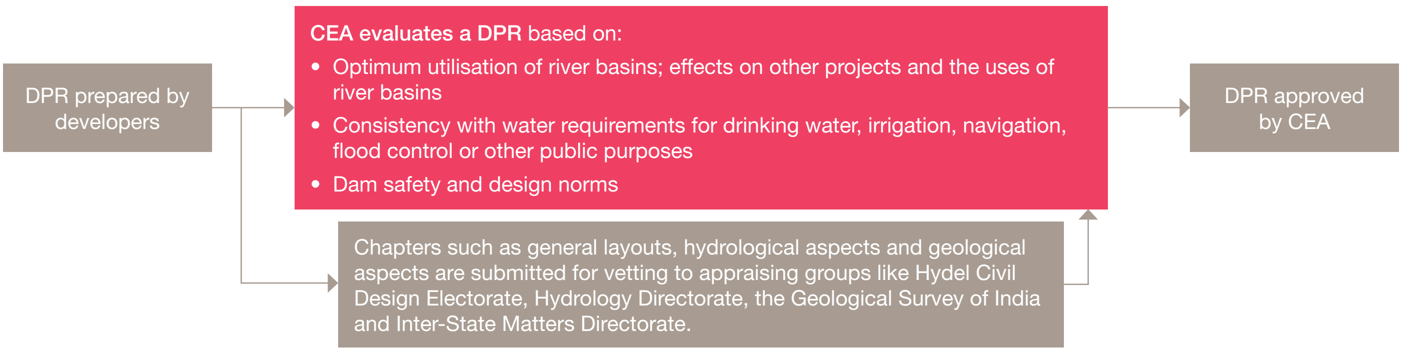
	Arunachal Pradesh	Jammu and Kashmir	Himachal Pradesh	Uttarakhand	Sikkim
Application fees (INR)	0	5 lakh	0	5 lakh	0
Threshold upfront charges (INR)	1.5 lakh/MW	5 lakh/MW	20 lakh/MW	5 crore/project	10,000/MW

Project approvals, land acquisition and enabling infrastructure

DPR approvals

The current approval process for a detailed project report (DPR) is provided in section 8 of the Electricity Act of India, 2003. However, the existing procedure, which mandates the vetting of DPR documents by various entities such as the Geological Survey of India, the Hydrology Directorate and Inter-State Matters Directorate, in addition to approvals from the CEA makes the entire process of preparation and approval of DPRs fairly complex, time consuming and expensive.

DPR approval process



As a result, project developers are reluctant to invest adequate time and finances in DPR preparation, leading to inadequate project reports, which in turn result in disputes related to project cost escalations or revenue assessments.

Land acquisition

Land acquisition has been one of the other key reasons for delays in hydropower projects. The Land Acquisition, Rehabilitation and Resettlement Act, 2013, and its subsequent amendments have attempted to streamline the land acquisition process through a number of provisions:

- R&R provisions are not mandatory in the case of private purchase of land of less than 100 acres in rural areas and 50 acres in urban areas. These provisions enable the developer to buy land in multiple parcels of less than 100 acres and also allow for no R&R in case of acquisition of agricultural land.
- Social impact assessment (SIA) is exempt for hydropower being developed under PPP where ownership of the land rests with the government.
- Uniform treatment of both public and private developers pertaining to the requirement of public consent for acquiring land.

However, some issues in the land acquisition process still remain. For instance, ideally, land acquisition should be complete before a project is tendered. In India, however, projects are often awarded with only part of the land physically acquired. This leads to delays on account of undervaluation of land price, dependence on state governments for land acquisition, etc. Furthermore, the unavailability of reliable land records with the requisite government departments often adds to existing complexities.

Enabling infrastructure

Most hydropower projects lack adequate power evacuation infrastructure as they are usually located in remote areas, making the sites inaccessible for project developmental work. These challenges are especially common in north-eastern regions of India known for their difficult terrains.

While the Ministry of Power's guidelines relating to a Right of Way (RoW) for transmission lines has provided clarity on compensation rates and RoW beneficiaries, the requirement of prior consent of landowners was still obscure. As a result, obtaining an RoW was still a difficult task, with several ongoing judicial proceedings. Although the recent judgement of the Hon'ble Supreme Court (refer to the box alongside) may lead to faster grants for RoWs, the identification of beneficiaries and the extent of compensation for RoWs may still be contested.

In addition, the development of associated infrastructure such as roads and bridges for improving accessibility to the project site increases the cost of project development, thus greatly affecting the financial viability of the project. Furthermore, the lack of infrastructure facilities such as schools and hospitals affects the movement of skilled manpower to isolated project sites.

Pallivasal hydro scheme HEP, Kerala

The Pallivasal Extension Scheme HEP (60 MW) that is to be developed by the Kerala State Electricity Board (KSEB) has been delayed by over nine years, primarily due to land acquisition issues. Although development works for the project started in March 2007, the land acquisition proceedings were started only in April 2007. The land acquired for the project included 2.45 ha of government land, which was encroached upon by private parties. Given that the government rules did not allow compensation for acquisition of non-patta land, KSEB had to pay the private parties ex gratia. This increased the land acquisition cost from 7.5 million INR (as projected in the project report) to 71 million INR. Apart from this, contractual issues have led to suspension of works since early 2015.

The associated transmission system for the evacuation of electricity from Kameng HEP (600 MW) is estimated at 11,000 million INR, which is about 50% of the project's cost of power generation. Similarly, in the case of Lower Subansiri, the transmission cost is estimated at 100 billion INR.

Supreme Court judgement on the RoW of land, December 2016

A cement manufacturer in the state of Chhattisgarh challenged the Power Grid Corporation of India's decision to erect transmission lines on its limestone lease area without its consent. The Supreme Court, after hearing both parties, finally ruled that its top priority was to enable the government and its agencies to get electricity to the last household and thus held that 'no prior consent of landowners was required to lay overhead power transmission lines and erect towers to support these lines'. The judgement settled the various conflicting judgements from several of India's high courts.

Insufficient market depth and scope

The Indian power market is still at a nascent stage of development, with the current market structure preventing hydropower developers from realising the potential benefits of meeting peak demand as the tariffs for both peak and off-peak powers are still undifferentiated. The volume of short-term market, which allows different instruments for peak and off peak supply, is also very low.

Additionally, as highlighted before, with the introduction of huge renewable capacities in power systems, stability in terms of voltage regulation, reactive power control, etc., are immediate requirements. Following the adoption of the National Tariff Policy (2016), the CERC has introduced ancillary services regulations for the Indian power sector as the market till date has been extended only to frequency support ancillary services. Hydropower, which was originally expected to benefit as a result of these regulations, has found limited traction in the frequency support market, given the limited 'un-despatched' surplus available from hydro stations. Moreover, it is observed that during high hydro periods, plants operate above 100% load, leaving limited margins for up-regulation without risking any spillage. On account of the limited market benefits and undifferentiated peak and off-peak tariffs, four major pumped storage projects have not been upgraded to run in the pumping mode.

Pumped storage schemes currently not in operation in India

Name of project/state	Installed capacity (MW)	Reason why the project is not operating in pumping mode
Kadana Stage I& II, Gujarat	240	Vibration problems
Nagarjuna Sagar Project, Andhra Pradesh	706	Construction of tail pool dam is still not completed
Panchet Hill Project, Damodar Valley Corporation	40	Construction of tail pool dam is still not completed
Sardar Sarovar Project, Gujarat	1,200	Construction of tail pool dam is still not completed

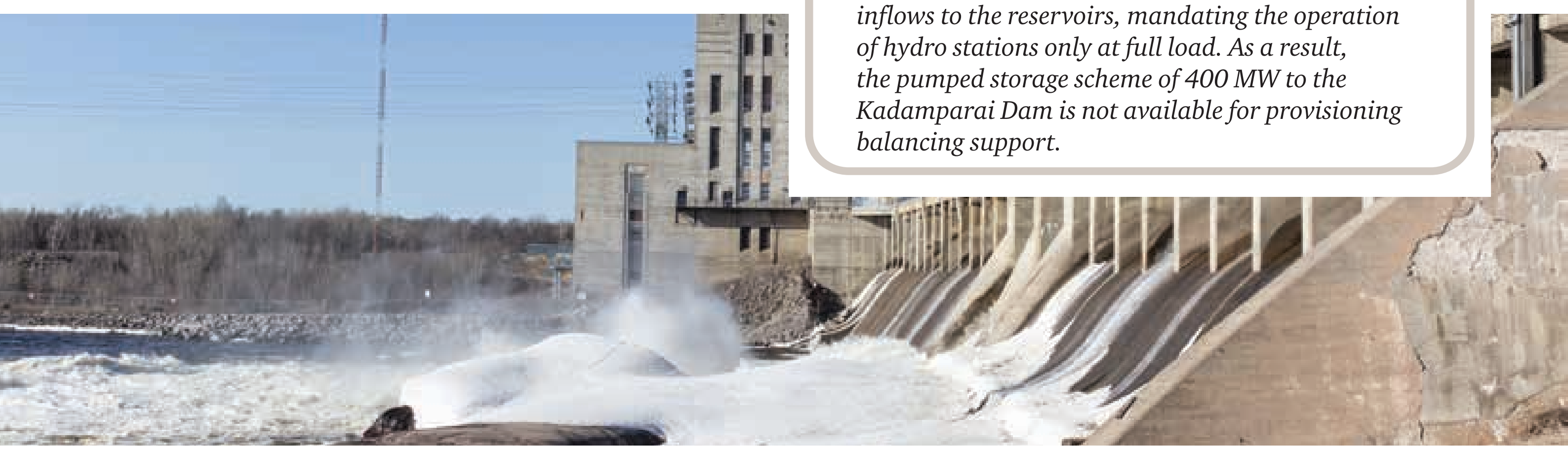
Summary of the Reserves Regulations Ancillary Services (RRAS) market from April 2016 to December 2016

- *The RRAS market was operationalised from 1 April 2016.*
- *Thus far, the number of 'up-regulation' instructions (1,378), far exceeds the number of 'down-regulation' instructions (271), indicating that limited and variable electricity supply is unable to cater to power demand, which has resulted in low operating frequencies.*
- *Limited or no procurement from hydropower-based power stations*

Balancing Tamil Nadu's renewable energy capacity

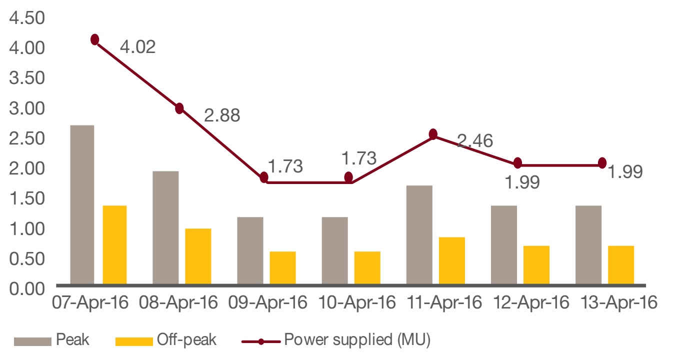
The state of Tamil Nadu has an installed wind capacity in excess of 7,500 MW. Rather than relying on its available hydro capacities, the state is having to manage its variability through coal-based plants. This is primarily due to the following reasons:

- *As against the total hydro installed capacity of 2,203 MW in Tamil Nadu, the total non-irrigation based capacity is only 1,325 MW. As a result, the entire installed hydro capacity is not available for balancing the intermittency of wind.*
- *The June–September period usually observes high inflows to the reservoirs, mandating the operation of hydro stations only at full load. As a result, the pumped storage scheme of 400 MW to the Kadamparai Dam is not available for provisioning balancing support.*



Further, due to this observed limited availability of peaking support from hydropower in the Indian power system, in early February 2016, India's national system operator, the Power System Operation Corporation (POSOCO), requested the National Load Despatch Centre (NLDC), Bhutan, for peaking power support, given Bhutan's surplus hydropower generation.

Bhtuan's Tala hydropower plant providing peaking support to India
Sample data: 7 April–13 April 2016 (in MU)



Source: Eastern Regional Load Despatch Centre, India

Safeguards issues

Hydropower development activities, especially large-scale capacity addition, do trigger changes in land use and human settlements. They also have impacts on biodiversity and the climate. While there is a need for adequate safeguards to minimise the impacts of hydropower development, special care needs to be taken to ensure that these safeguards do not act as deterrents to the development of projects.

The progress of many projects has also been affected on account of delay and non-clearance related to environment and forest aspects. Even if the requisite clearances are accorded, the option of judicial recourse and filing a public interest litigation (PIL) with the National Green Tribunal (NGT) is always available to activists, leading to costly delays and time overruns for hydro developers.

While hydropower developers are making sizeable efforts in communicating and engaging with project-affected families (PAFs) and the general public at large, little change has been observed in the societal attitudes towards hydropower, which is still perceived as a dam-building exercise that leads to unnecessary changes in settlement patterns.

Delay in clearances for hydro projects in Alaknanda-Bhagirathi river basins

Following the Kedarnath Tragedy in 2013, the Supreme Court of India revoked green clearances of 24 out of the 70 planned projects in the Alaknanda-Bhagirathi river basins, leaving them for further review with the Ministry of Environment, Forest and Climate Change (MoEFCC).

The Supreme Court asked the MoEFCC to examine if the projects were causing significant impact to the biodiversity of the river basins and ascertain the extent to which the project development works could have contributed to the flood situation. Thereafter, MoEFCC, on the basis of an expert committee report, stated that 5 out of 24 projects under review would neither affect the flow of the river nor would disrupt biodiversity.

Post these recommendations, the Ministry of Water Resources filed an affidavit with the apex court appealing for a stay on all new hydel projects, stating that existing dams and river water diversions have already caused significant damage to the river length. The Ministry opined that any further hydro developments should be done only after the requisite consolidated studies on river water conservation have been conducted.

Financing and risk sharing

Project financing and viability issues

Hydropower projects are capital intensive and require higher upfront costs to address greater complexities in design, engineering, environmental and societal impact mitigation, etc. These complexities and technical challenges often lead to time and cost overruns and increase the uncertainty of cash inflows, thereby resulting in higher risk premiums on financing charges. While a resolution to most of these issues has been proposed in the Ministry of Power's recommendations to the Expenditure Finance Committee (EFC) (see the next section for detailed discussion), the benefits are accrued to only those projects achieving the commercial operations date (COD) within five years of the notification of the scheme and not to all future projects. Therefore, the above-mentioned financing issues will persist for future hydro projects which are outside the purview of the Ministry of Power's recommendations.

State	Royalty payments
Arunachal Pradesh	12% of total energy from COD
Uttarakhand	12% of total energy from COD
Sikkim	0–15 years: 12% of total energy from COD Beyond 15 years: 15% of total energy from COD

Source: Hydro policies of respective states

Long construction periods

Long construction periods lead to high interest during construction. Also, delays in cash inflows increase uncertainty and risks, resulting in higher risk premium on financing charges.

High capital costs

The capital cost of hydro projects ranges between 60 million INR/MW and 80 million INR/MW as compared to 30 million INR/MW and 50 million INR/MW for thermal plants. Hydro projects require higher upfront costs to address greater complexities and risks.

Depreciation benefits

Non-availability of long-term debt in the Indian capital market necessitates higher provisions for depreciation to generate revenues required to meet repayment obligations.

Furthermore, policy provisions requiring delivery of free power to states, grant of additional funds/power for local area development in terms of local area development fund (LADF) and restrictions imposed on the quantum of merchant sales, irrespective of the technical and financial parameters of hydro projects, further affect project viabilities. Withdrawal of the Mega Power Policy, which provided VAT and custom duty exemption on the import of capital equipment and other benefits, will only add to the relatively high cost of generation of hydro projects, further impacting the competitiveness of hydro tariffs. The existing regulatory provisions for tariff determination, which cap the useful life for hydro schemes at 35 years, in addition to the O&M and the current regime on return on equity (RoE) rates, also negatively impact the viability of hydro projects.

Risk-sharing profile of hydro projects

Hydropower projects are site specific and developmental works greatly depend on geological, topographical and hydrological considerations. In such a scenario, the risk of unanticipated site conditions is ever present. India's relatively complex geology, especially in the young fold mountains of the Himalayas, only adds to the challenges, particularly for projects requiring extensive underground excavations and works. Such surprises during the critical project construction period may lead to lengthy time and cost overruns, impacting the contractual obligations of developers., The limited availability of experienced engineering, procurement and construction (EPC) contractors in India only adds to the total project risk .

At the other end of the value chain, because of the existing cost-plus tariff determination regime for hydropower, developers may, in effect, 'pass through' the resultant increased costs to the 'off-takers' of the hydro produce. This is subject to the necessary due diligence, which results in even higher hydro tariffs. Additionally, if off-takes/power purchase agreements (PPAs) of the projects are not secured, the entire project may become a sunk investment for the hydropower developer.

Action plan for accelerating responsible hydropower development in India

Realising the need for the immediate revival of the hydropower sector in India, the Ministry of Power has recently forwarded a proposal to the Expenditure Finance Committee (EFC) of the Cabinet for approval. This proposal, apart from highlighting the importance of the hydro sector in ensuring long-term sustainable energy security, recommends strategies to accelerate hydropower development. Key highlights of the proposal are given below:

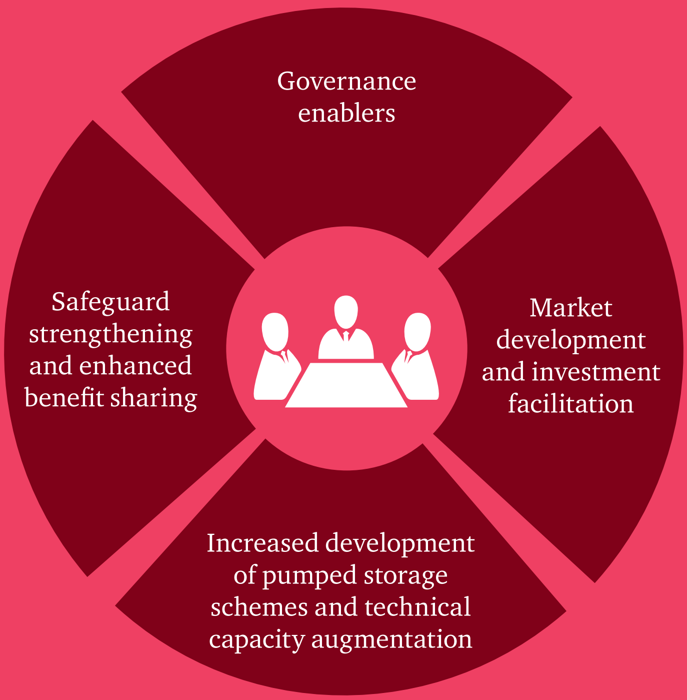
Ministry of Power recommendations for revival of hydro forwarded to the EFC	
Recommendations	**Envisaged impact**
Declaring all hydropower irrespective of size as renewable power	Hydro will be eligible for all benefits currently extended and accrued to renewable energy sources such as 'must-run' status and accelerated depreciation.
Hydropower purchase obligation within currently mandated non-solar renewable purchase obligations (RPOs) • Benefits extended to HPP >25 MW attain COD with 5 years of notification of the scheme	Mandated purchase of hydropower by distribution companies (DISCOMs) subject to introduction of the necessary orders/regulators by state regulators
Interest subsidy of 4% during construction (max. of 7 years) and 3 years post COD to all hydro projects >25 MW • Subsidy extended to only those projects obtaining COD within 5 years of notification of the scheme	Reduced financial burden on both public and private hydropower developers. Additionally, it is expected to lead to the reduction of levelised tariff of a standard 2500 MW hydro project by 0.8 INR/kWh.
Creation of a Hydro Power Development Fund (HPDF) to be funded from Coal Cess/National Clean Energy Fund (NCEF)/Non-Lapsable Central Pool of Resources (NLCER)/or any other source	This fund is envisaged to finance the interest subsidy of 4% to the eligible hydropower projects.
Excluding cost of enabling infrastructure from project cost for tariff calculations and reimbursement of the infra-related costs to the developers	Reduced cost of generation and less financial burden on hydro developers
Engaging with bankers/financial institutions (FIs) to modify lending terms and conditions	Hydropower developers will have greater access to long-term lending at affordable interest rates.
Engaging with CERC by rationalisation of tariff parameters such as depreciation, O&M expenses, RoE	Reduction of hydropower tariff and increased project returns for hydro developers

The implementation of these recommendations in a time-bound manner will help revive the stalled hydropower projects and also expedite time-bound operationalisation of hydropower projects in the next five years.

However, in addition to the above measures, other key interventions are required for accelerating hydropower power development in India. These measures can be segregated into four broad themes.

3. Ministry of Power, Government of India. Retrieved from http://powermin.nic.in/sites/default/files/uploads/proposal_for_EFC_consideration_for_revival_of_Hydro_Power_Sector.pdf (last accessed on 19 June 2017)

Action plan for accelerated hydropower



Governance enablers

Hydropower development in India needs to be channelised through an efficient governance framework by adopting a suitable policy framework coupled with uniform and transparent processes.

Integrated river basin development and project allocation procedures

- Considering the importance of adequate planning in the overall development of the hydro sector, an integrated river basin study is one of the critical requirements. The government's recent step to reassess the basin-wise hydro potential through a study taken up by the CEA through WAPCOS Ltd. is a welcome step and will aid in the better project planning of multiple projects on the same river basin. Requisite support from all concerned central and state departments needs to be ensured to enable on-time completion of this study. Exhaustive river basin studies will help avoid the risk of reduction of peaking capabilities and cost overruns due to upstream/downstream project development.
- Allocation of projects above a certain threshold, in the interest of uniformity and transparency, should ideally be done through the competitive bidding route across states. In order to ensure the participation of only select and responsible hydro developers, bidding of these projects may be explored only after the completion of all-project preparatory activities, similar to the process which was followed for Ultra Mega Power Projects (UMPPs).

Efficient coordination and institutional framework for policy implementation goals

- While recognising the fact that water is a state subject and the electricity sector a concurrent subject, the Ministry of Power/Government of India, along with the various state governments and departments, must approach sustainable hydropower development in an efficient and coordinated manner. The existing processes, structures and institutional frameworks must be re-aligned to the development goals and hydropower capacity addition targets while adequately recognising the role of the private sector.
- To this end, the possibility of establishing a 'Hydropower Commission' as a nodal agency which will coordinate the actions of various entities involved in the hydropower sector value chain and facilitate various investments and clearances needs to be explored

Power sector development in Bhutan, which is primarily dependent on hydropower generation, has shown visible signs of a slowdown in the recent past. In order to revive hydropower development in the country, the Royal Government of Bhutan (RGoB), in 2016, adopted a revised Economic Development Policy which includes provisions for the set-up of Bhutan Power System Coordination Committee (BPSCC). This committee is charged with mobilising investments in the sector and facilitating negotiations between various sector entities to assist in fast-tracking project approvals.

Source: Economic Development Policy 2016, Bhutan

Power evacuation and associated infrastructure

- Similar to the establishment of the Green Energy Corridor (GEC) for renewable power evacuation, a dedicated transmission corridor for hydropower would help in overcoming the power evacuation issues faced by hydropower developers, especially in the remote North-east regions of India.
- Additionally, state governments should ideally provision the building of pooling substations and the location/ point of pooling of generation from individual turbines in locations having a large concentration of hydro resources. This will help developers reduce project cost on last mile connectivity.
- With regard to the development of enabling infrastructure for hydropower projects, an optimum balance needs to be established between the role of the developer and the role of the state. It is advisable for state governments to take up a part of the enabling infrastructure development responsibilities as part of their overall economic development agenda.

The integrated river basin plan, along with a transmission system master plan, can help in the optimum utilisation of transmission infrastructure and prohibit delays in The commissioning of plants.

Market development and investment facilitation

Policies and regulations targeted at market development will play a crucial role in channelising investments and will lead to further private sector participation in the hydropower sector.

Market instruments for incentivising hydropower development

Incentive mechanism	Remarks
Higher tariffs for meeting peaking requirements	In the current scenario, tariffs for supply of peaking power and base power are not differentiated, despite the fact that meeting peaking requirements entails enhanced additional costs due to more wear and tear of the machinery. Regulators need to introduce differential tariff structures for peak and off-peak tariff, suitably compensating hydropower for its ability to meet peak demand.
Extending the scope of existing ancillary services	The current ancillary services market is limited to frequency support only. Given the onset of renewables in the power system, the scope of the existing ancillary services needs to be extended. The government and Regulators need to explore the requirements for extending the ancillary services market to include spinning reserves, voltage regulation, black start, etc. Additionally, the ancillary services market mechanism should be suitably modified to compensate pumped storage plants for both the 'generation' and 'pumping' modes of operation.
Separate hydropower purchase obligations (HPOs)	The EFC recommendations provide for HPOs as part of non-solar RPO obligations of DISCOMs. This categorisation of hydro with other non-solar sources such as wind imposes possible restrictions on the total hydropower offtake. A separate HPO with a clear mandate for hydropower procurement will help ensure greater offtake from hydropower projects.
Bundling of energy from variable renewable sources with hydropower	Support in the form of bundling of expensive solar power with cheaper thermal power in the past has helped ensure the offtake of once costly solar power, thereby aiding solar growth during the initial phase of its introduction. Pooling of hydropower with other renewables sources of power such as solar projects may be explored by the government in a fixed ratio of say 4:1, as an interim measure. Apart from ensuring hydro offtake, this mandate will improve the competiveness of bundled hydropower prices.

Incentives for the hydropower sector in the United Kingdom

The importance of hydropower is recognised globally and is evident from the policy and regulatory incentives bestowed on the sector. In the United Kingdom specifically, hydropower is considered in the category of renewable power (including large hydro). The hydropower sector is eligible for:

Feed-in Tariff (FIT): Fixed income on all generation with no need to enter into complex commercial negotiations. The FIT also gives a guaranteed minimum income for electricity not used on site, although projects are free to seek better prices elsewhere.

Renewables Obligation (RO): Obligations on licensed electricity suppliers to source a proportion of their electricity from renewable sources. Renewable generators receive Renewables Obligation Certificates (ROCs) for each MWh of electricity generated, and these ROCs can be sold independently of the electricity generated.

Contract for Difference (CfD): It is a contract between a low-carbon electricity generator and the Low Carbon Contracts Company (LCCC), a government-owned company. A generator party to a CFD is paid the difference between the 'strike price'—a price for electricity reflecting the cost of investing in a particular low-carbon technology—and the 'reference price'—a measure of the average market price for electricity. The CfD is supposed to replace ROs for new schemes by 31 March 2017.

The hydro projects also get additional benefits in the form of exemption from levies like Climate Change Levy (CCL) and Carbon Price Floor (CPF), which are applicable to fossil fuel power generation.

Source: Department for Business, Energy & Industrial Strategy, Government of UK

Incentives for peaking run-of-river (PRoR) and reservoir projects in Nepal

In order to incentivise hydropower developers in Nepal to build more peaking power plants and increase generation during the dry season, specifically to meet the seasonal deficits, the Government of Nepal has introduced a new tariff regime for PRoR and reservoir hydro plants.

While prior to the introduction of these rates, the generation tariff for the dry season in Nepal (December–May) was 8.4 NPR/unit and for the wet season (June–November) was 4.8 NPR/unit, the revised tariffs are:

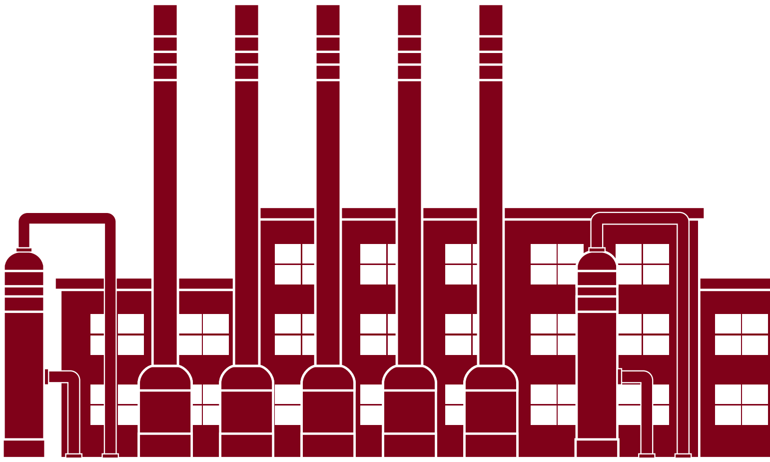
For PRoR schemes:

- Dry season: Subject to developers generating a minimum of 30% of their total annual generation during the dry season, the maximum generation tariff is set at 10.55 NPR/unit.
- Wet season: 4.8 NPR/unit

For reservoir schemes:

- Dry season: Subject to developers generating a minimum of 50% of their total annual generation during the dry season, the maximum generation tariff is set at 12.40 NPR/unit.
- Wet season: 7.10 NPR/unit

Source: Ministry of Energy, Government of Nepal



Investment facilitation

Considering the various risks and uncertainties innately associated with hydropower development, optimum risk allocation mechanisms between the various stakeholders are necessary to attract requisite investments into the capital-intensive hydropower sector. The key focus areas to facilitate investments in the hydropower sector are:

Streamlining of land acquisition and clearances processes

- In order to overcome the existing issues and delays concerning land acquisition, the public private people participation model may henceforth be adopted for hydropower projects. Under this model, land acquisition would primarily be the responsibility of the government, with the ownership and control of the land vesting with it. Apart from preventing any misuse of land by the developer, the model will help garner better acceptance from the original landowners.
- In order to avoid delays in land acquisition due to non-availability of land records, the government may provide land record data at the detailed project report (DPR) preparation stage itself, thereby assisting in the preparation of bankable DPRs. Furthermore, in order to ensure a time-bound land acquisition system, an appellate authority may be created to ensure just and effective implementation of land acquisition within a stipulated time frame, with directions of the authority being legally binding.
- Many hydropower projects have encountered significant delays, leading to avoidable cost overruns on account of PILs filed in the NGT and courts, sometimes even after the necessary clearances have been accorded. In this context, the possibility of including the NGT in the environmental and forest appraisal committees may be explored.
- The e-flow requirements of 20-25-30% of river discharge in different seasons have adversely affected the viability of many projects. E-flows of a project, which are important determinants of the project capacity, may be firmed up on the basis of comprehensive scientific studies and as per the natural hydrological data of the river flows.

Incentives for increasing financial viability

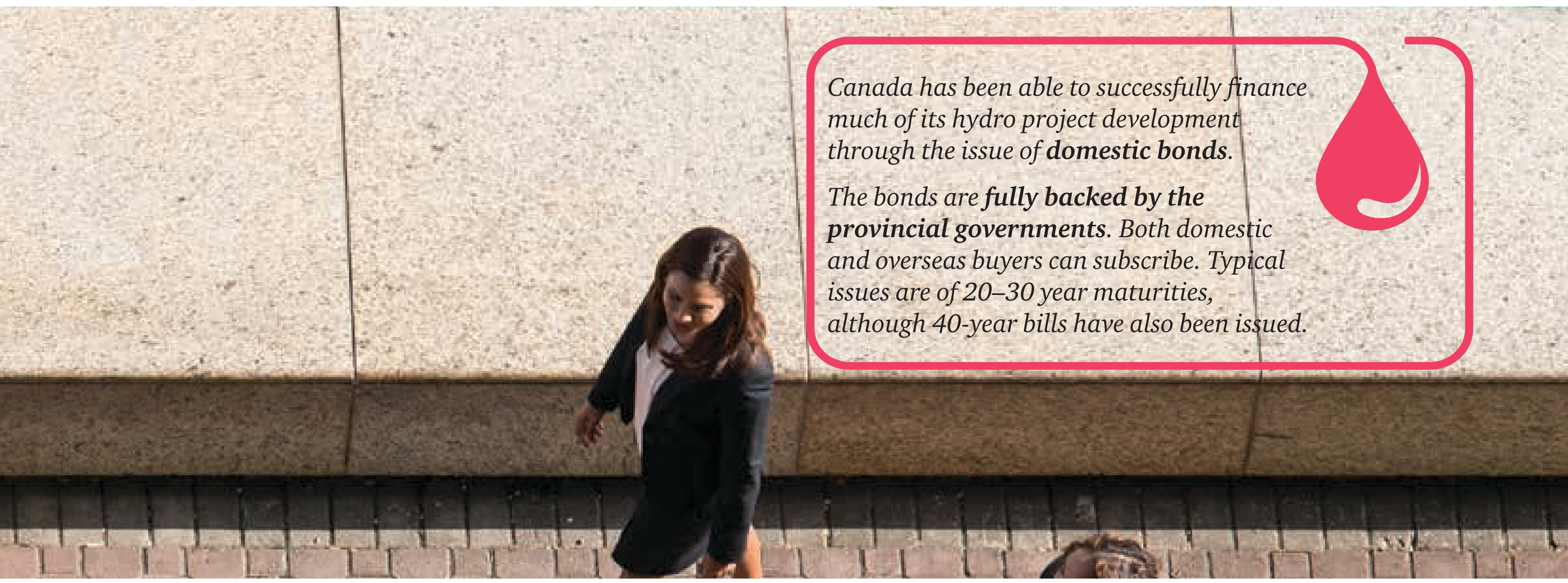
- At present, hydropower developers are mandated to provide the government free power as royalty and additional funds for local area development, which significantly impacts project viability and leads to cash flow problems, especially in the initial years of operation. In such a scenario, deferment of free power for the initial years of loan repayment will help in better cash flows and boost project viability. This option could be explored on a case-to-case basis, based on the results of preliminary viability studies of the project.
- Section 80I (A) of the Income-tax Act, 1956, provides for tax holidays on the income generated from infrastructure projects (including power projects). However, this incentive is available until 2017. Extension of this benefit will aid in improving the viability of projects under implementation and also aid in streamlining the flow of investments.
- Currently, there are several commissioned projects for which PPAs have not been signed with distribution licensees due to higher tariff levels. In order to avoid these assets being categorised as non-performing assets (NPAs), the government may also explore the possibility of extending the ambit of the EFC proposal to some of these projects.
- It is suggested to reintroduce the Mega Power Benefits for Hydro Projects, which were withdrawn in the year 2012. With this, the benefits of custom duty exemption on import of capital equipment and deemed export benefits accorded as per the EXIM Policy would again be available to hydro projects.

- Possible amendments to the existing tariff determination regulations may be explored to increase the set useful life of hydropower projects to beyond 35 years based on project type, namely RoR, storage and pumped storage. This step, along with the rationalization of O&M and RoE rates, will help in improving project viability.
- Waiver of interstate transmission charges with a sunset clause in line with the waiver available to renewable power could be explored.
- Waiver/reduction in ad valorem charges/tax (LADF, entry tax, labour cess, excise duty, work charge tax, etc.) in respect of project equipment and on inputs such as steel and cement, in addition to exemption from GST for services used in relation to hydropower projects, shall significantly reduce project cost and consequently help in reduction of hydro tariffs.

Innovative financial products

Considering the large capital requirements and relatively longer gestation period of hydro projects, there is a requirement for specialised financing solutions. Going forward, some of the options that may be considered in this regard are:

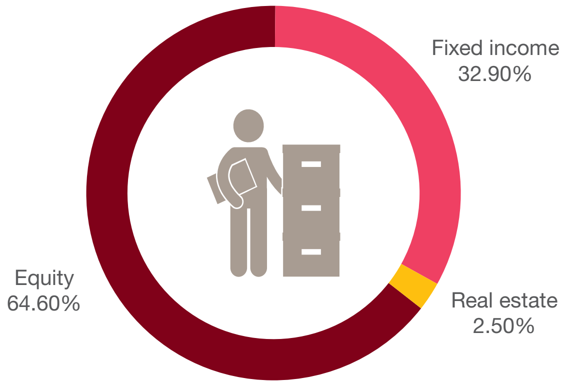
- Necessary interventions from the government and RBI are advised to revise financing policies for hydro projects and provide concessional and long-term debt of 25–30 years. In order to reduce the risk premiums on financing charges, minimum equity infusion by developers (say 50%) may be made mandatory before any loan disbursement.
- Risks relating to geology, construction, terrain and hydrology, which can have large-scale implications on project development, are usually mitigated after commissioning of dam (CoD) of hydro projects. Under such a scenario, FIs, along with a consortium lenders, may explore extending loans with a tiered interest rate structure, with substantial interest rebate on long-term loans post CoD.
- To ensure availability of financing for hydro projects, the possibility of setting a minimum exposure of lenders/FIs to hydro projects, to the tune of 30–40% of their total funding to the power sector, may be explored. This measure, coupled with the restoration of the exemption of tax for interest income of FIs under section 10(23)g of Income-Tax Act, 1961, which allowed exemption of tax on the interest income earned by FIs from hydro projects (and other infrastructure projects), will, apart from incentivising FIs, enable financing at concessional rates to hydro projects.
- Considering that large storage and pumped storage schemes require greater investment and have longer gestation periods as compared to RoR schemes, it may be prudent for this category of project to be developed primarily by state-/government-controlled companies. For such projects, financing through government-backed bonds may help in meeting a portion of the consolidated debt requirements of projects.
- Creation of a specialised hydro fund/special hydropower financing scheme (for all future projects, not only for those under the purview of the EFC recommendations) will help in financing hydro projects by ensuring a dedicated, long-term stream of funds.
- Issue of tax-free bonds, green bonds, etc., similar to the first issue by NHPC Limited in October 2013, which found great traction in the domestic capital market, needs to be increasingly encouraged. In addition, the possibility of channelising pension funds for long-term funding of the hydro sector, primarily in the public sector, will also help in meeting the consolidated investment requirements of hydro projects.



Canada has been able to successfully finance much of its hydro project development through the issue of ***domestic bonds****.*

The bonds are ***fully backed by the provincial governments****. Both domestic and overseas buyers can subscribe. Typical issues are of 20–30 year maturities, although 40-year bills have also been issued.*

Government Pension Fund Global, Norway



The Government Pension Fund Global, Norway, is the sovereign fund of Norway, sourced by surplus proceeds from Norwegian petroleum income. This fund is managed by Norges Bank Investment Management (NBIM) and invests heavily in the domestic and global hydropower sector. Apart from equity investments in large projects, such as those being developed by GDF SUEZ and Eletrobras, this fund also invests in in corporate bonds issued by hydro companies.

Increased development of pumped storage schemes and technical capacity augmentation

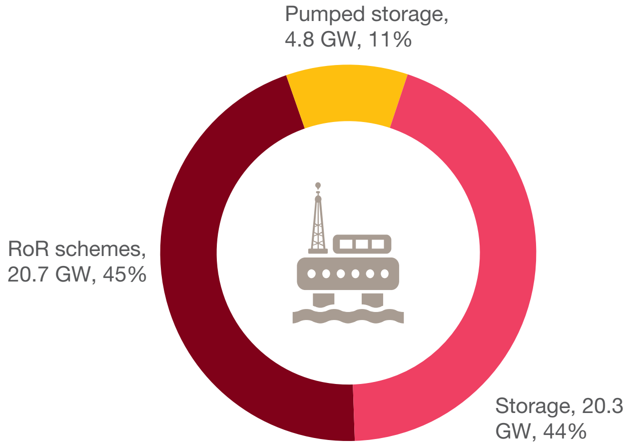
While presently, run-of-river schemes still account for a significant portion of the total installed capacity, the number of storage and pumped storage schemes in the overall hydro mix has also increased, particularly in the last two decades.

Although all hydro schemes are, by design, able to provide balancing and ancillary support to the grid, pumped storage schemes, by virtue of their capabilities to store and regulate water flow, also serve as a 'natural' power battery, thus enabling better support for renewable integration. Pumped storage schemes are also more environmentally friendly when compared to toxic and polluting Li-ion and lead acid batteries, which are some of other popular storage solutions.

Pumped storage schemes have a higher capital cost compared to other storage solutions. However, in terms of levelised cost of energy (LCOE), which takes into account the entire project life cycle, O&M costs, fuel costs among other factors, pumped storage schemes, they compare favourably to the other storage technologies.

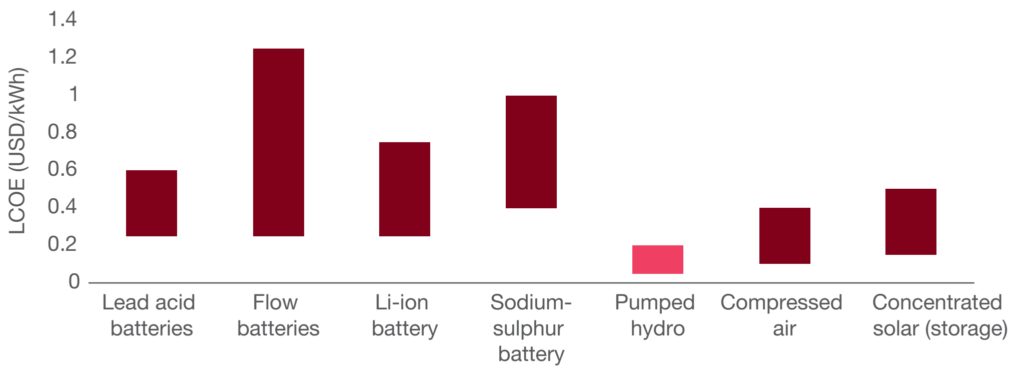
With the impending addition of large scale renewables in the power mix, greater number/capacity of pumped storage schemes needs to be developed.

Hydropower schemes (April 2017)



Source: CEA

Energy storage technologies in terms of LCOE (USD/kWh)



Source: IRENA, AECOM Technology Corporation, 2015

- To begin with, necessary guidelines for the development of pumped storage schemes need to be framed. These guidelines, apart from forming the roadmap for pumped storage development on the basis of required balancing services from hydro, may suitably include incentives for the development of pumped storage schemes in India.
- Simultaneously, opportunities need to be explored to manage the storage capacities of existing reservoirs by raising dam levels/other parameters. Also, the possibility of providing greater interconnection between reservoirs to overcome regional inflow variabilities also needs to be explored. These options have the twin benefits of being more cost-effective and involving lower environmental impact as compared to the development of a new pumped storage scheme.
- Furthermore, the option of converting existing storage run-of-river schemes into pumped storage schemes through planned upstream and downstream retrofitting also needs to be evaluated from a technical and financial feasibility perspective.

Pumped storage hydroelectric schemes in China

Considering the importance of storage systems, both in terms of balancing renewables and ensuring water security, the Government of China has mandated at least one pumped storage in each province of the country. In line with the increasing rate of renewable capacity addition in China, particularly from wind and solar, the government, in its 13th FYP (2016–2020), has committed to the introduction of 17 GW of pumped storage capacity, which is expected to result in 40 GW of pumped storage capacity by 2020.

The Chinese government plays an active role throughout the life cycle of pumped storage schemes, with planning/ inception of pumped storage schemes being done mainly on the basis of provincial power grid or regional power grid requirements. Similarly, site selection is done in a way that ensures reasonable layout for the pumped storage power station. The provincial governments also facilitate the development of pumped storage schemes by provisioning financial and social capital for pumped storage development.

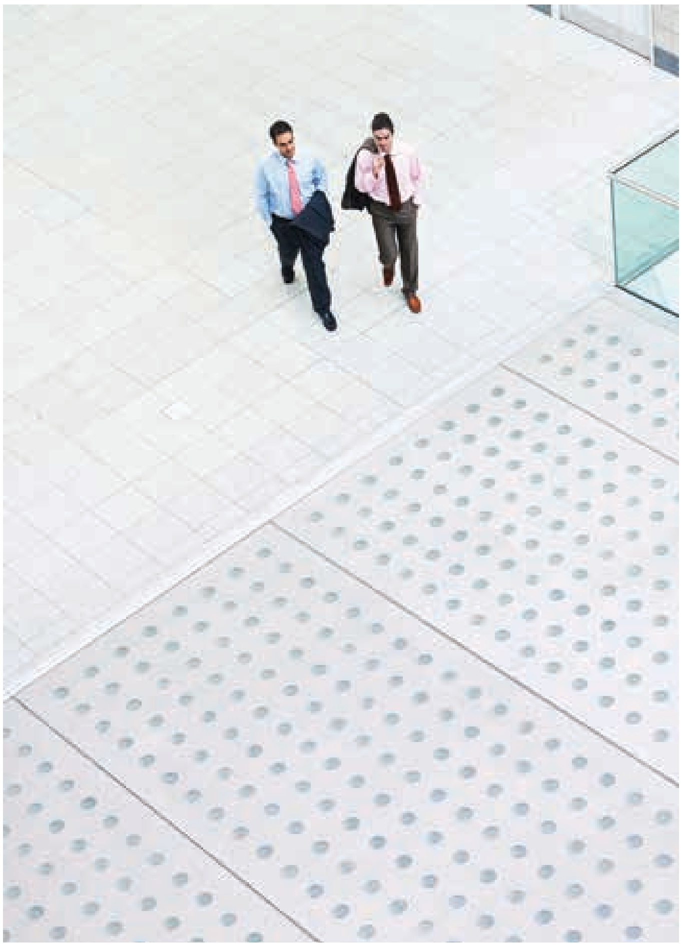
For example, East China Electric Power Group's Tianhuangping pumped storage plant, which is the biggest pumped storage project of Asia, with installed capacity of 1800 MW, received partial funding from the Shanghai, Zhejiang, Jiangsu and Anhui provinces of China.

Source: World Hydropower Congress, Renewable Energy Storage 2016

Norway, which is home to roughly half of all the hydroelectric water storage reservoirs in Europe, is currently exploring the option of modifying its existing hydro infrastructure through retrofitting and upgrades, which will allow faster filling and drainage of reservoirs.

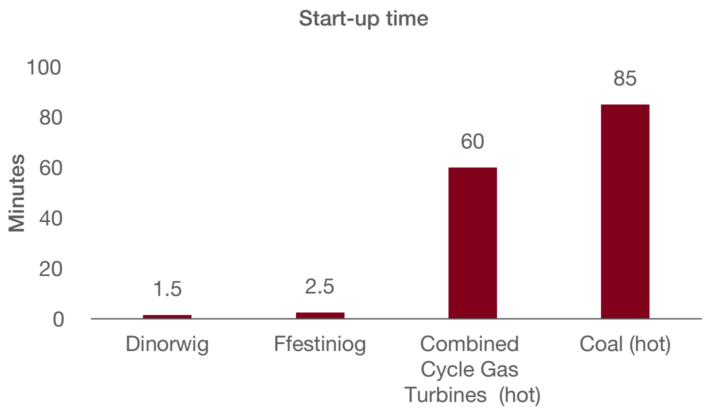
If these upgrades are approved, it is estimated that an additional 20 GW of pumped storage hydropower capacity will be available to Norway in the next 5–10 years.

Source: Centre for Environmental Design of Renewable Energy (CEDREN), IHA



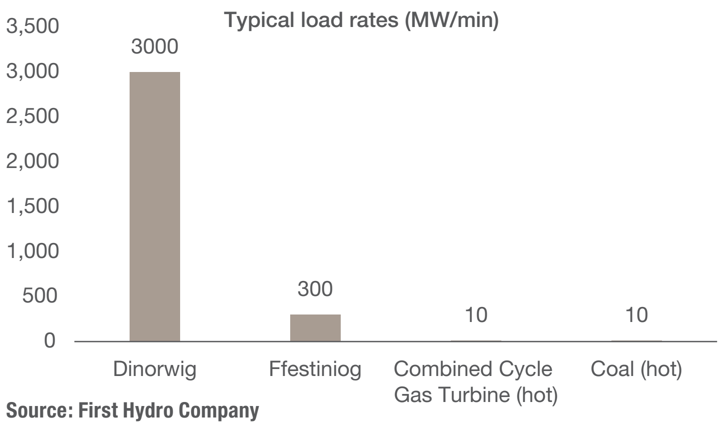
First Hydro Company, UK

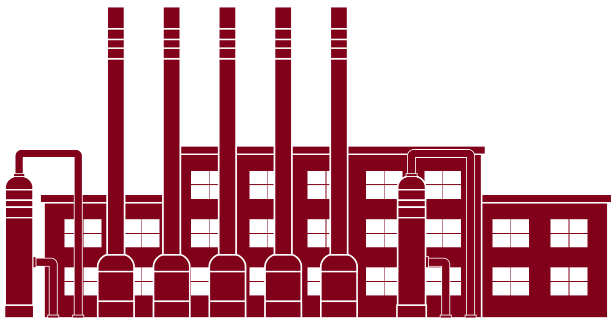
First Hydro operates the pumped storage plants at Dinorwig and Ffestiniog in the Snowdonia region of Wales. The ancillary service advantages of having hydro capacity and the reasoning behind providing incentives to such projects become clear from the following statistics:



First Hydro plants: Dinorwig (360 MW; .3 GWh) and Ffestinog (1728 MW; 10 GWh) serve the UK ancillary services market through:

- High reliability and availability, with over 25,000 mode changes per year
- Dinorwig full output <15 seconds; and Ffestinog full output ~60 seconds





Source: First Hydro Company

- In-addition to the above, since ramping support will be of special importance going forward due to flexible generation requirements, 'wear' and 'tear' of hydro assets is likely to be an important developer concern. In order to adequately address this concern, developers need to increasingly leverage the technical expertise of select hydropower developers in the world and embrace new technological advancements in the sector. The role of the Government of India in achieving this is particularly important, as the formulation of technology transfer and knowledge-sharing modalities will need to be initiated first through bilateral government-level discussions.

With the use of adjustable variable speed turbines, the rotational speed of the pump-turbine can be controlled. This enables frequency regulation support, both during generation and the pumping mode. In addition, the turbine operating range can be adjusted using just the currently available amount of energy, thus enabling enhanced grid stabilisation.

Le Cheylas, a pumped storage project located in France and with a rated capacity of 480 MW, was commissioned in 1979. Operated by Électricité de France (EDF), the project is being upgraded from fixed speed to variable speed in order to adapt to the new market requirements.

Source: Voith, EDF

Safeguard strengthening and enhanced benefit sharing

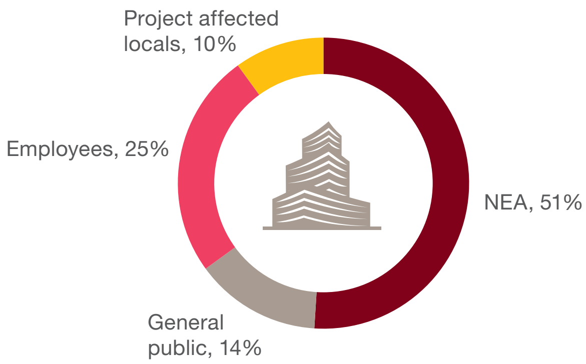
Since the overall benefits associated with hydropower development are often unevenly distributed, benefit-sharing mechanisms and mitigation measures are critical for ensuring responsible and sustainable hydropower development. With regard to the unique challenges being faced by the hydropower sector, the following strategies need to be adopted:

- Developers need to broaden their existing performance evaluation criterion as hydropower generating utility by adopting a 'triple bottom line' approach—accounting for social and environmental performance in addition to measuring the financial value created by them.
- Furthermore, the existing mechanisms for benefit sharing, which currently seem to concentrate more on royalty benefits, need to be revised and strengthened to find an optimum balance for distribution amongst all stakeholders. Provisioning of 'local shares', for instance in hydropower projects of Nepal, provides a mechanism for locals to become active 'co-investors', thereby enabling developers to obtain a 'social license' to develop and operate their projects. Moreover, it opens up the possibility of perpetual and direct enhanced financial returns in the case of successful projects.

Local shares as a benefit-sharing mechanism in Nepal: A case study of Chilime Hydropower Company

In Nepal, the provisioning of local shares is a legal requirement for public companies which harness natural resources (as per the amended Securities Registration & Issue Regulation, 2008), requiring 10% of the total 25% equity dilution to be marked for locals. However, in the past, strong political support and good response to this benefit-sharing mechanism has also encouraged private companies to offer a portion of their equity as shares to local people. The recent model project development agreements (PDAs; applicable for all hydropower projects with installed capacity of less than 500 MW) formulated by the Ministry of Energy provide flexibility to locals to purchase up to 10% equity shares in the project company.

Chilime Hydropower Company, a public listed company, is often cited as a success story in the effective use of local shares as a benefit-sharing mechanism.



Commissioning	Aug 2003
Initial public offering	March 2011 (9 years after COD)
Offer price to highly affected locals	100 NPR (Par value) (~ 1 USD)
Offer price to affected locals	408 NPR (~4 USD)
Share price returns	18%
Dividend	Yearly dividends since offer, dividend per share in FY16: 10.5 NPR/share

Source: Chilime Hydropower Company Limited

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