

# Sustainable Energy : Is Hydropower the Answer?

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## 1. Background

Hydropower is viewed as the cornerstone of the Bhutanese economy, contributing to 14 percent of GDP and 26 percent of the annual revenue. India is Bhutan's major partner in developing its hydropower resources, and co-operation in this sector symbolises the mutually beneficial nature of Bhutan-India relations. Electricity exports to India contribute a major chunk of INR earnings for Bhutan. India benefits from access to reliable and affordable electricity from Bhutan while avoiding social and environmental criticism surrounding India's hydropower.

In Bhutan, it is hydropower that pervades in the minds of most people when there is talk about electricity or energy. In terms of the overall energy usage, electricity from hydropower constitutes 28 percent of the total energy consumption. Of this energy from electricity, 21 percent is consumed by energy intensive industries, with household and institutional consumption accounting for only 7 percent. Biomass, or the cutting of trees to be used as firewood, continues to be the largest contributor of energy at 36 percent. A rising and disturbing trend is the use of imported petroleum products that now constitutes 21 percent of Bhutan's energy consumption.

With global warming and climate change, there are concerted efforts being made worldwide to promote energy from renewable resources. Solar and wind are fast becoming major sources of electricity with some countries passing policy decisions to pay more for renewable energy. Hydropower is also gaining more acceptance as a renewable energy resource, despite controversies over large dams and reservoirs, with social and environmental concerns getting mitigated. The versatility of hydropower in balancing weather dependent solar and wind energy and the changing patterns of energy consumption make hydropower a very practical energy alternative.

Bhutan has a huge 30,000 MW of hydropower potential. Until the last decade, Bhutan had pursued a measured pace of developing this "white gold" resource. As electricity boosted socio-economic development and brought in substantial revenue,

there was a heightened sense of urgency to accelerate the harnessing of the abundant hydropower resources. By 2008, Bhutan and India had agreed to cooperate in developing additional capacity to generate 10,000 Megawatt (MW) by 2020. There was renewed enthusiasm as the two countries worked towards this target. Bhutan envisioned itself becoming self-reliant while India's energy-hungry market saw an abundance of affordable, reliable and clean electricity.

The decade starting 2008 saw many activities in accelerating the pace of hydropower development. Three mega projects aggregating 2,940 MW through Inter-governmental (IG) collaboration between Bhutan and India and one 600 MW project as a joint venture (JV) between public sector units of the two countries are in various stages of construction. A limited investment avenue was opened to the private sector through the 126 MW Dagachhu project. A few other projects are in the pipeline. However, the pace is far behind what is required to reach the target of generating 10,000 MW by 2020.

## **2. Emerging Issues from Accelerated Hydropower Development**

In recent years, the significant delays in the ongoing Punatshangchhu I and II mega IG projects due to geological surprises and huge cost escalations have raised a lot of concerns in both Bhutan and India. The difficulties faced and time taken to resolve a wide range of issues with the first JV project between Bhutanese and Indian public sector units have also highlighted the perceived long-term adverse impact of fast tracking hydropower development. There is growing public concern and criticism of hydropower planning and implementation despite the immense economic benefits.

A more pressing issue is the question of sustainable energy and energy security as nations prosper and the demand for energy grows. This could determine the future course of harnessing Bhutan's hydropower resources for which Bhutan needs to address the emerging criticism and questions. These criticism and questions range from whether Bhutan can sustain the pace at which hydropower development is being pursued, service the debt burdens, gain access to energy markets, and mitigate adverse social impact and environmental degradation. An even more basic question emerging in the minds of many is whether, in the haste to develop its hydropower resources for economic growth, Bhutan is overlooking the very fabric of its development philosophy of Gross National Happiness, which commits Bhutan to protect its pristine environment, cultural heritage, sustainable economic development, and good governance.

As Bhutan's most important partner in developing its hydropower resources, India has funded almost all of Bhutan's hydropower projects and transmission systems through a mix of grant and debt financing. However, the grant component has been declining over the years while the debt component has been increasing. The interest rates on the debt component have also been on the upward trend putting higher debt servicing risks on Bhutan. More recently, it has been suggested that the partnership has evolved from one of assistance to one of interdependence. Nevertheless, the role of the Bhutanese in the management of these projects has remained almost the same as it was when Chukha was conceived in 1974. While competencies have been built among the Bhutanese in the operation and maintenance of power plants, Indian entities continue to dominate in the construction and supply of equipment for the projects. Consequently, much of the investment in the hydropower sector continues to flow back to India.

Global warming and climate change are also eliciting questions on the sustainability of the water resources that feed the hydropower plants. Glaciers are fast disappearing and snow lines are receding even faster. As Bhutan endeavors to preserve its rich biodiversity and avert environmental and ecological imbalances, there are emerging concerns on the adequacy of the social and environmental impact assessments and the proposed mitigation measures. Geological surprises and the more frequent incidences of earthquakes and other natural disasters are also setting off alarms on the safety of the dam and other hydropower related infrastructures and the probable impact on downstream habitats and habitants in case of catastrophic failures.

The 2014 SAARC framework agreement for energy co-operation and the emerging Bangladesh Bhutan India and Nepal sub-regional understanding on sharing of energy resources are expected to liberalise the electricity market. While India will continue to be Bhutan's major partner in developing its hydropower resources and electricity trade, other energy markets such as Bangladesh are likely to emerge through regional co-operation. This will not only open new markets but has the potential to bring financing into the sector, thus making tariffs more competitive.

With increasing reliance on the hydropower sector, here is also a growing concern regarding the risks of "putting all the eggs in one basket". More and more, there is an appreciation for the need to diversify the Bhutanese economy with hydropower as a strategic enabling resource. Diversification into industries and other end uses could also add value on some quantum of the electricity that would otherwise get directly exported.

### 3. Strategic Considerations for Bhutan's Hydropower

Based on its plans in the hydropower sector, Bhutan projects its GDP to grow at the present rate of 6-7 percent. Bhutan could, therefore, expect to achieve its target of becoming a middle income country within the first half of the next decade. Bhutan should also be able to meet its domestic electricity demand well into the later part of the next decade even considering a high growth projection in the industrial sector as was experienced on commissioning of the Chukha and Tala projects. However, considering the recent spate of criticism and the concerns, there is a growing need to review and re-strategise its policy of accelerated hydropower development.

Bhutan's Electricity Act and the Sustainable Hydropower Policy are already under review and a strategic hydropower road map is being formulated. As Bhutan reviews the investments and hydrological risks, considers evolving energy markets, and plans for sustaining the sector, there is this window of opportunity to incorporate the development philosophy of Gross National Happiness in the future hydropower plans.

#### 3.1 Investment Modalities

No matter how the energy markets evolve, India will be the primary market for Bhutan's surplus electricity. Therefore, the financing arrangements with the Government of India are expected to continue to be the preferred mode, with the exception perhaps of some of the smaller projects as in the case of Dagachhu and Nikachhu. If more favourable financing options emerge, it will benefit both Bhutan and India through competitive tariffs.

The IG mode of co-operation between Bhutan and India on the Chukha, Kurichhu and Tala projects has proved to be highly successful and mutually beneficial. This is considered a model of co-operation that other countries could emulate. Bhutan has benefitted through the India's investments. India has benefitted from access to clean energy at competitive tariffs while avoiding social, environmental, and political controversies that appear to be quite common to hydropower projects in India. The three mega hydropower projects, aggregating 2,940 MW, that are being presently implemented under the IG mode are, except for some unexpected geological surprises, proceeding without any further problems. On the other hand, the implementation of the Kholongchhu project in the Joint Venture (JV) mode is turning out to be difficult and challenging and the project is yet to get off to a good start. The JV mode could undermine the exemplary and friendly Bhutan-India

relationship if sensitivities on both sides are not respected.

While India has been suggesting that the Joint Venture mode puts less pressure on investment requirements, the ease of implementation and the lower tariffs under the IG mode could offset much of the initial investment difficulties. While the nomenclatures differ, it is ultimately the Government of India's funds under both IG and JV modes of financing. The IG mode of financing has been very successful and it has generated a lot of goodwill for India. For Bhutan, the IG mode has proven to be the preferred financing mode for its hydropower projects.

### **3.2 Social and Environmental Concerns**

Having achieved just under 100 percent grid coverage of electricity, the use of firewood as a fuel alternative is on the decline. Domestic generation is able to meet domestic demand, limiting energy imports to system requirements only. However, use of petroleum products is on the rise with the dramatic increase in the number of motor vehicles and growth in the transportation sector, mainly on account of the hydropower projects under construction. To offset dependency on imported petroleum products and to remain committed to carbon neutrality, Bhutan could lead the way in introducing electricity and solar technologies, especially for mass transport systems.

A proliferation of projects across the country to achieve the 10,000 MW by 2020 has raised many social and environmental concerns among the Bhutanese. The lives of those living in the vicinity of the projects are disrupted by the huge influx of expatriate labour, noise and dust pollution, damaged roads, and traffic congestion, albeit tempered by some economic opportunities and better access to basic amenities. Projects need to be more sensitively integrated to the livelihood and living environment of the local communities.

The controversies over large dams and reservoirs and their impacts continue. There is a need to better understand the overall impact of damming the rivers that could forever change the fragile ecosystems in Bhutan's river basins. More studies and analysis of the social and environmental impact of hydropower projects on the entire basin catchment areas are now being advocated rather than limiting such studies to the areas specific to the projects.

More recently, there have been suggestions to opt for micro and mini hydropower plants as more sustainable alternatives. However, small hydro is not always cost

effective considering economies of scale. Small hydro has succeeded mostly where grids have not reached or where electricity tariffs are high or where Government/communities provide subsidies. In the Bhutanese context, where hydropower development is primarily considered for export revenues, it would be better to take up a few mega hydropower projects rather than a large number of micro and mini hydro schemes. The social and environmental issues would also be limited to a few areas if just a few sites are developed rather than a proliferation of small projects.

### **3.3 Emerging Energy Markets in India and the Region**

Electricity export tariffs have to remain competitive for Bhutan to access the Indian and regional electricity markets. Bhutan has so far been able to implement most of the hydropower projects on time and within costs compared with similar projects in India, thus making the export tariffs competitive. The selection of projects for implementation are primarily based on the per MW cost of investment. Hence projects with lower per MW costs get considered for implementation first. The economies of scale have also ensured the comparative advantage of the large and mega projects over the smaller projects.

What is also emerging is an Indian energy market with a huge demand for balancing energy considering the huge investments that India has made in recent years to add solar and wind power capacity. Hydropower, with its quick start and stop capabilities, can provide such ancillary services for the Indian grid and kick in on short notice to generate peaking power. While the Indian energy market is yet to evolve into one that is fully market driven, the trade through energy markets that effectively price a premium for versatility in energy generation is expected to pick up.

Many of the mature energy markets in the world are finding hydropower to be an indispensable mix for the stability of their grids. These markets are now attracting huge investments in reservoirs and pumped storage schemes. Of late, India has also started making some policy changes to revitalise the hydropower sector which otherwise has come to almost a standstill, with large investments tied up in stranded mega projects, because of social and environmental concerns and political issues.

The likelihood of sub-regional co-operation in energy opens up the prospects of tapping the huge energy market in Bangladesh. The opportunities are immense for hydropower export to Bangladesh through India. Developing a hydropower project in Bhutan through a trilateral arrangement is already being explored.

In the long-term, the Indian and the regional energy markets are expected to evolve into a seamless energy grid with open access and competitive tariff mechanisms. For this to take place, the bilateral arrangements for energy transactions will have to be expanded to enable regional integration. Participating countries will then need to support a liberal energy access and trading environment. As India borders with all the countries in the region and no two other countries have common borders, India will have to take a lead in ensuring non-discriminatory transmission grids and access.

### **3.4 Water Security, Global Warming, and Climate Change**

Water availability is synonymous with energy, water and food security - all critical issues for the future of the region. With the huge growth in population, large parts of the region are already acutely short of drinking water. There is barely enough water to meet the irrigation requirements to grow more food to feed this growing population. The shortage of water is a looming crisis. Even in Bhutan, without proper distribution systems, the shortages in drinking water and water for irrigation can only get worse.

With global warming and climate change already upon us, there are apprehensions that the rivers in the Bhutanese Himalayas could dry up, thus posing sustainability questions for hydropower. Studies and forecasts, however, generally predict that the monsoons will be more severe and there could actually be higher hydrological discharges in our rivers in the long term future. Rainfall patterns and intensity may change and the region could instead be afflicted with more severe floods, endangering peoples' lives and submerging cultivatable land along the river valleys.

In keeping with these trends, and in order to cater to the evolving energy markets, many more reservoirs and pumped storage schemes are being built across the world. Reservoirs have multipurpose benefits - from water security to flood control, regulating energy generation, maintaining grid requirements, and generating livelihoods through tourism and fisheries - thus creating a lot more value for the water stored in the reservoirs other than just the revenues from electricity.

## **4. Re-strategising Policy for Sustainable Energy**

Bhutan is mandated, by its Constitution, to preserve at least 60 percent of its land area under forest cover for perpetuity. Fifty-one percent of the land area has already been declared as protected areas and parks. Bhutan has pledged to the world community

to remain carbon neutral, if not carbon negative. It is therefore unequivocally important that Bhutan's forests, the source of 36 percent of the domestic energy consumption, are protected and preserved. Making reliable and affordable electricity available at the doorsteps of each and every household will help reduce the usage of firewood for energy as has been the experience over the last decade or so.

Introducing electric buses and affordable mass transport systems and incentivising use of electric cars can also substantially cut down on the import of petroleum products, 100 percent of which is imported from India. Promoting clean technology industries by keeping electricity tariffs affordable can value add to the electricity that otherwise would be directly exported. Such industries can effectively become a sustainable alternative market for hydropower and also generate gainful employment for many Bhutanese.

Instead of proliferating the countryside with many hydropower projects with wide spread social and environmental impacts, priority should be given to develop a few of the larger mega reservoir projects. The economies of scale would make electricity tariffs of these mega projects highly competitive. Mega reservoir schemes such as the 2,585 MW Sunkosh and the 2,640 MW Kuri Gongri could become difficult to build in future due again to emerging social and environmental sensitivities. The opportunities as they present themselves now should be taken to develop these mega reservoir projects for their multipurpose benefits. While Bhutan would benefit from the higher firm power generation and the emergence of a pricing mechanism for ancillary services in future, India would additionally benefit from flood control and water security. These reservoir schemes would, in future, mitigate the impact of global warming and climate change on hydrological flow patterns and intensity of monsoons by regulating water storage and discharges from the reservoirs.

With the energy markets evolving and matured markets investing in pumped storage projects to act as “batteries” for their electricity grids, present day plans and designs for reservoirs and other hydropower projects should consider incorporating pumped storage capabilities wherever possible. As and when the future opportunities become available, the existing power plants and reservoirs could then be more easily converted to pumped storage schemes. This would safeguard and ensure more optimal and sustainable use of water resources now and also at appropriate times in the future.

The Indian and the sub-regional/regional energy markets are evolving and Bhutan must prepare to take advantage of these opportunities as they emerge. There is a need to work with the stakeholders, especially India, to ensure a free and liberal

non-discriminatory energy market that would ensure the optimal sharing of the scarce energy resources and for regional energy and water security. Such a free market mechanism would drive market based tariffs. While tariffs from solar and wind power are likely to keep falling, hydropower with its versatility and potential for ancillary services will fetch premium based market tariffs, thus ensuring the competitiveness of hydropower.

In a strategic sector like hydropower, Bhutan should continue to invest in and build competencies in the “water to wire” business of electricity, to become a leader in hydropower. It will also be important for Bhutan to be prepared to deal with the evolving energy markets in India and the region to take advantage of the emerging opportunities.

The current problems and issues facing Bhutan’s hydropower sector - from management to investments to energy markets – have raised many questions on the pace at which Bhutan is developing its hydropower resources. On the other hand, most economic indicators show that Bhutan will achieve the target of becoming an upper middle income country if the present GDP growth levels can be maintained, mostly through the ongoing hydropower projects. Co-operation in hydropower development plays an important role in the exemplary Bhutan-India relationship. It would, therefore, be very important to avoid any negativity in the collaboration in hydropower as it could spill over and affect the excellent friendly relations between the two countries.

There is, therefore, imperative for Bhutan to review the current pace and modalities of hydropower development. Hydropower is the answer to sustainable energy for Bhutan and Bhutan could also contribute to sustaining the energy needs and providing water security to the region. However, hydropower development should be at a pace and on conditions that Bhutan is comfortable. With above all, hydropower development should advance the development philosophy of Gross National Happiness in the context of nation building and Bhutan’s sovereignty and independence.