HYDROPOWER IN BHUTAN

EDITORIAL
Dieter Zürcher

Since the commissioning of the first hydropower plant in 1988, Bhutan has largely expanded its economy by exploiting its rivers for the generation of electricity through hydropower. Thanks to its geography, with the steep gradient between the Himalayan peaks and the plains of India, Bhutan claims a hydropower potential of about 30,000 Megawatt (MW), or double the currently installed hydropower capacity of Switzerland. So far, it has installed an electricity generation capacity of 2,326 MW (see table on next page). This falls short of high flying dreams and targets that were announced earlier but possibly offers better prospects to absorb the various consequences of this rapid expansion.

The off-budget investments in the hydropower sector are quite substantial compared to the small economy of Bhutan. For example, the costs for the 760 MW Mangdechhu hydropower project to be commissioned in 2019 are higher than the annual budget of the Government. These investments have undoubtedly benefitted Bhutan’s economy and contributed to the amazing economic growth over the past three decades. The income from electricity exports have substantially contributed to the national revenues and provided incentives to start new industries and services. This income also helped to finance the expansion of the education and health systems and to bring electricity to every community in Bhutan by 2016.

On the other hand, the relatively big investments in hydropower plants and transmission lines have also exposed Bhutan to new and severe economic and environmental risks and stress. Each year a big dam is delayed, the economy growth is reduced by 3-4%. In order to finance the schemes, Bhutan’s debt has continuously increased and stands at more than 105% of the GDP in 2017 (or around CHF 2.5 billion) and a big chunk is related to the investments in hydropower and borrowed from India, thus increasing Bhutan’s dependency on India.

The hydropower development was only possible due to technical and financial assistance from India and can be considered as a win-win situation overall. It provides big contracts for Indian companies and employment to thousands of Indian construction workers whereas almost 30% of the Government revenues in Bhutan stem from electricity exports today. However, the recent delays with Punatsangchhu I – which is delayed by several years due to geological problems – have resulted in massive cost increases making Bhutan’s electricity more costly and less attractive for the Indian market in the long run. Similarly, the negative consequences of the dam constructions on the so far undisturbed rivers are rising, especially among the tourism and river rafting community as well as among ecologists, who see the indiscriminate damming as risk to river eco-systems.
With regards to this fact the SSB board felt that it was time to look a bit closer into this engine of stunning economic growth as well as into its social and environmental consequences. We are glad to present a diverse portfolio of articles written by experts, who illustrate the achievements and perils of the hydropower sector from various angles. We would like to wholeheartedly thank all the contributors for this newsletter on hydropower in Bhutan.

Tashi Delek

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All photos presented here were taken by him during a visit to Bhutan in 2017

Source: Vasudha Foundation (2016): A Study of the India-Bhutan Energy Cooperation Agreements
HYDROPOWER IN BHUTAN: LIGHTS AND SHADOWS

Dr Günter Fischer

Bhutan is one of the fastest-growing economies in the world. However, as a resource-poor, landlocked, remote and small country, Bhutan had — and has — to shape a development path that is distinct from conventional models. The construction of hydropower plants and the export of electricity have been key elements of the economic transformation process that the country has been undergoing in recent years and are the base of its developmental success.

Hydropower capacity

The Bhutan’s hydropower sector has grown steadily since the 1970s. It dominates the economy in terms of industrial production, revenue generation, export earnings, and also in terms of share in the external debt. Moreover, it generates positive spill-over effects on other economic activities, such construction, mining and quarrying, and transport. In fact, Bhutan’s former Prime Minister Tshering Tobgay called hydropower the first among the country’s five economic jewels (the others being agriculture, tourism, cottage industries and mining). Benefitting from its geographical location in the Himalayas with suitable terrain and swift flowing rivers, Bhutan has one of the largest repositories of hydropower in Asia. The total hydropower capacity is estimated at 30,000 Megawatt (MW), of which about 24,000 MW are economically viable. Currently, the installed hydropower capacity amounts to 1,600 MW or 7 percent of the potentially usable capacity. There are several major hydropower projects currently operational in Bhutan (see table in the Foreword), all of which are run-of-river schemes. Once these hydropower plants have become operational – scheduled for the period 2020 to 2025 – Bhutan’s hydropower capacity will rise to 5,300 MW.

Additional projects, including reservoir dams with a larger environmental footprint, are in the planning phase. This includes the implementation of the Sunkosh project which is currently under discussion with the Government of India. With a planned capacity of 2,585 MW, it would be Bhutan’s largest hydropower project when commissioned in 2027/28.

While Bhutan’s domestic need for electricity is on the rise, most of the hydropower plants are built with a view to exporting electricity to India. India is not only the most important market for Bhutanese electricity, absorbing more than three-fourths of Bhutan’s hydropower output, but it is also the most important partner in pre-financing these projects through a combination of loans and grants.

Hydropower debt

Hydropower plants are long-term capital-intensive investments. Geological, climatic and technical challenges can cause considerable implementation delays and cost overruns. Moreover, increasing complexity and dimension of the projects add to their construction costs. Thus, while the Chhukha hydropower plant was completed in 1988 at a total cost of USD 34 million (about 3 times the initial estimate), the costs of the ongoing construction of the Punatsangchhu I hydropower plant have exploded from projected USD 540 million to provisional USD 1.3 billion. Since the grant component of the project funding provided by the Government of India declined from 60 percent to 30 percent over time, Bhutan’s indebtedness vis-à-vis India has risen. As of 31 March 2019, hydropower debt denominated in Indian rupee, amounting to USD 2.2 bn or 80 percent of Bhutan’s GDP, constitutes about 77 percent of the total external debt of Bhutan.
The mounting public liability has raised doubts about Bhutan’s debt sustainability. Critics point to the monopoly of India being Bhutan’s sole market for electricity exports and express their concerns about the risks of possible changes in bilateral and economic ties, geopolitics and market behaviour which could jeopardize the hydropower funding and debt service, as well as investment returns.

The Royal Government of Bhutan is aware of such concerns. It introduced measures to control the growth of external debt, including a cap on debt repayments for hydropower projects. At the same time, it emphasizes that – different from non-hydropower debt – the rupee debt is not subject to exchange rate risks and that India has agreed to buy all surplus power on a cost-plus basis, which means that hydropower debt is self-liquidating. In fact, the hydro power debt service coverage ratio, measuring the ability of the hydropower projects to meet hydro power debt service obligations from annual operating income, has remained well above the mandated threshold of 1.2 (meaning that annual income from hydropower projects must be at least 1.2 times their annual debt service obligations).

The RGoB also holds the view that strong political commitment in India for clean energy is expected to improve Bhutan’s external debt situation in the medium- to long-term future and that therefore the risk of debt distress is significantly reduced. This position is supported by the World Bank which concludes that “Bhutan has a moderate risk of debt distress due to the country’s hydropower debt” and “hydropower external debt is unlikely to lead to a debt crisis”.

The way forward

The hydropower sector will continue to be the main driver of Bhutan’s economic growth, the largest source of the country’s export revenue, and it will also play a major role in bringing about sustained improvements in human development and poverty reduction. However, the country is facing a series of related challenges, such as keeping public debt on a sustainable path and mastering the social and environmental impacts of the expansion of the hydropower sector. It therefore will not be sufficient to narrowly focus on enhancing the technical know-how of the country while neglecting the strengthening of institutional capacity to handle planning and implementation of hydropower projects in line with Bhutan’s overall development philosophy.

Dr Günter Fischer
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1 National Transmission Grid Masterplan of Bhutan – 2018, p. 3
2 In comparison, the capacity of all 1,365 hydropower installations in Switzerland totals 16,000 MW.
INTERVIEW WITH HIS EXCELLENCY LYONPO LOKNATH SHARMA, MINISTER FOR ECONOMIC AFFAIRS, who talks to Society Switzerland - Bhutan (SSB) about the government’s policy on hydropower in Bhutan

1. What is your government’s policy on hydropower in Bhutan?

I think the hydropower policy in Bhutan doesn’t necessarily change with the change of the government because it is understood that hydropower has so far been able to fund our health, education and other sectors. It is the hydropower that has brought our economy to this level, and we should not diminish its potential. Hydropower is a corner stone to the economy of the country. Therefore, the hydropower policy of our government might not be different to the policy of other governments.

However, we don’t have that rushing kind of policy where sudden “Mega Watt (MW)” should be achieved. There was an umbrella agreement in 2006, during which the target was set at 5,000 MW and it was revised in 2008 to achieve 10,000 MW by 2020. While we are also within that 10,000 MW initiative we have found out that it is not possible to achieve it within 2020. 5,000 MW by 2025 might be achievable. Back at the time we didn’t understand the complexities with mega-hydropower.

In a nutshell I would like to say we don’t have a different hydropower policy but what we have is that probably hydropower policy is not the only one but there should be other baskets, too. At the same time hydropower shall continue to be the corner stone of Bhutanese economy. However, there is no rush, that says we should achieve this many mega-watt by this year. We are within that range, but the only thing is that we want to go step-by-step and do what is best for the country, meaning “to go phase-wise.”

Currently certain hydropower projects are on-going and one is being completed and two are still under construction, and we have seen the difficulties with it. Therefore, before we introduce another hydropower project we should make sure that at least several mega-hydropower projects are not introduced at once, as this brings lots of difficulties with it, too.

2. During the election campaign, DNT said when it came to hydropower it wanted to focus on an approach of “Let’s go slow.” What does it mean for the on-going hydropower projects and for future hydropower projects in the country?

To be very precise, we didn’t directly say “Let’s go slow” but what it says is that we do understand, and not just us but the entire country has understood the difficulties with the mega-hydropower projects. And there are also geological surprises, which the citizens were never aware of before, when Chhukha, Tala and Kurichhu projects came. Back then, we thought that it was white gold and everything would be fine with hydropower, probably all our agriculture would stop and everyone get their pockets full. That was probably the concept. But with the mega-hydropower projects being introduced in parallel, there were lots of difficulties and mixed feelings amongst the people.

We just wanted to say that hydropower may be the cornerstone to the economy of the country but let’s go in a phase-wise process. For example, right now that one project “Mangdechhu” has been completed, maybe it is time to start another hydropower project and when this one is near completion then start another one. So we just want to say: do it phase-wise and not all of a sudden start several mega-hydropower projects in the country because it leads to micro economic difficulties, structural imbalances and affects the flow of Indian rupee currency, too.
When we started three of the mega-hydropower projects the geological surprises were unknown to us. We have seen the geological glitches with Punatsangchhu I and it has become a cancerous problem for us.

3. Does going slow or phase-wise as you mentioned mean reducing hydropower related debt?
It is again something that needs to be looked into more deeply if you see hydropower debt and the amount of funding or money that is necessary for the construction. Now, since we are aiming for the inter-governmental relationships and going for mega-projects like probably the next one “Sunkosh”, for instance, the amount required is heavy, too. Therefore, it necessarily doesn’t mean that the debt related to hydropower will be reduced by going phase-wise or slowing down. Still, it might stabilise slowly because it will not be like, “starting together two to three projects at once”. Rather, if we start another project when one is near completion that would fill up some of the vacuum. Therefore, the debt would not be so distressful. If we start several mega-projects at once, the debt will be worrisome. We would like to see the matter from that angle, too.

4. What does “going slow” mean for the ongoing hydropower projects?
With regards to the ongoing projects, we are 100 percent committed to complete them as early as possible but at the same time with quality. This is because the hydropower projects once completed should serve the country for another 80 to 90 years. If difficulties arise in between, we don’t have adequate expertise. Also the financial burden will possibly also increase because the projects are not small. We are already facing some kind of difficulties with “Tala”, which is showing the need of heavy maintenance. Similarly, this government and particularly as a chairman of some of the hydropower projects, I have repeatedly said that we cannot be slow in the on-going hydropower projects. We should take up all possible solutions to resolve the pending problems and complete them as early as possible. So that it would be beneficial to both countries. Furthermore, these hydropower projects should not be seen as being pursued merely for the sake of relationships, but more than that it is the commercial aspect that should be considered and carried out by the management in a very diligent and dutiful way. Therefore, we are really committed to bringing all the ongoing hydropower projects to completion as early as possible.

Except for Punatsangchhu I, the rest of the on-going hydropower projects are moving fine on time. Mangdechhu is completed and Punatsangchhu II is moving forward well on time.

I have visited the on-going projects several times and even requested the power secretary of India to visit the Punatsangchhu I site, so that he understands the difficulties. I have asked for holistic solutions to the problems because we cannot go on in the same way. The issue with Punatsangchhu I is not the right-side dam alone, it’s the highway above and the hillock above where many settlements are located. We cannot be negligent of all those things. This has become a cancerous matter and we are really committed to take out the tumor. I am waiting and hope that within a few months we will try to solve Punatsangchhu I problems.

I think the wait-and-see approach should be over. During the last four or five years not much could be done. We do understand that we are fighting with nature and geological problems but we should now move forward in some way or another.

5. How are the too many delays and cost escalations of Mangdechhu and Punatsangchhu projects affecting Bhutan’s economy (tax revenues, employment, etc.)?
Delays and cost escalations do affect the economy. It is also
true that hydropower project constructions usually do not create direct employment opportunities in the country, but the ancillary hydro-related sectors such as Druk Green Power Corporation (DGPC), Bhutan Power Corporations (BPC) and others, if taken into consideration, then growth of employment is there. If we do not take up mega-hydropower constructions, probably these offices would not be as big as they are now. In addition, some hydro related constructions are also generating work.

It is also because most construction workers were hired from outside Bhutan since we have not developed that capacity. However, we are slowly within view of really concentrating on building such capability inside the country. Therefore, DGPC is involved in these projects throughout, and similarly we would now like to involve Construction Development Corporation Limited (CDCL) as well, so that they could build in-country capacity.

When it comes to delays and cost escalations, there is an enormous burden on the country because the interest of the money borrowed, which Bhutan will have to pay back later, increases with the costs. There are lots of other imbalances as we have to involve our resources for longer and there are also lots of stabilization methods that cost extra money. When the projects are not able to commission on the envisaged timeline, it also affects the country’s GDP.

Every successive government has made every effort to complete these projects on time. However, some of these problems are very technical in nature and mostly related to geological problems.

6. How do you see the current dependency on India in the hydropower sector and the future trend?

I would rather see this as inter-dependence between, India and Bhutan. The Indian government has given us with the knowledge that we have potential resources for hydropower generation, and we saw huge market potential in India. Thus we are still not worried about the market for Bhutan’s electricity.

When it comes to inter-dependence, India needs power and we need financial support. It is not possible for Bhutan to manage alone. For example, with “Sunkosh” coming up, the project will be more than 2,000 Megawatt, and it would cost more than hundreds of billions Ngultrum for Bhutan. To take up this money from our resources would be difficult. It is a win-win situation. India is helping us with a grant as well as with equity. If we go to further developed countries, there might be better technologies and better ways to construct such projects. However, as we are landlocked nearest to India and share most borders with them, it will be difficult for us to directly introduce other countries’ technologies. We should look at the matter from a realistic point of view. Therefore, so far, our inter-dependence and our relationship as well as our collaboration in hydropower with India is good and must and will continue.

Having said that, it doesn’t mean we don’t want to extend our commercial corporations and business-to-business relationships in hydropower with other neighboring countries. We will do so. Furthermore, we are also looking into possibilities of corporations with Bangladesh, which needs more power.

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The interview was conducted by Dawa Gyelmo, independent journalist, Thimphu.
MANGDECHHU PROJECT AND EXPORT TARIFF ISSUES
Sangay Chophel

Hydropower has driven the economy of Bhutan since the construction of the first hydropower plant in Chhukha began in 1979. Electricity is the highest export component worth Nu 11.9 billion (or approximately CHF 184 million) followed by silicon worth Nu 9.6 billion in 2017, and it comprised of 13.2% of nominal GDP in 2017. Whenever a hydropower project is commissioned, it spikes the growth rate of GDP the following year, as was the case of commissioning the Tala hydropower project in 2006, which shot up the growth rate by 19.7% the following year.

Mangdechhu project is situated 1.6 km below the Trongsa Dzong on the left bank of Mangdechhu river. It has a dam, which is 114m high and 150m long, an underground powerhouse cavern that is linked with a 13.5 km long tunnel carrying up to 118m3 of water per second (passing Kungarapten in the tunnel). The power-house is 155m long, 23m wide, and 41m high. It contains four turbines (180MW each). The dam is being built by Indian construction companies and the construction started in 2012.

The funding modality of the Mangdechhu project is 70 % loan and 30 % grant from the Government of India at 10 % interest rate. For earlier hydropower projects the loan and interest rate were lower. As the loan component and interest rate increases, debt obligation naturally increases with less return on equity.

Mangdechhu project was initially scheduled to be commissioned in mid-2017 but it has already missed deadlines several times due to cracks in floodgate, landslides, shortage of labour and cement supply, financial constraints of the contractors, and flooding in Phuntsholing, which washed away equipment. The project required on average about 400 to 500 metric tons of cement a day. The cost has escalated by 82% to Nu 53 billion (or approximately CHF 760 million) in 2018.

The basic assumptions, as stated in its Detailed Project Report and the Agreement signed between the Government of India and the Royal Government of Bhutan regarding the Mangdechhu project in 2010, is an annual energy generation of 3 billion units (KWh) with net saleable energy of 2.5 billion units. The difference results from deducting auxiliary consumption and free power (a royalty of 346 million units of electricity given to the government of Bhutan). The cost of rehabilitation and resettlement of Nu 120 million, cost of land of 21 million Nu, annual operation and maintenance cost of 2%, 5.72% escalation factor, 11.33% tax, and the construction duration of 7 years are further assumptions amongst others. With these assumptions, i.e. without any cost escalation and delays, the tariff was initially estimated at Nu 1.96 per unit.

Logically, the base rate for some of the parameters can no longer be applied as they have undergone some changes due to the revised tariff regulation as mentioned in the Central Electricity Regulatory Commission Regulations 2019, which is also the basis for determining Bhutan’s tariff. The annual operation & maintenance cost has been increased to 2.5% of overall investment costs because of potential increase in harsh weather conditions and the tightening of environment regulation. This is in line with the global average of around 2.5%, according to International Energy Agency. In addition, we have to use Bhutan’s corporate tax rate of 30% as the tax has to be paid in Bhutan. The original escalation factor of 5.72% is based on Indian inflation, which cannot be applied in Bhutan as operation and maintenance of the plant will be borne by Bhutanese personnel.
Save for spare parts, which may have to be procured from India, the escalation factor will have no input from India. The revised escalation factor comes to 6.82% using a weighted average inflation of India and Bhutan.

Using these parameters (2.5% annual operation & maintenance, 6.82% escalation factor, 30% tax rate) and Nu 52.7 billion plant construction cost, the export tariff works out to Nu 4.13 per unit\(^1\). Dams have to be decommissioned when they have become unsafe or expensive to maintain after the expiry of their useful life. Sometimes the decommissioning cost is more than the cost of building the dam.

In January 2019, the final tariff was agreed at Nu 4.12 by the government of India and Bhutan (see GoI commits Nu 1B more outside the tariff, Kuensel, January 3, 2019) which is equivalent to CHF 0.059\(^2\). The tariff schedule, which is part of an intergovernmental protocol, mentions that the tariff will increase by 10% every 5 years till the loan is repaid and 5% thereafter. The final agreed tariff is slightly lower than my estimates of Nu 4.13 per unit, resulting in annual revenue loss of 25 million Nu respectively. The reduced water-flow due to climate change also poses risk to hydropower revenue stream. In winter, less electricity is generated because the volume of water-flow declines.

On 23rd April 2019 the government agreed tariff at Nu 4.12 per unit for Mangdechhu project is higher than the tariff of Nu 2.12 for Tala project and Nu 2.55 for Chhukha project. The present tariff of Chhukha was revised several times since the first tariff was fixed at Nu 0.19 per unit in 1989. Similarly, the present Tala project tariff was revised twice since its commissioning in 2007.

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\(^1\)See my paper Export Price of Electricity in Bhutan: The Case of Mangdechhu Hydroelectric Project, Journal of Bhutan Studies, Vol.32, Summer 2015 on methodological details for tariff calculation

\(^2\)Interestingly, the average production price of all Swiss hydropower plants is exactly the same price, namely CHF 0.059.
THE FUTURE OF BHUTAN-INDIAN ELECTRICITY TRADE

Himanshu Takkar

Prime Minister of India, Narendra Modi, has been saying, “Our hydropower cooperation with Bhutan is a classic example of win-win cooperation and a model for the entire region.” However, the dimensions of hydropower trade between India and Bhutan have been changing. The Central Electricity Authority (CEA) under Union Ministry of Power provides monthly reports about power imports from Bhutan since 2005. CEA also provides regular updates of Indian hydropower projects in Bhutan, however, the CEA list only includes those projects, in which India has provided funding or other cooperation. The Detailed Project Reports of the projects for which India provides funding to Bhutan are approved by the CEA from techno-economic perspective.

India has been importing hydropower from Bhutan for over a decade now. India imported almost 6 billion units (one unit is one kilowatt hour) way back in 2008-09. The import has been lower than that figure every year in the following decade. In 2018-19, India imported 4.43 BU, almost 25% lower than the peak import ten years ago. No new project supported by India has been commissioned since 2006-07 when the 1,020 MW Tala project started production.

The Mangdechhu project is expected to get commissioned soon. The tariff for this project has been fixed after protracted negotiations at IRs 4.12 per unit. Bhutan reportedly wanted a tariff of 4.40 per unit, while India was willing to pay 3.90 per unit. However, the agreed tariff is higher than the solar and wind tariff fixed in recent months through competitive bidding. Yet, the tariff is lower than the tariff from recently commissioned hydropower projects under construction in India.

Big hydropower projects in India remain mostly stalled except for a few government-funded projects, due to economic unviability among other reasons. For India, if power from solar and wind is available at cheaper rates, imports from Bhutan may be questioned. This may become even more pertinent in case of Punatsangchhu I and II, since tariffs for these projects are likely to be even higher than that of Mangdechhu with a cumulative installed capacity of 2,220 MW. Therefore, it will be tougher nut to crack.

Bhutan also faces all the social and environmental costs of the hydropower projects, besides facing the increasing uncertainty about returns from new hydropower projects. This will become an even bigger question in case of storage hydropower projects, such as the “Sunkosh”.

Lower power import in winter: the power import from Bhutan during the summer period (April to October) of any financial year is higher compared to power import during the winter period (November to March) of the same financial year. Indeed, the power import during the summer period (7 months) has always been above 82%, and the power import during the remaining five months in winter has remained below 18% in all.
The power import by India during the winter months have been steadily going down, and has come down to 10.0% in 2014-15. This is because the electricity consumption in Bhutan has been steadily rising in the cold period, leading to reduction in power export to India during lean winter months, since these are the months when power requirements for heating would be high. The increasing power requirement for under construction hydropower projects is another factor here.

What about peaking power? One of the justifications put forward for pushing more hydropower projects is that they provide peaking power that thermal (coal) power projects cannot provide. However, a review of daily reports from Eastern Region Load Dispatch Centre shows that the power import from Bhutan is generally providing base load and not peak load. So, hydropower import from Bhutan also does not provide peaking power and thus might face difficulties to get higher prices for peak energy supply.

India power surplus? India’s energy and peak deficits have been decreasing and were 0.6% and 0.8% during the just concluded 2018-19. India has in recent years become a net-exporter of electricity, the overall export quantity being higher than what is imported from Bhutan. For example, during the 11 months between April 2016 to February 2017, India exported 4% more power than it imported from Bhutan during the same period.

So for India, justifying increasing import of hydropower may be difficult in the longer run just based on economics. However, as far as Bhutan is concerned, the decision will not be dictated just by economics, since Bhutan remains a strategically important neighbour for India. Indian companies, however, will need to perform much better than what they have done in case of Punatsangchhu I and II, where the projects have faced massive cost and time over-runs, thanks to poor appraisal and decisions by Indian companies.