Techno economic evaluation of planned large hydropower capacity installations by India in Nepal and Bhutan

Strom-, Wärmeerzeugung & Speicher

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Objective and Motivation

Hydropower technology is one of the major drivers in an energy transition towards 'Green' energy, providing a sustainable option for a continuous and stable electricity generation unlike most of the other Renewable Energy Technologies (RETs). Similarly, hydropower also plays a major role in the ongoing energy transition process in India. India has set individualistic targets for the electricity sector, to comply with its agreement on the 2-degree climate goals in the Climate Change Conference Paris, December 2015. The country, in the last few years has been rigorously investing in RET installations, particularly Onshore wind and Solar PV capacities [1]. Wind power capacity has increased almost six-folds from 16,08 GW in 2010 to 34,05 GW in 2018, and solar PV capacity has increased from 161 MW in 2010 to almost 22 GW in the year 2018 [2]. With such a high Variable Renewable Energy (VRE) penetration, it can be expected for the electricity system to have subsequently high integration costs, even with a large renovation of the existing transmission network. Studies [3] suggest that Dispatch-able RETs like Hydropower and Biomass can be used to minimize the integration costs inflicted by a high penetration of VRE technologies.

Hydropower installations in India already face several critical challenges, like land disputes, population displacement, water sharing disputes, and environmental concerns. Also, as most of the Indian rivers carry more than 80 percent of their annual flow in three to four monsoon months [4], there is a large seasonal variation in the availability of hydropower potential. In regards to this seasonal variation, the optimal approach is to build large reservoir power plants. The untapped hydropower potential in India comes to around 150 GW [2], which, when used effectively and economically can solve most of the bottlenecks and roadblocks to the energy transition process in the country. However, the region with the largest untapped hydropower potential in the country, the North East region, has been riddled with most of the mentioned challenges with hydropower. Several of the large hydropower capacities planned in the last decade have never made it out of the planning phase, because of such challenges.

The Government of India (GoI) has made several long term plans on installing large hydropower capacities, the most prominent of them being investments in neighbouring countries. Nepal and Bhutan have been historically on good terms with India for the development of infrastructure and other commodity trades. One of the long term plans of the GoI is to invest on several large scale hydro power capacities in these countries, and operate them on a bi-lateral sharing basis [5]. These hydropower installations, are planned such, that they can be potentially used for large scale energy storage in the future. This plan not only provides a solution for the hydropower situation in India, but also brings in the development of the transmission infrastructure, the social and economic welfare in these two countries.

This study analyses the several approaches of the country's long term plans on large hydropower capacity expansions, and then evaluates the technical and the economic impacts using the techno economic simulation model *ATLANTIS_India* [6]. The model *ATLANTIS_India* is designed and developed at the Institute for Electricity Economics and Energy Innovation, Graz University of Technology. Conclusions based on futuristic simulations, until the target year 2050, would provide an outlook of the techno economic scenario in the Indian subcontinent region.

Methodological approach

The simulation model *ATLANTIS_India* was designed and developed for the Indian subcontinent region, with realistic data on the existing and planned transmission, generation and demand components. Scenarios are initially constructed with and without the inclusion of the long term hydropower plans of India. The model can simulate up to the target year 2050, which is also in-line with the target year of the long term plans of the country. These scenarios are then simulated and the results are to be analyzed. The overall energy exchange, the load flow between the regions, the

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change in the market prices (Zonal Pricing) and the capital stock of the power plant fleet is then calculated for the justification of these technical and economic impacts in the region.

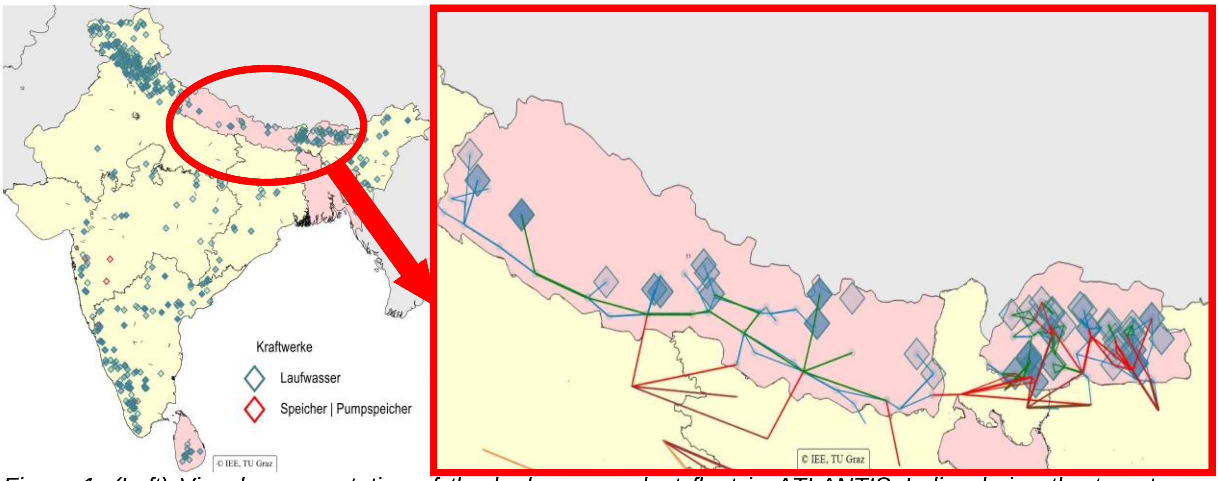

Figure 1: (Left) Visual representation of the hydropower plant fleet in ATLANTIS_India, during the target year 2050 (Right) Visualization of the Nepal and Bhutan power regions in the model

Conclusions

The results of this study aim to provide an overall view of the role that large hydropower plants play in the Indian energy transition process, and the impacts of large hydropower installations in the region. The initial comparison of the results shows a clear distinction in the power load flow, where Nepal and Bhutan become surplus producing regions and also a significantly large increase in the capital stock of the Indian power plant fleet is observed. The construction of large hydro power plants in Nepal and Bhutan not only develops the countries' energy infrastructure, but also increases the overall wealth of their respective energy systems. Nepal joins Bhutan to provide peaking support to the Eastern and the North Eastern power regions of India, thus creating improved cash flows in to their electricity economy. This 'wealth' can be used as a driver to the improvement of the economic and social welfare in these regions.

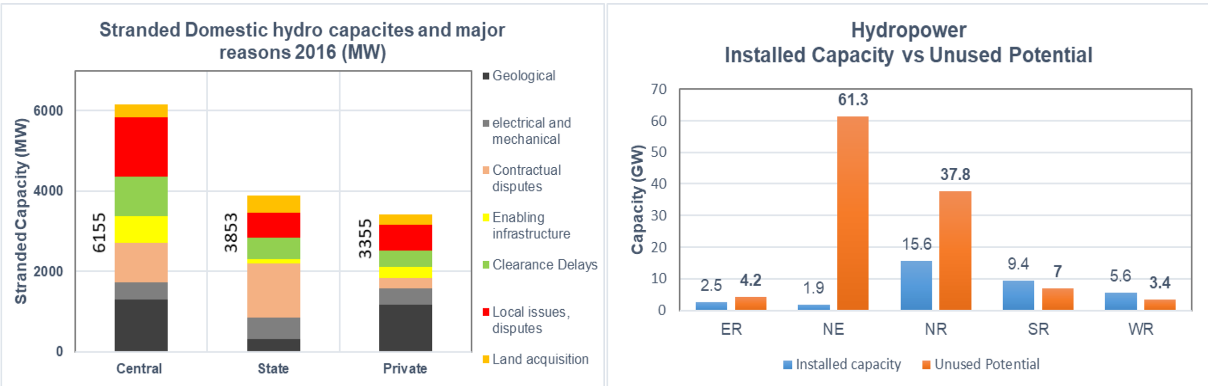

Figure 2: (Left) Stranded hydro power capacities due to bottlenecks as of 2016 (Right) Installed capacity and unused hydropower potential in each of the power regions in India

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