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Capital Stock Intensive Planning for India's Energy Transition

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Introduction and Motivation

In the global energy context, India has been in between the cross hairs as a developing country with unchecked emissions. India, along with China, has always been a major emitter of greenhouse gases after the liberalization of economic reforms and industrial revolution [1] in the 1990s. With India's agreement to reduce its carbon intensity by 31 percent from its 1990 levels at the COP 21 Paris summit in 2015, several pathways have been proposed and analysed by several notable energy research groups [2] [3]. Most of these analyses point towards a major increase in solar Photo-Voltaic (PV) and wind capacity installations in India in an attempt to reduce its carbon intensity of electricity generation by 2030. With regards to this goal, India has already drafted a plan to have at least 175 GW of solar PV and Wind capacity by 2025 [4]. In this study, an alternative analysis on the sustainability of a long-term capital stock intensive strategy for India has been conducted, with a focus on long term sustainability in conjunction to the country's short- and medium-term goals.

Capital stock in energy economics can be economically termed as the ‚wealth' of an energy system, representing the invested capital, while considering the economic and technical lifetime of the assets [5]. In energy planning, the capital stock actually plays a silent albeit a major role in deciding the long-term economic sustainability of the energy system. The illustration of the capital stock, classified with respect to different electricity generation technologies shows the replacement value of the entire power plant fleet.

By comparing the future totally installed capacity or the produced electricity with the calculated capital stock, conclusions for an inter-generational sustainable plan can be drawn where investments made now would provide benefits until a few generations to come. Therefore, the technical lifetime of power plants always needs to be considered while analysing energy systems. Technologies with a high capital stock and a long lifetime should be given preference over technologies with a high capital stock and shorter lifetimes; i.e. giving preference to hydro power over solar PV where the geographical situation enables it. Among all generation technologies, hydro power shows one of the highest technical lifetimes up to 100 years or more. Presently, India's carbon free alternative energy policies are heavily directed at PV and wind capacity expansions, even with their significantly lower economical and technical lifetime compared to hydro power or nuclear power plants. Thus, the capital stock intensive planning is very much necessary for a developing country like India, where there are already existing financial hurdles [6].

India's overall installed capacity by technology share (Figure 1) shows that a major portion of the installed capacity is coal-based and conventional generation technologies [7]. In this study, the existing power plant fleet of India is thoroughly investigated from both technical and economic points of view, and the capital stock for the current and the futuristic electricity systems are to be determined. Calculating the capital stock of the power plant fleet gives us a measure of the wealth of the energy system over the lifetime of the power plants. Using the calculated capital stock values, several indicators like the installed capacity of each power plant technology types are presented. Based on the development of the capital stock, the future fixed costs of the electricity system comprising of depreciation and interests on borrowed capital can be shown. Thereby, the economic sustainability of the electricity system in accordance with the Indian energy transition process is thoroughly investigated.

Probable conclusions

A capital stock intensive strategy for the energy transition in India revolves around the logical fact that India has to invest more in hydro and nuclear power plants, with their longer economic and technical lifetime as long-term investments, rather than adopting clean coal technologies and other variable renewable energy technologies like solar PV and wind on a large scale.

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Moreover, a large share of PV and wind capacities in the system would introduce very high 'integration' costs, due to the variable nature of such technologies. However, with a large portion of India's installed capacity being relatively newer conventional power plants (Figure 2), the 'stranding' of such assets has to be strategically avoided as well.

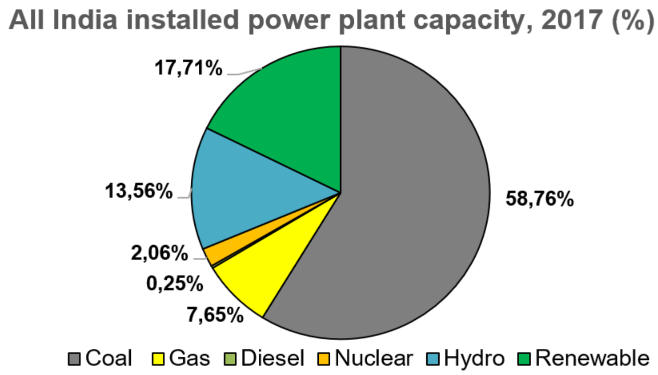

Figure 1: All India Installed capacity by generation technology type, 2017, CEA

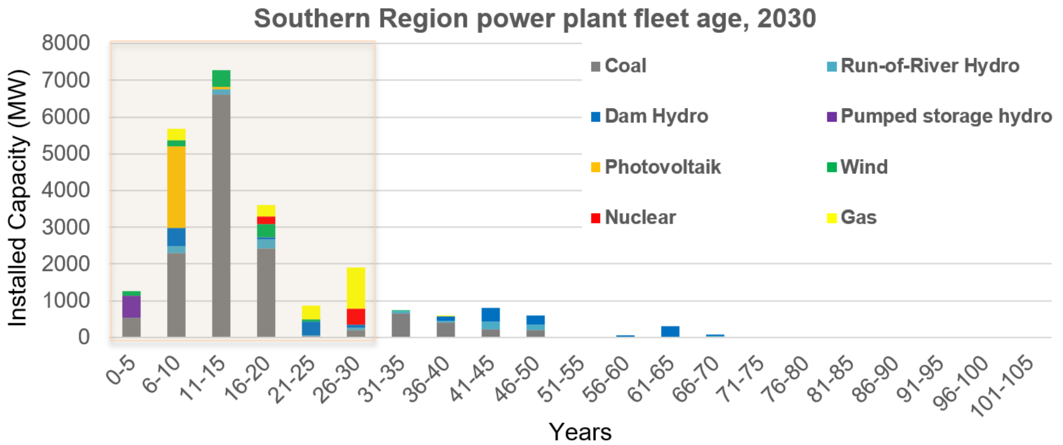

Figure 2: Graph showing the relatively young fleet of conventional and coal power plants in 2030, considering a lifetime of 50 years, for the Southern Power region in India

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