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OPTIMIZING TECHNOLOGY MIX FOR POWER GENERATION IN INDIA THROUGH TECHNOLOGICAL LEARNING CONSIDERATIONS

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Overview

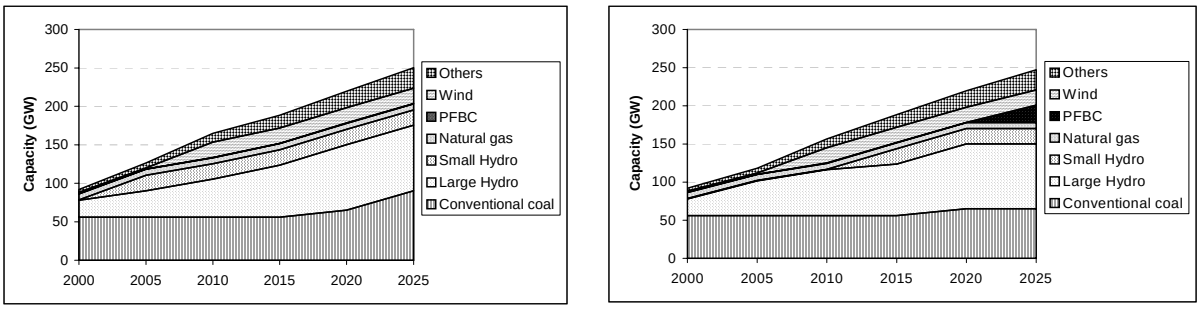
The Indian Power Sector is increasing rapidly. It has few typical features that make it different from many developing countries. On the aspect of power generation potential, there exists beside coal and nuclear a huge potential of large hydro (84 GW), wind (20 GW) and small hydro (10 GW) based power generation in addition to potentials of solar, ocean and bio energy. Investigations of the history of different technologies and their key indicators e.g. plant cost and power generation efficiency, have shown that there is a continuous improvement in both the fields. The specific cost of technologies trends to decrease and their performance e.g. efficiencies increase with their cumulative capacity. For finding the effects of technological learning on the suitability of technologies at different points of time, the Indian power sector has been modeled. The objective was to find the optimum set of choices under dynamic conditions. A much widely used energy planning software MARKAL (MARket ALlocation) has been used for this purpose which operates with the bottom-up approach to deal with energy systems.

Methods

In India, many studies have been conducted for finding optimum combination of technologies for capacity expansion planning. The Central Electricity Authority of India had used EGEAS software for formulating strategy for development of technologies with least cost objective [1]. Loulou et al. [2] had conducted a detailed analysis of Indian power sector for suggesting the growth for power sector with varying conditions of the economy. Mathur et al. [3] had conducted studies to find potential of greenhouse gas reduction through technological selection. Mathur et al. [4] further found maximum growth rates for different power generation technologies that govern technological mix in the power sector. Messner [5] defined „Technological Learning rate" by concluded that due to „Learning by Doing" and „Economy of Scale" investment requirement in almost all technologies decreases with time. Learning rates used in this work have been deduced by literature and own calculation.

Results

Simulations have been carried out for case of Indian Power Sector in absence and presence of learning rates. Results of the first case i.e. case of no learning rates, suggest that the model finds hydro power as the most economic option. Coal is found to be the next most attractive option for capacity expansion. Among the three coal power technologies, conventional coal power is preferred by the model due to least initial investment and maintenance costs among three coal based technologies. Low prices of coal do not overshadow the efficiency related advantage of other two coal based technologies. Due to relatively high fuel prices, gas and oil based power plants do not get any allocation. The IGCC based coal power technology, does not get any allocation at all due to high investment. Growth of various technologies allocated given by the model has been shown in figure 1(a).



(a) (b)

Figure 1: Growth of technologies (a)without learning rates, (b) Learning Technologies Scenario

With introduction of learning effect in the investment related to various technologies, the choices get slightly altered as shown in Figure 1(b). As small hydro and wind power both are relatively fast learning technologies, MARKAL, assesses advantage in waiting for these technologies to learn. Therefore, it picks up large hydro technology first, and after the first period i.e. after five years, when it expects some decrease in investment related to wind power plants due to faster learning rate as compared to small hydro, decision about increase in capacity of wind plants is taken. Wind power capacity gets saturated in the second period itself and by that time, small hydro power investments also come down and hence

Conclusions

Investigation about the effect of technological learning shows that small hydro, wind power and pressurized fluidized bed combustion based coal power plants become better choices than their present position among preferences. Therefore, these learning in these areas must be ensured through special boost to research and development programs. In addition, to increase the effects of learning by doing and economy of scale, artificial means such as subsidy or tax benefits may also be adopted. It is also concluded that IGCC and PV technologies have still not reached a stage to be economically attractive in India during the next 20 years. Therefore, some more R&D is required in these fields and India should wait for the developed countries to adopt these technologies and learn through their experience to improve the economy of these technologies.

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