DYNAMIC MULTI SECTOR ENERGY ECONOMIC MODEL FOR SUSTAINABLE DEVELOPMENT IN THE ELECTRICITY SECTOR OF BANGLADESH

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Overview

As energy demand grows at a faster rate in developing regions, energy security and environmental sustainability become issues of concern. The transition from traditional fuels to modern forms of energy requires huge infrastructure development and poses greater financial risk at the same time. In this study, we analyse the long-term electricity sector expansion of one of the fastest developing regions of the world, Bangladesh using a dynamic multi-sector energy economic model. We also evaluate the interrelation between energy consumption and environmental emission by imposing different emission limits as per national commitments and international agreements. The social implications and optimal power generation mix for different policy scenarios have been investigated.

Methods

The Dynamic Multi-Sector Energy Economic (DMSEE) model developed for this analysis, uses linear programming approach to quantitatively analyse the interrelationship among Top-Down (TD) economic sectors and thus elaborate the Bottom-Up (BU) electricity sector in term of different power generation technologies considering techno-economic and environmental constraints. We used the TD information obtained from Global Trade Analysis Project (GTAP) 10 database that represents the world economy through bilateral trade information. For the BU electricity sectors, eight power generation technologies were considered: nuclear, coal-fired, gas-fired, oil-fired, biomass, hydro, solar PV and wind power generation. The objective function of the model is to maximize utility for consumptions. The constraints include supply-demand balance, resource balance, capital investment limit, labour availability from TD perspective and other technical limitations from the BU electricity sector. Different carbon-emission limits are imposed to obtain optimal electricity generation mix for different scenarios.

Results

Our model computes results for 6 time points starting from 2025 to 2050 at 5 years interval. Hourly electricity generation from different technologies is obtained to generate optimal power generation mix for a particular year. We consider 3 different economic scenarios naming Business As Usual (BAU), Low Growth (LG) and High Growth (HG) with per-capita annual household consumption growth of 3.5%, 5.5% and 7.5% respectively. Carbon emission limit was introduced by by imposing 50% emission reduction with respect to BAU case by the year 2050. The GDP over the years, import, and export were also calculated in addition to electricity generation mix for these scenarios. The results for different scenarios imply that imposing carbon emission limits have a profound impact on the energy mix. In order to satisfy environmental policy concerns, advance planning and adjustment with new technologies need to be ensured for continuous and sustainable development.

Conclusions

Developing countries experience increasing energy and electricity demand as they transform into industry based economy and people's purchase power increase. The interrelation between economic growth and energy is important for national policy planning and sustainable growth, especially for the electricity sector. It is the environmental factors which could bring positive changes towards a sustainable future with diversified energy and electricity generation technologies if taken into consideration in time ensuring energy security and environmental sustainability at the same time.

References

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