GGBP Case Study Series

Developing a National Energy Map for India

Related Chapter: Prioritization of green growth options and pathways

Case developed by: Shailly Kedia

Country: India

Sector(s): Energy, electricity

Key words: Modeling, MARKAL, electricity, energy security

Energy security is central to the green growth policy of the Government of India. In 2005, the government commissioned The Energy and Resources Institute to undertake a study of technological options for achieving the desired growth rate under various scenarios. Using the MARKAL (Market Allocation) model, the study was carried out based on estimated figures for factors including cost, population, gross domestic product, and energy demand and distribution. The modeled scenarios showing different levels and rates of growth were set against 'business as usual', taking into consideration different sectors of the economy. The study generated interest among policymakers and contributed to discussions on national climate policy.

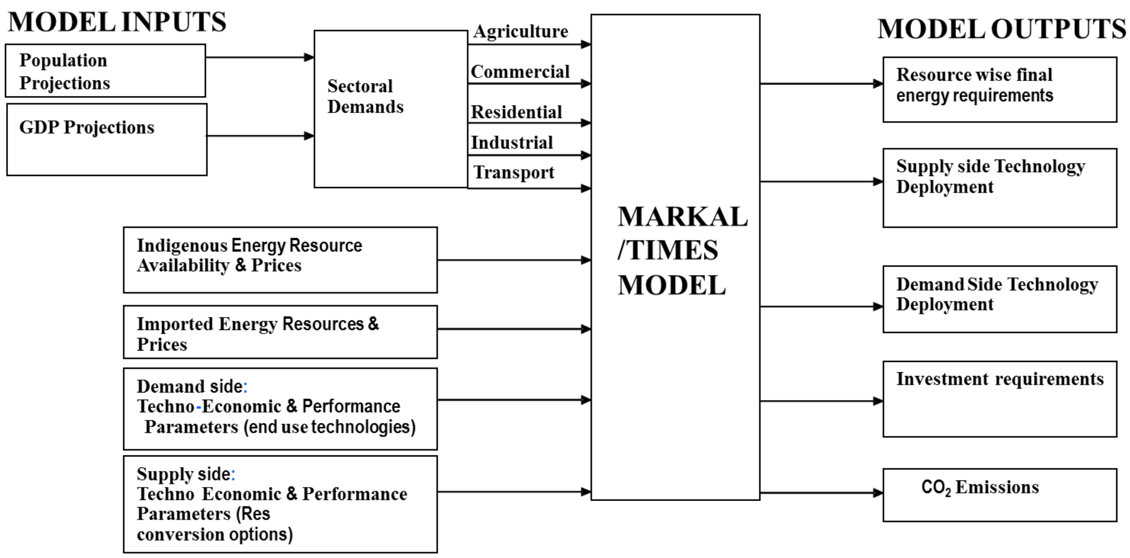
Context

The Indian government aims to sustain economic growth rates of 8 percent, which will require major provision of infrastructure, and particularly energy and electricity. Energy security is a key concern for the government, and it has set a goal to achieve energy independence in the next 25 years. To support decision-making on the technologies and policies needed to achieve energy security, the Principal Scientific Adviser of the Government of India commissioned The Energy and Resources Institute (TERI) in 2005 to undertake a study of technology options under different scenarios (TERI, 2006).

Approach

MARKAL(Market Allocation) is a dynamic linear programming constraint-based optimization model of a generalized energy system. Apart from indicating cost minimization options of the energy sector under various scenarios, the model results provide information regarding the level of uptake of total energy resources, their distribution across the consuming sectors, the choice of technological options at the resource supply, conversion and end-use levels, investment levels, an indication of capacity additions and retirements, the emission level associated with resource supply, and end-use technological options adopted. See the Figure 1 below for schematic representation of the methodological framework in the MARKAL model.

Figure 1: Schematic representation of the methodological framework



Source: TERI

The MARKAL database has been created to model a 35-year period, from 2001 to 2036, at five-year intervals, coinciding with the Government of India's Five-Year Plans. Population and gross domestic product (GDP) figures were used to estimate end use demand in the five sectors of the economy (agriculture, commercial, residential, industrial, and transport) over the modeling period. The year 2001/02 is chosen as the base year as it coincides with the first year of the Government of India's Tenth Five-Year Plan (2001/02–2006/07).

Technological characterization was done based on extensive literature review. This was supplemented with focused interactions with sectoral experts, researchers, industry associations, research and development institutions, government agencies, and policymakers in each of the individual sectors were held via workshops to finalize the input data to the model. Energy demands were categorized by end use in five major energy sectors: agriculture, commercial, residential, industrial, and transport. The energy demands were estimated using regression equations established using population and GDP as the key drivers to growth. The seven alternative scenarios listed below were set up against the BAU (business-as-usual) scenario to examine variations with regard to policy options and technological options pursued.

- BAU represents energy development as per current government plans and policies, representing a GDP growth rate of 8 percent.;
- LG (low growth) represents low GDP growth rate of 6.7 percent;
- HG (high growth) represents a high GDP growth rate of 10 percent;
- EFF (high efficiency) includes energy-efficiency measures spanning across all sectors;
- REN (aggressive renewable energy) represents a high penetration of renewable energy forms;
- NUC (high nuclear capacity) considers an aggressive pursuit of nuclear-based power generation;
- HYB (hybrid) is a combination of the BAU, EFF, REN, and NUC scenarios;
- HG-cum-HHYB (high-growth hybrid) represents a high growth rate of 10 percent in addition to the hybrid scenario.

Outcomes

The results were published in 2006 as the National Energy Map for India: Technology Vision 2030. The findings from this model, alongside others such as the computable general equilibrium (CGE) model, Activity Analysis model, and McKinsey model were discussed in climate policy forums (MOEF, 2009). It informed climate and energy policy. For example, the analysis is cited in the National Action Plan of Climate Change (NAPCC), which lays out eight missions related to climate change mitigation and adaptation (GoI, 2008).

Lessons

- ***Robustness****:* The robustness of the model is considerable as it generated sufficient interest among policymakers on the issue of looking at alternate technological options and implications arising therein. The analysis also informed the national interventions of India on climate change including the National Action Plan of Climate Change (NAPCC) (see page 50 of NAPCC);
- ***Results orientation***: The analysis is directed to the objective of achieving energy security in the subsequent planning periods in India up to 2031. The analysis provides recommendations on the technological options in the hydrocarbon sector as well as recommendations on policies for making options such as renewable energy more competitive. The model also recommends stepping up hydropower generation;
- ***Leading to ambition/impact***: The model was useful in generating interest among the policymakers in taking action related to both climate change and energy security.

References

Government of India. 2008. National Action Plan on Climate Change (NAPCC). Prime Minister's Office, Government of India: New Delhi

Ministry of Environment and Forests. 2009. India's GHG Emissions Profile: Results of Five Climate Modeling studies. Climate Modeling Forum. Ministry of Environment and Forests, Government of India: New Delhi

The Energy and Resources Institute (TERI). 2006.National Energy Map for India: Technology Vision 2030. Study by The Energy and Resources Institute (TERI) for the Office of the Principal Scientific Adviser, Government of India. ISBN 81-7993-064-5. TERI Press: New Delhi

The Global Green Growth Institute (GGGI). 2011. Green Growth in Motion. Global Green Growth Institute.

Disclaimer

This case is a summary of research input to the Green Growth in Practice: Lessons from Country Experiences report published by GGBP in July 2014. The views and information expressed in this case study are not necessarily endorsed by the GGBP sponsors or organizations of the authors.

December 2014

GGBP sponsors:

Global Green Growth Institute
European Climate Foundation
CDKN Climate & Development Knowledge Network
Ministry of Foreign Affairs of the Netherlands
UKaid from the British people