TURKISH ELECTRICITY SECTOR: BOTTOM-UP APPROACH

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Overview

The importance of this study, roots from being the first attempt to model and examine Turkish energy system using so called TIMES (The Integrated MARKAL (MARKet Allocation) –EFOM (Energy Flow Optimization Model) System) modelling methodology to assess the future pathways of the system under various policy options.

Over the past ten years, Turkey has experienced some of the fastest growth in energy demand of countries in the Organization for Economic Cooperation and Development (OECD) [1]. As a fast-growing country, energy consumption has raised in Turkey due to economic developments by industrialization and urbanization. As an indicator of this statement, average electricity consumption growth rate (6.27%) exceeds the average GDP growth rate (5.07%) in between 2003 and 2012 [4]. To meet the increasing demand, significant investments are required in electricity generation technologies. This study will respond when to invest and which technologies to invest in a certain time period.

Turkish electricity system is currently dominated by hydraulic, lignite and natural gas power plants while sustainable energy resources such as geothermal, waste, solar and wind have limited capacity. Turkey is increasingly dependent on natural gas imports as its domestic consumption rises each year. Natural gas is used domestically mainly in the electric power sector [1]. Enhancing the capacity of hydraulic and renewable energy resources would break the dependency on imported resources and decrease the CO_2 emission as a benefit. Also current government sees the nuclear energy as an alternative way of reducing energy imports for the economy. In this respect, there are two nuclear power plant projects under development one in Mediterranean region and other in Black Sea coast of Turkey.

To determine future energy technology mix of Turkey, current system will be modelled as reference energy system with a well-balanced and detailed representation of electricity, transport, industry and residential sectors. Based on reference scenario possible policy scenarios such as GHG emission abatement and energy security/import reduction scenarios will studied to see effects of those policies on total energy sector. While the assessment will be focused on electricity sector such as investment strategies, and price dynamics also interactions with other sector will also be elaborated.

Methodology

Study will be based on TIMES energy modelling scheme. TIMES is an economic model generator for energy systems and provides technology-rich basis for estimating energy dynamics over user identified time horizons. TIMES is a perfect-foresight, bottom-up, dynamic, linear programming optimization modelling framework [3]. TIMES has the capability to portray the entire energy system from resource supply, through fuel processing, representation of infrastructures, conversion to secondary energy carriers, end-use technologies and energy service demands [2]. In such a bottom-up model, technologies are linked together by their inputs and outputs. Exogenous demand assumptions will be used to generate detailed technology characterization and high intertemporal disaggregation [2].

In TIMES framework, annual demand is distributed within the year using time slices concept. Different from the classical MARKAL definition, they may have variable length (hour or a part of the day) representing time divisions within a year, such as seasons, day/night, and/or weekdays/weekends. This creates an advantageous representation of important parameters at different times of the year that significantly effects the investment strategies and electricity prices which cannot be modeled under MARKAL framework. In this study, there will be 24 hour time slices will be used in order to cover demand of electricity at different times.

A new TIMES database that represent general energy system of Turkey will be developed. This database will cover the period 2012 through 2062 in five-year increments and represent electricity sector in a single region model. Characterization of current and future technologies within database will be developed from Energy Information Agency's 2012 Annual Energy Outlook Report and a project of Ministry of Energy and Natural Resources which use economic indicators and macro models to generate accurate data. Public data sources, government agencies, and non-profit organizations will be used as data generation sources in this study.

Results

As a result of this study, a primary resource mix, a system wide cost analysis, investment decisions (timing and technology selections), potential electricity prices and reflections on other industries are able to be generated. Results of proposed scenarios will be compared with the reference case.

Conclusions

Based on the results that are presented, we will come up with the least cost strategies that can be implemented for the desired energy/ electricity sector outcomes such as GHG emission abatement, higher penetration of renewable energy and/or reduced energy import. In that respect we will be able to generate minimum cost strategies to achieve the target for these fast growing economy focusing to the electricity sector.

References

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