IICEC-Sabancı University TIMES Energy Model (ISTEM)

During 2017, one of the major new IICEC projects was the new IICEC-Sabancı University TIMES Energy Model (ISTEM), an international energy technology and energy trade model that particularly focuses on the Turkish and regional economies. ISTEM is a technology-rich bottom-up optimization model under development by IICEC and Sabancı University that represents energy dynamics over a multi-period time horizon in the context of Turkish energy system.

Similar to other bottom-up models, ISTEM requires comprehensive information about each and every aspect of energy systems: 1) Primary energy resources and technologies (including domestic supply, imports, and exports); 2) Conversion and transmission technologies; and 3) Energy service consumption (energy-using technologies in the residential, commercial, industrial and transportation sectors). Since a more detailed model can provide more precise results, ISTEM will have a Reference Energy System with an advanced level of detail. For example, in the power sector, technologies are not specified as classes of electricity-generating technologies, but as separate power plants with specific information for each plant. This provides several advantages that makes the more extensive data collection effort a good investment. A model characterized at this much information will more likely accurately represent and predict the characteristics and performance of the Turkish power sector as a whole. In addition, this level of detail can accommodate knowledge about planned additions to Turkish electricity capacity (tenders, contracts, etc.) . It will also provide a more accurate prediction of what the Turkish Reference Energy System will look like in future periods, since the optimization conducted for those periods will already accommodate what is expected about future power additions instead of just trying to estimate them without taking account of all current information. The same emphasis to achieve a detailed Reference Energy System is also being applied to the other energy sectors (transportation, industry, residential and commercial).

To provide enough input for the proposed data-rich model, we rely on a wide variety of databases, such as ETSAP-Technology data, IEA reports, TURKSTAT documentations, Turkish State Meteorological Service, and information about business developments that are not yet reflected in statistical databases.

Contrary to analyses that rely on econometric trends to make longer-term projections, technology scenarios serve as the only practical choice to estimate energy trends beyond a few years. A scenario provides a set of consistent assumptions that describe the main drivers of technology choice and energy use. This leads to a coherent organization of the system under study. In sum, scenarios will reflect:

- Primary resource supplies
- Energy service demands
- Energy technologies, current and future
- Policies
- Demographics and economic growth

Solving different scenarios may lead to contrasting solutions; therefore, comparing these unequal solutions can reveal important information about the role of dissimilar components in the energy system. ISTEM can be used to explore the possible energy futures assuming various contrasting scenarios. Differences among scenarios can concern:

- Government policies that would affect the energy sectors in a variety of ways, some of which would not be apparent without ISTEM analysis. These could involve stricter environmental requirements, tax regimes and incentives, policies aimed at greater Turkish energy security and many others,
- Future improvements in the cost or performance of energy-generating technologies,
- The emergence of new energy technologies or associated technologies (that affect the economic performance of energy-generating technologies),
- Changes in natural conditions that would affect the energy system,
- Turkish economic growth,
- Interest rates, and
- Other factors.

ISTEM will also provide many research opportunities: For example, in the power sector it can be used for:

1. Predicting the long-term development of the dispatched power from each technology and power plant.
2. Observing the impact of regulations[1], technologies[2], and market players' configuration on each energy carrier, technology, and demand.
3. Environmental effects of current technologies on the viability of each technology in the Turkish energy system.
4. Investigating socio-economic factors on interchangeable technologies and the energy demand from each source.

[1] introducing new regulations or changing current ones

[2] such as breakthrough in introduced technologies or adding new technologies that are not available before

5. Assessing the economic viability of investments in lesser-known future technologies and their success in the context of Turkish energy system.
6. Estimating the most cost-effective combination of technologies that meet specified greenhouse gas (GHG) emission objectives.
7. Estimating key research priorities to value the cost of clean energy development.
8. Assessing the possibility of using new technologies[3] as frequency regulators and fast-response reserves for integrating intermittent generation sources such as renewables.

Important estimates and insights will also be provided for the transportation, residential, commercial and industrial sectors. For example, in the transportation sector, ISTEM will provide insights on:

1. Future Turkish light vs. medium distillate demand and impacts on the Turkish refinery sector,
2. Scenarios for plug-in electric vehicle (PEV) growth in Turkey,
3. Pressures that PEV growth scenarios could have on the Turkish grid and power supply,
4. Consumer requirements and infrastructure to enable PEV growth in Turkey,
5. Mobility as a service, and
6. Transportation-sector responses to environmental pressures.

ISTEM will address relevant policy and resource questions in all Turkish energy sectors in equilibrium (accounting for all feedbacks among sectors) producing an integrated *Turkey Energy Outlook*. ISTEM will show which scenarios are both sustainable and realistic, aiming towards long-term growth that can best meet a variety of policy priorities.

[3] e.g., fuel cells in EVs and other electricity storage systems.