Argonne NATIONAL LABORATORY

Energy, Environmental & Economic Systems Analysis

ENPEP-BALANCE: A Tool for Long-term Nuclear Power Market Simulations

Opportunity

A resurgence of interest in nuclear energy is taking place in the United States—driven by national energy security and greenhouse gas emission reduction policy goals. The ultimate success of this resurgence will be contingent on successfully addressing the economic aspects of competition in a marketplace of fossil alternatives.

Argonne Solution

Argonne uses the BALANCE module of the Energy and Power Evaluation Program (ENPEP) to develop long-term energy market projections and to assess the competitiveness of nuclear power vis-à-vis alternative technologies. ENPEP consists of a set of tools for analyzing integrated energy and electricity systems.

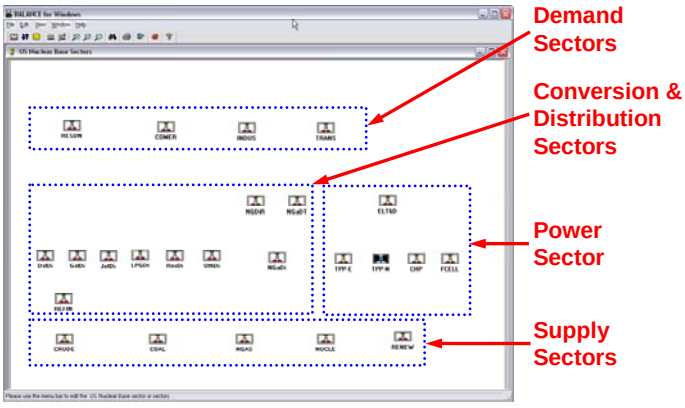
Worldwide Use of ENPEP

ENPEP is used around the world to analyze strategic energy issues. In the last 25+ years, in collaboration with independently, each optimizing individual objectives. the International Atomic Energy Agency, the World Bank, the US Agency for International Development, the UN Development Program, and others, Argonne has trained more than 1,300 experts from over 80 countries in the use of various aspects of ENPEP. In many countries, private and government analysts are using the model for energy planning. Further, the World Bank and other lending agencies regularly rely on ENPEP analyses in their loan evaluation process.

Modeling Approach

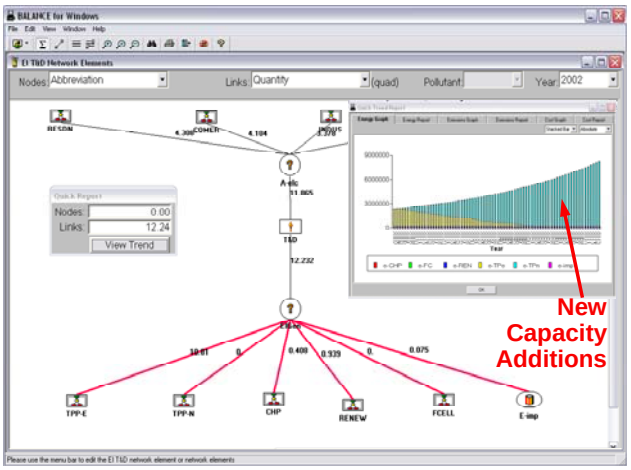
ENPEP-BALANCE provides an energy network that the user can design to trace and project the flow of energy throughout the entire energy system from resource extraction, via processing and conversion, to demands for useful energy across all consuming sectors. The ENPEP-BALANCE market simulation approach is based on the concept that the energy industry consists of autonomous energy producers and consumers that carry out production and consumption activities independently, each optimizing individual objectives.

ENPEP-BALANCE finds its solution by determining the intersections of the supply and demand curves for all energy forms and uses in the model. Equilibrium is reached when it finds a set of prices and quantities that satisfy all relevant equations and constraints. Because market shares of energy depend on prices, and energy prices rely on the quantity of fuel demanded, ENPEP-BALANCE uses an iterative process to bring network prices and quantities into equilibrium. The model also computes the associated environmental burdens, such as emissions of greenhouse gases and standard criteria pollutants.

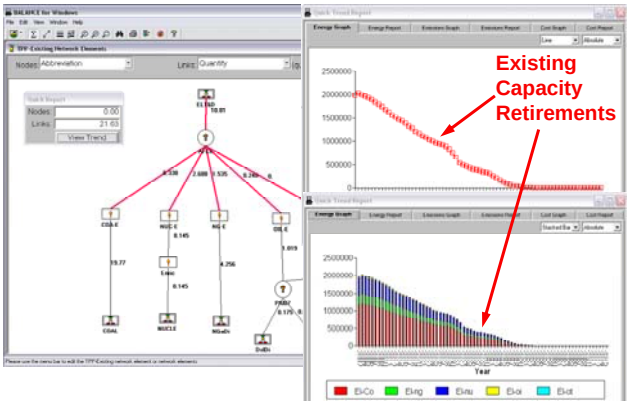


Model Design and Results

The model configuration developed by Argonne can project future US nuclear electricity market penetration under a number of different scenarios. The configuration includes various resource supply sectors (nuclear, gas, coal, renewables), conversion and distribution sectors (power, oil refining), and electricity-consuming sectors (industry, households).

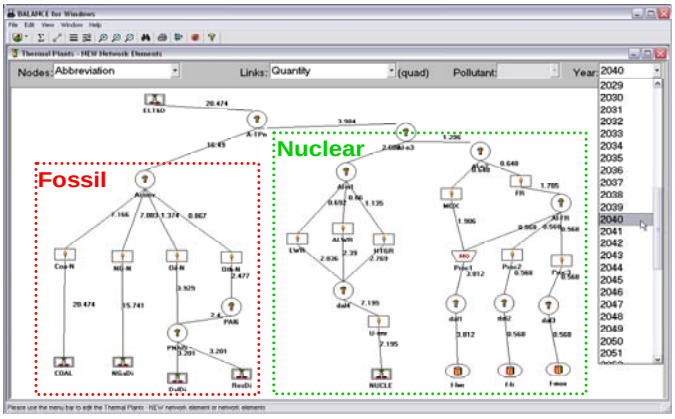


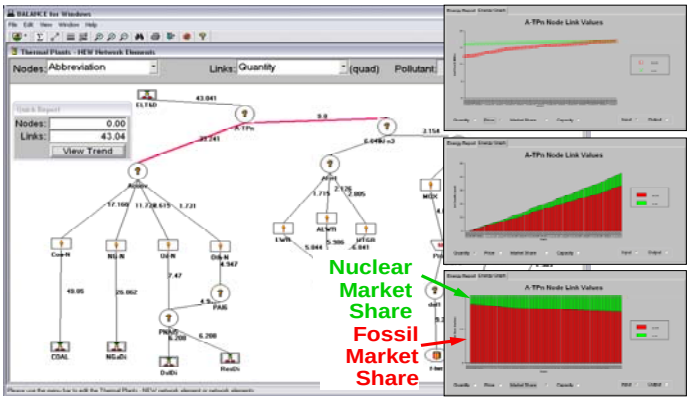
While existing generation capacity is forecast to decline, the demand for electricity by households, industry, commerce, and transport systems is forecast to continue to grow. This growth, in combination with the expected retirement of the existing generation park, drives the need to build new capacity.



The model is configured to evaluate various power system expansion options. The expansion is decomposed into different expansion technologies, such as coal, gas, oil, and nuclear reactor types. The expansion algorithm uses a nested approach; the model first allocates market share between fossil and nuclear and then decides, within each of these two categories, the share each individual technology or reactor type will reach.

The model forecasts technology shares based on underlying assumptions on performance, capital cost, operation and maintenance cost, process efficiencies, interest rates, risk premium, and projected fuel prices.





Learn more about the Center for Energy, Environmental & Economic Systems Analysis at:
http://www.dis.anl.gov/ceeesa

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