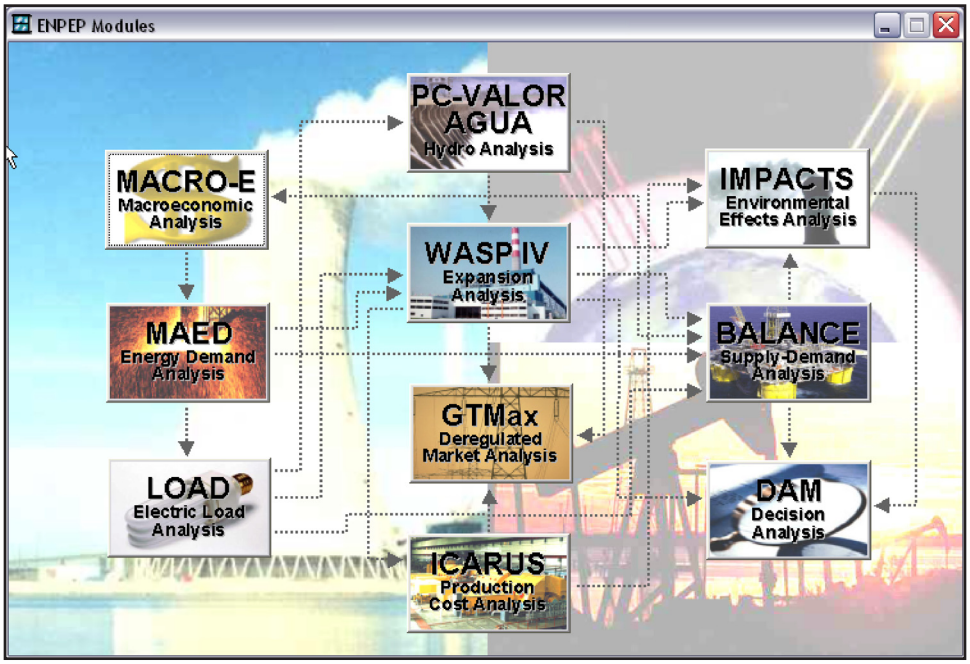
# Energy, Environmental & Economic Analysis

# Analyzing Greenhouse Gas Mitigation Issues in Turkey

## Opportunity

The purpose of this analysis is to assist Turkey in its interactions with the United Nations Framework Convention on Climate Change (UNFCCC). The work establishes a "base case" for the growth of energy supply and demand in Turkey through 2012. This will be used as a reference point against which alternative scenarios and options will be evaluated. These alternatives are currently being analyzed.


## ENergy and Power Evaluation Program (ENPEP)




*ENPEP Modules*

## Approach

CEEESA trained a team of experts from Turkey's Ministry of Energy and Natural Resources (MENR) and the Turkish Electricity Transmission-Generation Company (TEAS) to use various ENPEP modules.

Under this World Bank-funded project, CEEESA staff continue to support the local team in analyzing a variety of greenhouse gas (GHG) mitigation options, including reduction of transmission and distribution losses, demand side management, market-based instruments, clean coal technologies, and increased renewables. CEEESA collaborates with Japan's Chubu Electric Power Company and other consultants to provide this support.

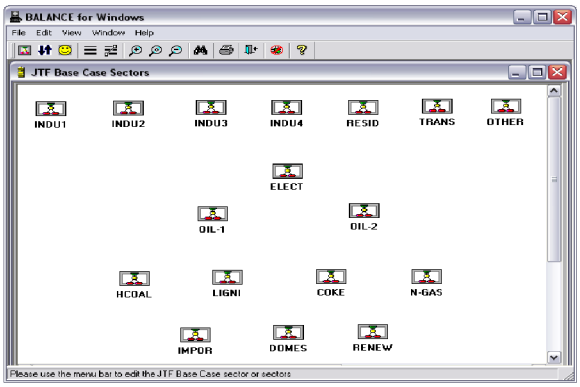
## Advantages/Benefits

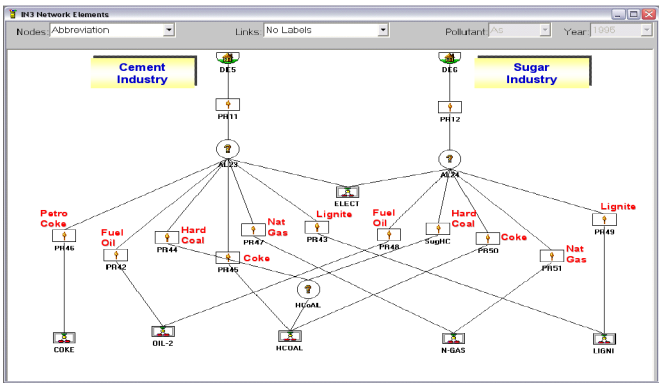
Because ENPEP is a well-established tool, its results are accepted equally by international agencies and major lending institutions. The model is used by many countries to develop their UNFCCC national communications.

## Technical Concept

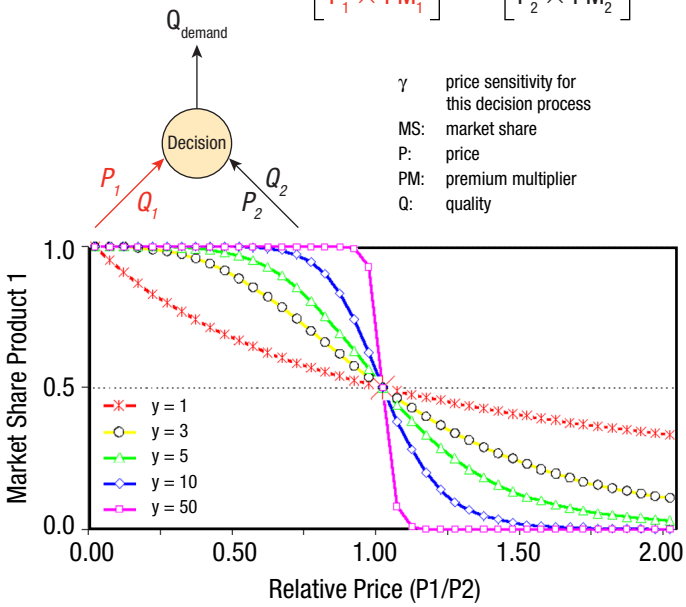
The team uses ENPEP's MAED model to develop energy demand projections. The electricity demand forecast is fed into the power system expansion model (ELECTRIC or WASP). The expansion plan and the demand projections for the other fuels and sectors are transferred into BALANCE, which uses a nonlinear, market-based equilibrium approach to determine the energy supply

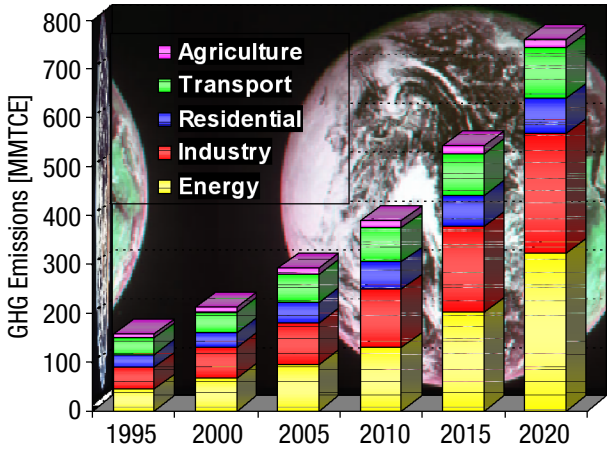
and demand balance for the entire energy system. The model's energy network is designed to trace the flow of energy from primary resource (e.g., crude oil, coal) through final energy demand (i.e., diesel, fuel oil) and/or useful energy demand (i.e., residential hot water, industrial process steam). The two screen captures below show the Turkish energy network and an example for two industrial sectors. BALANCE simultaneously finds the intersection of supply and demand curves for all energy supply forms and all energy uses included in the energy network. Equilibrium is reached when the model finds a set of prices and quantities that satisfy all relevant equations and inequalities.




$$MS_1 = \frac{Q_1}{Q_1 + Q_2} = \frac{\left[\frac{1}{P_1 \times PM_1}\right]^{\gamma}}{\left[\frac{1}{P_1 \times PM_1}\right]^{\gamma} + \left[\frac{1}{P_2 \times PM_2}\right]^{\gamma}}$$




## Results

The figure to the right shows the $CO_2$ emissions for the base case by sector. Emissions are projected to grow to 762 million tons by 2020. The annual average growth rate is 6.5%, which is higher than the historic growth rate of 4.9% for 1990-1999. However, under base case conditions, Turkey's emissions per unit of GDP fluctuate but end up at approximately the same point as current levels, that is, 0.93 kg $CO_2$ per US$1990. The emissions per population double to 5.8 tons $CO_2$/capita, but even at this rate, Turkey is still ranked near the bottom for 1998 levels of OECD countries. All sectors show emission increases; the largest are in the power and industrial sectors. This is a result of the expected base case energy development.

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

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