Appendix D

NEMS/EMM Model Changes From *AEO99*

This appendix discusses enhancements to the Electricity Market Module (EMM) of NEMS that were used in this study but made after completion of the *Annual Energy Outlook 1999* in 1998. The key changes involve revisions to the electricity dispatching algorithm, the methodology used to estimate sales growth for capacity planning decisions (demand foresight), and the representation of biomass co-firing. Two of these changes, those for demand foresight and biomass co-firing, were made to represent the assumptions of CECA. The revised dispatching algorithm is an enhancement to the model unrelated to CECA. Testing during its development produced results similar to those for the previous algorithm, with slightly higher interregional trades.

Electricity Dispatch

The Electricity Fuel Dispatch (EFD) submodule determines how to utilize (dispatch) existing generating capacity to meet the demand for electricity at the lowest cost. In the *AEO99* version of the EMM, this task was accomplished using a heuristic algorithm which started by ordering plants from lowest to highest cost (typically referred to as merit order) in each region. From the merit order the algorithm chose the capacity needed to meet each region's needs for each season and time of day. After this initial dispatch, the model then compared the costs of unused capacity in contiguous regions to evaluate whether it would be economical to trade power between the regions. If so, the initial dispatch was revised to take advantage of the interregional trade opportunity, subject to transmission constraints. This process has been replaced by an integrated linear programming algorithm that makes dispatch and trading decisions simultaneously.

The linear program provides a least-cost solution for all regions simultaneously, given fuel prices, plant availabilities, and interregional transmission constraints. Whereas the previous model solved for each region independently, the linear program provides unique solutions for all NERC regions and each of the 108 time slices. Certain technologies, such as hydroelectric power, solar thermal and photovoltaic power are not merit-order dispatched and are treated outside the linear programming structure by assuming they operate at a fixed capacity factor. The replacement of the heuristic algorithm with a linear program was done to improve the model's representation of competitive electricity markets, allowing multiregion power trades where they are economical.

Demand Foresight

Before making decisions about how much and what type of new capacity to build, the Electricity Capacity Planning (ECP) submodule of the EMM needs an estimate of what consumers' demand for electricity will be in the future. The demand growth projections—often referred to as demand foresight—together with fuel price and generating technology cost and performance information, are critical in capacity planning decisions. In *AEO99*, future demand growth expectations were based on the average growth over the previous 3 years. This algorithm tended to yield somewhat volatile projections, because the use of electricity in any given year—or short period of years—can be dramatically affected by weather and business cycles. For example, a mild weather year followed by 2 years of normal or warmer than normal weather together with strong economic growth could lead to unrealistically high

demand growth projections in the ECP. This algorithm has been revised to provide a smoother trajectory in the years immediately following the historical period. The demand foresight algorithm now uses exponential smoothing of the previous period's growth rates to create a growth rate for the planning horizon. An average historical growth rate was chosen, rather than the actual value derived from the year-to-year variation in demand.

Biomass Co-firing

In the *AEO99*, NEMS did not have the ability to allow coal plants to choose to co-fire with biomass fuel if it was economical. Several studies have reported that coal plants can burn a small amount (typically a few percent of their total fuel input) of biomass in place of coal without having to make significant capital expenditures. In addition, several bills in the Congress include incentives to encourage biomass co-firing in coal plants. As a result, the capability to represent biomass co-firing has been added to both the ECP and EFD submodules. Co-firing coal plants with biomass is now an additional option available in the ECP. The biomass fuel share chosen by the ECP is communicated to the EFD, and for those units dispatched, the fuel choice is adjusted accordingly.