

RENEWABLE FUELS MODULE

The renewable fuels module (RFM) represents renewable energy resources and large-scale technologies used for grid-connected U.S. electricity supply (Figure 11). Since most renewables (biomass, conventional hydroelectricity, geothermal, landfill gas, solar photovoltaics, solar thermal, and wind) are used to generate electricity, the RFM primarily interacts with the electricity market module (EMM).

New renewable energy generating capacity is either model-determined or based on surveys or other published information. A new unit is only included in surveys or accepted from published information if it is reported to or identified by the Energy Information Administration and the unit meets EIA criteria for inclusion (the unit exists, is under construction, under contract, is publicly declared by the vendor, or is mandated by state law, such as under a state renewable portfolio standard). EIA may also assume minimal builds for reasons based on historical experience (floors). The penetration of grid-connected renewable energy generating technologies, with the exception of landfill gas, is determined by the EMM.

Each renewable energy submodule of the RFM is treated independently of the others, except for their least-cost competition in the EMM. Because variable operation and maintenance costs for renewable technologies are lower than for any other major generating technology, and because they generally produce little or no air pollution, all available renewable capacity, except biomass, is assumed to be dispatched first by the EMM. Because of its potentially significant fuel cost, biomass is dispatched according to its variable cost by the EMM.

The near-term costs of renewable energy technologies can increase due to infrastructure constraints if new capacity is projected to increase by greater than 50 percent a year nationally. With significant growth over time, costs in the longer term are also assumed to be higher because of growing constraints on the availability of sites, natural resource degrada-

tion, and the need to upgrade existing transmission or distribution networks.

Geothermal-Electric Submodule

The geothermal-electric submodule provides the EMM the amounts of new geothermal capacity that can be built at 51 individual sites, along with related cost and performance data. The information is expressed in the form of a three-step supply function that represents the aggregate amount of new capacity and associated costs that can be offered in each year in each region.

Geothermal resource data are based on Sandia National Laboratory's 1991 geothermal resource assessment. Only hydrothermal (hot water and steam) resources are considered. Hot dry rock resources are not included, because they are not expected to be economically accessible during the NEMS forecast horizon.

Capital and operating costs are estimated separately, and life-cycle costs are calculated by the RFM. The costing methodology incorporates the effects of Federal and State energy tax construction and production incentives (if any).

Wind-Electric Submodule

The wind-electric submodule projects the availability of wind resources as well as the cost and performance of wind turbine generators. This information is passed to EMM so that wind turbines can be built and dispatched in competition with other electricity generating technologies. The wind turbine data are expressed in the form of energy supply curves that provide the maximum amount, capital cost, and capacity factor of turbine generating capacity that could be installed in a region in a year, given the available land area and wind speed.

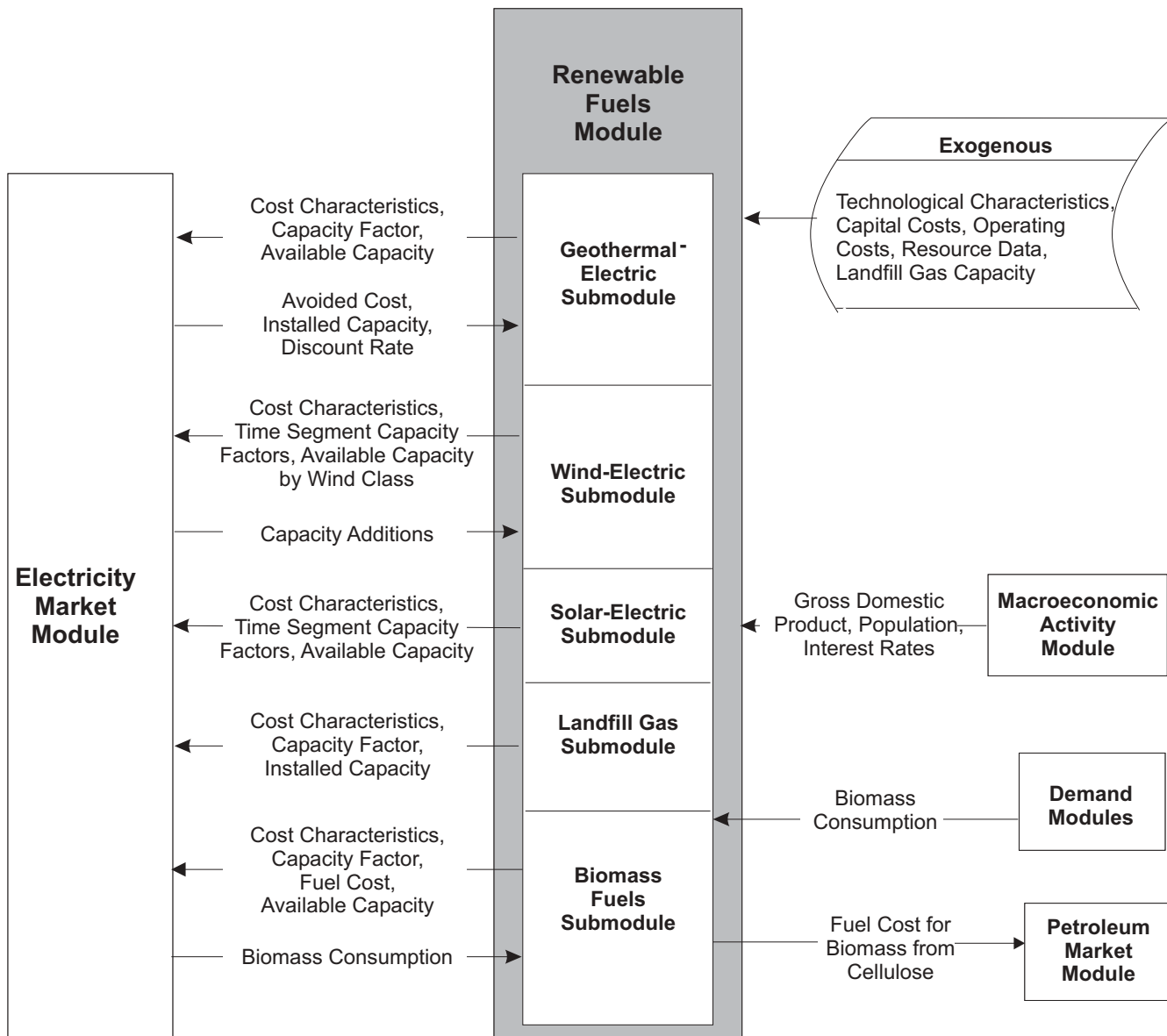
Solar-Electric Submodule

The solar-electric submodule represents both photovoltaic and high-temperature thermal electric (con-

RFM Outputs	Inputs from NEMS	Exogenous Inputs
Energy production capacities	Installed energy production capacity	Site-specific geothermal resource quality data
Capital costs	Gross domestic product	Site-specific wind resource quality data
Operating costs (including wood supply prices for the wood submodule)	Population	Plant utilization (capacity factor)
Capacity factors	Interest rates	Technology cost and performance parameters
Available capacity	Avoided cost of electricity	Landfill gas capacity
Biomass fuel costs	Discount rate	
Biomass supply curves	Capacity additions	
	Biomass consumption	

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Figure 11. Renewable Fuels Module Structure



centrating solar power) installations. Only central-station, grid-connected applications constructed by a utility or independent power producer are considered in this portion of the model.

The solar-electric submodule provides the EMM with time-of-day and seasonal solar availability data for each region, as well as current costs. The EMM

uses this data to evaluate the cost and performance of solar-electric technologies in regional grid applications. The commercial and residential demand modules of NEMS also model photovoltaic systems installed by consumers, as discussed in the demand module descriptions under “Distributed Generation.”

Landfill Gas Submodule

The landfill gas submodule provides annual projections of electricity generation from methane from landfills (landfill gas). The submodule uses the quantity of municipal solid waste (MSW) that is produced, the proportion of MSW that will be recycled, and the methane emission characteristics of three types of landfills to produce forecasts of the future electric power generating capacity from landfill gas. The amount of methane available is calculated by first determining the amount of total waste generated in the United States. The amount of total waste generated is derived from an econometric equation that uses gross domestic product and population as the forecast drivers. It is assumed that no new mass burn waste-to-energy (municipal solid waste) facilities will be built and operated during the forecast period in the United States. It is also assumed that operational mass-burn facilities will continue to operate and retire as planned throughout the forecast period. The landfill gas submodule passes cost and performance characteristics of the landfill gas-to-electricity technology to the EMM for capacity planning decisions. The amount of new landfill-gas-to-electricity capacity competes with other technologies using supply curves that are based on the amount of high, medium, and low methane producing landfills located in each EMM region.

Biomass Fuels Submodule

The biomass fuels submodule provides biomass-fired plant technology characterizations (capital costs, operating costs, capacity factors, etc.) and fuel information for EMM, thereby allowing biomass-fueled power plants to compete with other electricity generating technologies.

Biomass fuel prices are represented by a supply curve constructed according to the accessibility of resources to the electricity generation sector. The supply curve employs resource inventory and cost data for four categories of biomass fuel - urban wood waste and mill residues, forest residues, energy crops, and agricultural residues.²⁸ Fuel distribution and preparation cost data are built into these curves. The supply schedule of biomass fuel prices is combined with other variable operating costs associated with burning biomass. The aggregate variable cost is then passed to EMM.

²⁸ Urban Wood Waste and Mill Residues: Antares Group, Inc; Forest and Crop Residues: Oak Ridge National Laboratory; Energy Crops: Oak Ridge Energy Crop County Level Database (December 20, 1996); and Agricultural Residues: Oak Ridge National Laboratory.