Greenhouse Gas Reduction Measures, Interactions, and Cumulative Impacts: The All-Modular Integrated Growth Assessment (AMIGA) System

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The AMIGA economic model, coupled with four detailed, energy-intensive sector process models, form a general equilibrium system for studying energy markets and reduction of greenhouse gases (Figure 1). The AMIGA model, developed primarily by Donald Hanson, is part of the international Integrated Assessment Modeling Consortium (IAMC).

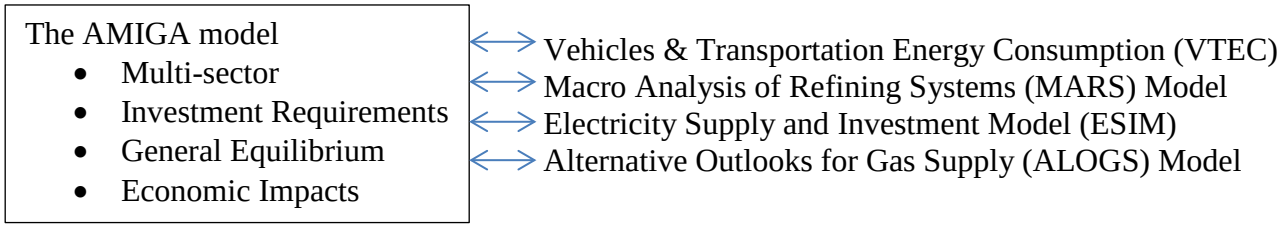

Figure 1: AMIGA Model System

The AMIGA economic model contains 80 industrial and service sectors. The model is used to develop the major components of gross domestic product (GDP) — consumption, investment, government, imports, and exports — based on bottom-up equations. The industrial and service sectors also provide intermediate inputs to production. Figure 2 shows a standard hierarchical configuration for production and input substitution in a typical economic sector.

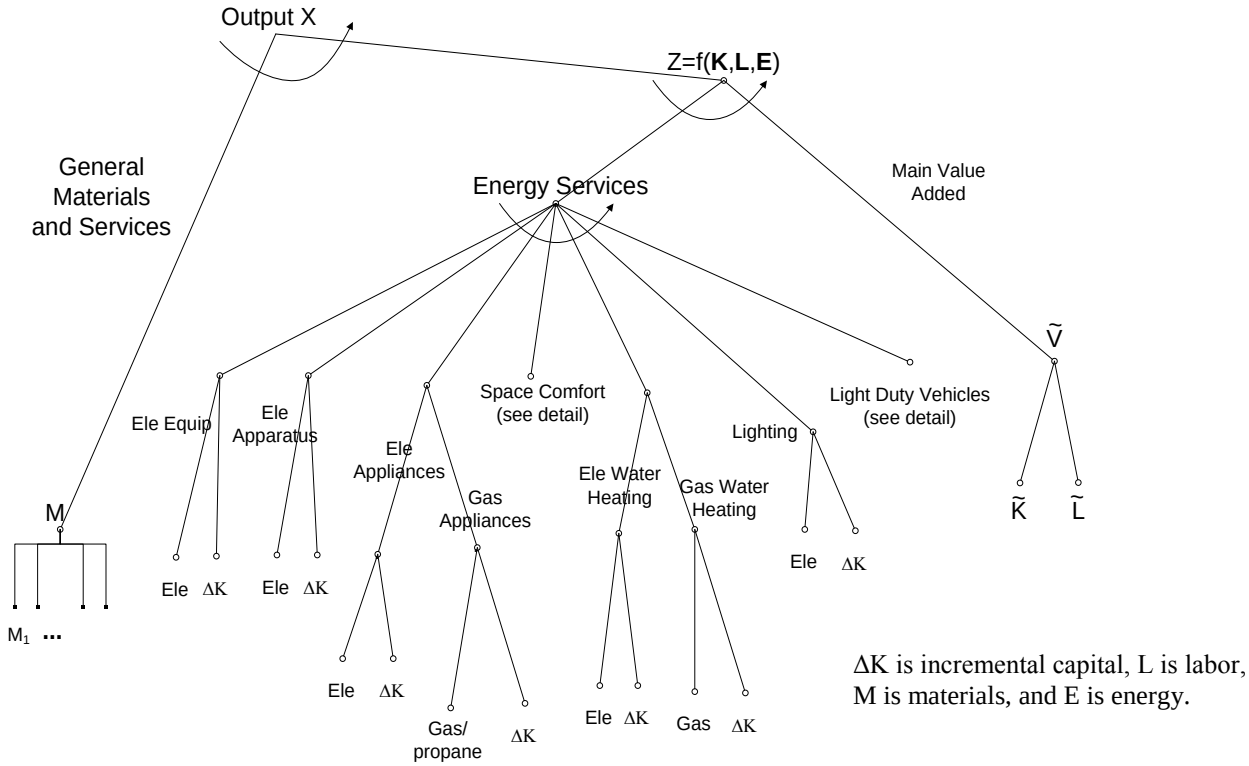

Figure 2: Typical Sector Production Hierarchy Configuration

Figure 2 shows how interaction effects are modeled. For example, building space heating and cooling are represented by an additional hierarchy in which building shell insulation interacts with heating, ventilation, and cooling requirements. At the broad general equilibrium level, a typical interaction category is “rebound effects’ due to substitution opportunities. The AMIGA model allows technical progress in production and factor substitution potential. The VTEC model uses similar hierarchies to capture interactions such as vehicle drivetrain options (e.g., hybrid electric vehicles), fuel economy, acceleration performance, cost, and vehicle miles traveled for ten vehicle size categories. Freight transportation is also modeled. This work was done in conjunction with the Argonne Center for Transportation Research. Refining of transportation fuels (including hydrogen production) is represented by the MARS model with 22 process steps (Figure 3), as specified by a refinery industry expert. Energy inputs and CO_2 emissions for each process have been characterized.

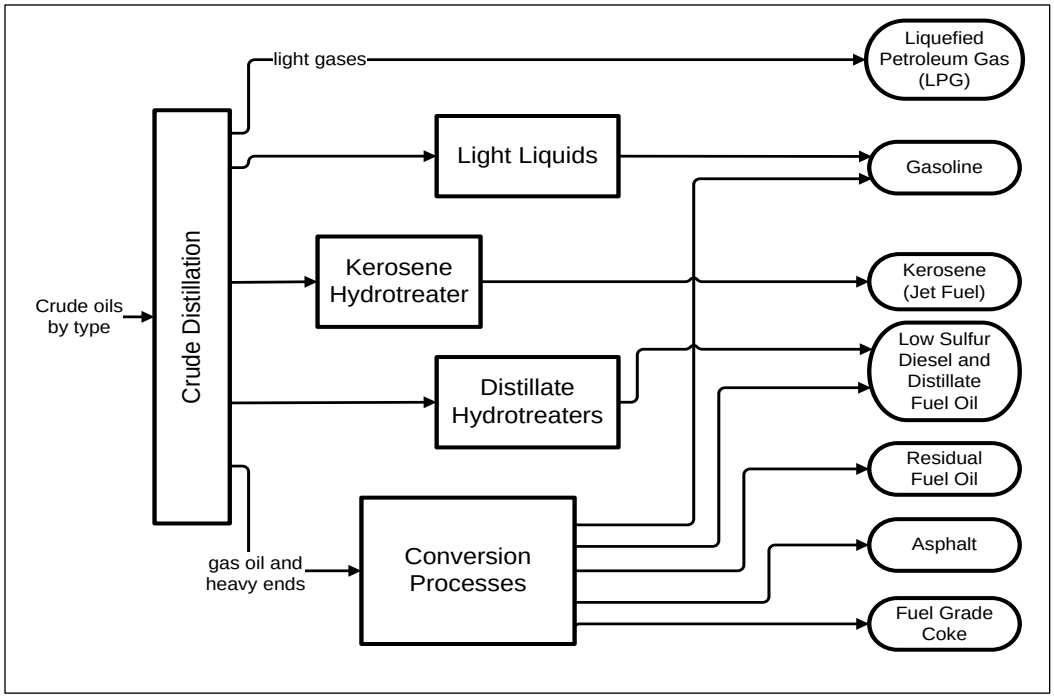

Figure 3: Fuel Refining

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