U.S. Energy Scenarios for the 21st Century:

Appendix D: AMIGA Model Abstract and Documentation

Prepared for the Pew Center on Global Climate Change

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Model Name

All-Modular Industry Growth Assessment Model

Model Acronym

AMIGA

Most Recent Model Documentation Available

D. Hanson, *A Framework for Economic Impact Analysis and Industry Growth Assessment: Description of the AMIGA System*, Policy and Economic Analysis Group, Decision and Information Sciences Division, Argonne National Laboratory, Argonne, IL, April 1999.

Description of the Model

The *All Modular Industry Growth Assessment* (AMIGA) model is a general equilibrium modeling system of the U.S. economy that covers the period from 1992 through 2050. It integrates features from the following five types of economic models:

1) *Multisector* — AMIGA starts by benchmarking to the 1992 Bureau of Economic Analysis (BEA) interindustry data, which a preprocessor aggregates to approximately 300 sectors;

2) *Explicit technology representation* — AMIGA reads in files with detailed lists of technologies (currently with a focus on energy-efficient and low-carbon energy supply technologies, including electric generating units) containing performance characteristics, availability status, costs, anticipated learning effects, and emission rates where appropriate;

3) *Computable General Equilibrium* — AMIGA computes a full-employment solution for demands, prices, costs, and outputs of interrelated products, including induced activities such as transportation and wholesale/retail trade;

4) *Macroeconomic* — AMIGA calculates national income, Gross Domestic Product (GDP), employment, a comprehensive list of consumption goods and services, the trade balance, and net foreign assets and examines inflationary pressures;

5) *Economic Growth* — AMIGA projects economic growth paths and long-term, dynamic effects of alternative investments including accumulation of residential, vehicle, and producer capital stocks.

In addition, the AMIGA system includes the Argonne Unit Planning and Compliance model that captures a wide variety of technology characteristics within the electric generating sector. This includes a system dispatch routine that allows both the retirement and the dispatch of units on the basis of traditional cost criteria as well as the impact of various permit prices on operating costs. It also includes non-utility generation sources such as industrial combined heat and power applications and renewable energy systems.

The AMIGA modeling system is a highly organized, flexible structure that is programmed in the C language. It includes modules for household demand, production of goods, motor vehicles, electricity supply, and residential and commercial buildings and appliances.

The production modules contain representations of labor, capital, and energy substitutions using a hierarchy of production functions. The adoption rates for cost-effective technologies depend on energy prices as well as policies and programs that lower the implicit discount rates (sometimes referred to as hurdle rates) that are used by households and businesses to evaluate energy-efficiency and energy supply measures.

Climate change mitigation policy has been the main application of the AMIGA system to date. But the AMIGA modeling system recently has been enhanced to include policies involving the reduction of sulfur dioxide, nitrogen oxide, and mercury emissions. Moreover, a new intertemporal optimization module has been added to AMIGA that allows an evaluation of early reductions and the banking of allowances to be incorporated into policy scenarios. Hence, the system is well suited to evaluate a variety of multi-emission strategies that are driven by price incentives as well as R&D programs, voluntary initiatives, and cap and trade policies.

Independent Expert Reviews

The following individuals provided an independent expert peer review of the April 1999 AMIGA Documentation Report:

(1) Hillard Huntington, Executive Director, Energy Modeling Forum

(2) Duane Chapman, Professor, Cornell University,

(3) Mustafa Babiker, Research Associate, M.I.T. Joint Program on Climate Change.

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Full Papers Available on the Model and its Applications

D. Hanson and J. Laitner, An Economic Growth Model of Investment, Energy Savings, and CO_2 Reductions, *Proceedings of the Air & Waste Management Association 93rd Annual Meeting*, Salt Lake City, UT, June 2000.

D. Hanson, P. Thimmapuram, M. Ross, and J. Laitner, Sector Impacts and Industrial Energy Reductions in the Clean Energy Futures Study , *Proceedings of the Air & Waste Management Association 93rd Annual Meeting*, Salt Lake City, UT, June 2000.

D. Hanson and J. Laitner, Energy-Economy Interactions Revisited Within a Comprehensive Sectoral Model , presented at the ENERGEX 8th International Energy Forum, Las Vegas, July 2000, and included in the book, *Energy 2000: The Beginning of a New Millennium*, Balaban Publishers, 2000.

J. Laitner, and D. Hanson, The Economic Impacts of a Clean Energy Future: An Integrated Analysis of Policies that Increase Investments in Advanced Efficient/Low-Carbon Technologies, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Washington, DC, 2000.