
ENERGY 2020 Documentation

Volume **6**

Professional History
and Bibliography

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Introduction

Systematic Solutions, Inc. (SSI), located in Fairborn, Ohio, was founded in 1985 by its President, Jeff Amlin. SSI employs a professional staff with complementary skills in economics, engineering, system dynamics, statistics, finance, and management science. SSI works closely with Policy Assessment Corporation, headed by George Backus. Mr. Backus has twenty years of experience developing integrated simulation models and is responsible for the methodological development of ENERGY 2020.

SSI also works with Regional Economic Models, Inc. (REMI), developer of the REMI socioeconomic model, developed by its president, George Treyz, and in use for over twelve years. REMI links with the ENERGY 2020 model to form a completely integrated model run through the ENERGY 2020 menus.

Our Beginnings and Track Record

The ENERGY 2020 system represents the culmination of a model development process that began in 1972 when techniques from the Apollo Space and Nuclear Safety Programs were used at MIT to provide an indication of the 1974 OPEC crisis to come. In 1976 an early version of the model (FOSSIL1) was developed at Dartmouth College under primary sponsorship from the US. Department of Energy (DOE).¹ FOSSIL1 modeled the supply and demand for all fuels including solar and nuclear power. The electric utility sector alone chose between 31 generation technologies.

In 1979, the DOE model was revised and renamed FOSSIL2 and it has been used to formulate national energy policy since President Carter's National Energy Plan II.² In 1990, FOSSIL2 was

¹Backus, G.A. et al., FOSSIL1: A Policy Analysis Model of the United States Energy System, Dartmouth System Dynamics Group, Dartmouth College, Hanover, New Hampshire, April 1977.

²U.S. Department of Energy, Energy Projections to the Year 2000, NTIS Document DOE/PE-0029, Washington, D.C., July 1981.
see also:

used for the pollution and greenhouse effect assessment of the U.S. energy strategy.³ FOSSIL2 replaced the original PIES (Project Independence) model developed during the Nixon Administration.

The public version of FOSSIL2 was called FOSSIL79⁴ and has been used by many oil companies and consulting firms for the analysis of synthetic fuels, oil and gas deregulation, and fuel needs for electric utilities.⁵ An international version of the FOSSIL79 model (NEP-2000) was also developed at Dartmouth College in 1979.⁶ This model showed the "1979 Fall of Iran" and is still properly "predicting" the recent trends in world oil prices.

In 1981, for national energy demand policy analysis, a new type of causal demand model (DEMAND81) was developed at Purdue University for incorporation into the FOSSIL2 model.⁷ After further development related to regional issues, DEMAND81 became the basis of the demand sector of ENERGY 2020. The ENERGY 2020 demand structure is a generalized enhancement of that used in REEPS, COMMEND, and ORIM.⁸

U.S. Department of Energy, Energy Projections to the Year 2010, NTIS Document DOE/PE-0029/2, Washington, D.C., October 1983.

³Naill, R., "Analysis of the Cost Effectiveness of U.S. Energy Policies to Mitigate Global Warming," 1990 International System Dynamics Conference, Boston MA, July 10-13, 1990.

⁴Backus, G. A., FOSSIL79: National Energy Policy Model, Resource Policy Center, Thayer School of Engineering, Dartmouth College, Report No. DSD-165 through DSD-168, 1979.

⁵Meloe, Tor, "The Good News and The Bad News," Energy Management, October/November 1980.

⁶Backus, G. A., Integrated Energy Analysis, Resource Policy Center, Thayer School of Engineering, Dartmouth College, Report No. DSD-194, 1979.

⁷Backus, G. A., DEMAND81: National Energy Policy Model, School of Industrial Engineering, Purdue University, Reports AFC-7 through AFC-10, 1981.

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Steinhurst, W., Energy Use in Vermont and the Public Interest, Vermont Department of Public Service, January 1984.

⁸Cambridge Systematics, Inc., Residential End-Use Energy Planning Model System (REEPS), Electric Power Research Institute, Report EA-2512, Palo Alto, California, July 1982.

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Jackson, J.R., et. al., "Conservation Policy Analysis and End-Use Models: A Commercial Sector Example" in Proceedings: End-Use Models and Conservation Analysis, Electric Power Research Institute, Report EPRI EA 2509, Palo Alto, CA, July 1982.

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Reister, D, et. al., "The Oak Ridge Industrial Model: An Introduction," in Proceedings: End-Use Models and Conservation Analysis, Electric Power Research Institute, Report EPRI EA 2509, Palo Alto, CA, July 1982.

In 1982, FOSSIL79 was refined, updated, and renamed the SUPPLY82 model.⁹ SUPPLY82 predicted the following five years would be a traumatic state of transition for the electric utilities. This forecast was proven to be accurate as the decade progressed.

The first integrated electric utility model to use the new demand concepts and a detailed electric supply sector was IPM (Integrated Planning Model).¹⁰ It was designed to examine the impacts of excess capacity and the completion of nuclear power plants. An advanced version with an integrated regional macroeconomic model called IPAF (Integrated Policy Analysis Framework) was implemented in 1984.¹¹ In the same year, the model was expanded to focus on the impacts of conservation programs on energy prices, consumer demand, and capacity expansion.

Finally, after completion of rigorous field and empirical testing, the IPM/IPAF models were standardized as UTILITY 2020.¹² UTILITY 2020 also was the model's first implementation on a microcomputer and included an advanced interactive user's interface for efficient and fast scenario analysis. This model was used to analyze issues relating to utility over capacity and conservation at Wisconsin Power and Light Company and was also used to simulate strategies to mitigate nuclear over capacity at Kansas Gas and Electric Company.

The ENERGY 2020 model expands on the UTILITY 2020 model by allowing disaggregation of energy consumers by economic category, end-use, and fuel. It also simulates all fuel supplies/prices for a specified level of detail.¹³ At the user's discretion, non-model segments can be replaced by those of the customer's choice.

In 1985, A breakthrough in uncertainty, sensitivity and confidence analysis capability was incorporated into ENERGY 2020 through the combined efforts of Los Alamos National Laboratory and the Control Data Corporation. The new package, called HYPERSENS, can quantify uncertainty and the data/assumptions that contribute to the uncertainty in a minimal

⁹Backus, G.A., and Amlin, J. S., SUPPLY82: Introduction to the Model, Control Data Corporation, Advanced Modeling and Simulation Group, January 14, 1982.

¹⁰Backus, G.A. and Amlin, J.S., Integrated Planning Model, Control Data Corporation, November 1983.

and see also:

Backus, G. A., "Integrated Utility Planning," ORSA/TIMS Joint Conference, San Diego, CA, October 25-27, 1982.

¹¹Backus, G.A., Integrated Policy Analysis Framework, Control Data Corporation, March 1984.

¹²Backus, G.A., UTILITY 2020 Documentation, Policy Assessment Corporation, St. Paul, MN, March 1986.

¹³Backus, G.A., ENERGY 2020 Documentation, Policy Assessment Corporation, St. Paul, MN, April 1987

number of simulations. Optimally robust plans can be quickly determined and data requirements/costs minimized.¹⁴

By 1986, Vermont DPS, Massachusetts Energy Office, Illinois DENR, American Public Power Association and the New Zealand Ministry of Energy were using ENERGY 2020 for assessing integrated supply and demand policy. Each model, custom-tailored for the user, varied in emphasis. For example, the Illinois Department of Energy and Natural Resources used ENERGY 2020 to complete their required annual Statewide Gas and Electric Utility Plans involving the assessment of a large number of scenarios and policy options.¹⁵

After extensive review, the American Public Power Association (APPA), under DOE's LCUP program, selected ENERGY 2020 in 1987 as the basis for its COMPLEAT (Comprehensive Model for Planning Least-Cost Energy Alternatives and Technologies) model. COMPLEAT provides complete planning capabilities for small public power utilities. Its easy-to-use user-interface is now the basis for the ENERGY 2020 interface.

In 1988, the state of Massachusetts Executive Office of Energy Resources was the first organization to utilize simultaneously ENERGY 2020's gas utility, electric utility, independent power producer, and macroeconomic simulation capabilities for truly comprehensive and integrated planning.¹⁶ Also in 1988, a gaming version of ENERGY 2020 was developed, allowing the testing of utility deregulation policies.¹⁷

In 1989, the state of Vermont's Department of Public Service added environmental capabilities to assess the economic, financial and environmental impacts/benefits of the Champlain Pipeline

¹⁴Ford, A., G. Moore, and M. McKay, Sensitivity Analysis of Large Computer Models, A Case Study of the COAL2 National Energy Model, Los Alamos National Laboratory, LA-7772-MS, informal report, April, 1979.

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Amlin J., et. al., A Practical Approach to Sensitivity Testing of System Dynamics Models, 1983 International System Dynamics Conference, Chestnut Hill, MA, July 27-30, 1983.

¹⁵Jensen, V., "Least-Cost Planning: The Illinois Experience," Public Utilities Fortnightly, March 29, 1990.

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Jensen, Val., et. al., The Illinois Statewide Electric Utility Plan, Illinois Department of Energy and Natural Resources, Report ILENR/RE-SP/89/01 (3 Volumes), Springfield, Illinois, January 1989.

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Jensen, Val., et. al., The Illinois Statewide Gas Utility Plan, Illinois Department of Energy and Natural Resources, Report ILENR/RE-SP-90/03 (2 Volumes), Springfield, Illinois, February 1990.

¹⁶State Annual Forecast of Energy Resources 1988-2000, The Executive Office of Energy Resources, Commonwealth of Massachusetts, 3 Volumes, Boston, Massachusetts, December 1988.

¹⁷Xiaobo Zhang and Jeff Amlin, "A System Dynamics Gaming Model of Deregulation of the Electric Utility Industry," 1988 Winter Simulation Conference, San Diego, January 5-9, 1988.

project.¹⁸ Central Maine Power, the Massachusetts Energy Office and the American Public Power Association also used the model for integrated resource planning and environmental accounting.

Several foreign organizations have the ENERGY 2020 model, and ENERGY 2020 has been evaluated both at home and internationally.¹⁹ In 1990, a California Energy Commission study which evaluated 26 energy simulation models showed that ENERGY 2020 is the best model for planning and analysis for a 3 to 30 year time horizon.²⁰

Also in 1990, the PROMULA language (in which ENERGY 2020 is written) was used to link ENERGY 2020 to existing Electric Power Research Institute (EPRI) models for Southern Company Services. Independent documentation for the model also became available.²¹ Instar Community Systems, Inc., APPA, and EPRI initiated the LOAD-UP (Library of Automated Demand-Side Uncertainties and Parameters) and DSM-UP (Demand-Side Management Uncertainties and Priorities) programs which take advantage of ENERGY 2020's HYPERSENS

¹⁸Steinhurst, W., "Application of System Dynamics to an Integrated Economic and Environmental Policy Assessment," 1990 International System Dynamics Conference, Boston MA, July 10-13, 1990.

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Steinhurst, W., et.al., Champlain Pipeline Project: Energy and Economic Systems Assessment, Vermont Department of Public Service, Technical Report 15, Montpelier, Vermont, September 1989.

¹⁹W. Wils, Overview of System Dynamics the World Over, Croon DeVries bv, Maarssen, The Netherlands, October 1988.

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Adelaar, Martin, "DSM Model Survey for the Canadian Energy Association," Marbek Resource Consultants, Ltd., Ottawa Canada, in preparation 1990.

²⁰Borison, A., et. al., Integrated Energy Models: Recommendations for the California Energy Commission, Applied Decision Analysis, Inc., ADA-88-2066, Menlo Park, California, October 1989.

²¹Davulis, J. and Barton, J., "A Systems Approach to Sustainable Growth Modeling," 16th Annual International Conference of the Solar Energy Society of Canada, Halifax, Nova Scotia, June 18-20, 1990.

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Davulis, J. and Goluke, U., "Building an Operational Learning Environment," 1990 International System Dynamics Conference, Boston MA, July 10-13, 1990.

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Central Maine Power Company, Determining Energy Demand, Market Research and Forecasting Department, Central Maine Power Company, Augusta, Maine, June 1990.

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Central Maine Power Company, Long-Range Forecast of Electric Energy and Peak Load 1988-2018, Market Research and Forecasting Department, Central Maine Power Company, Augusta, Maine, June 1990.

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Davulis, J. et. al., ENERGY 2020 Model Documentation, Central Maine Power Company, Augusta, Maine, October 1987.

and dynamic DSM scenario capabilities to analyze DSM programs that are robust and effective under any conditions.²²

In 1991, the Canadian Ministry of Energy used ENERGY 2020 in its National Energy Planning and the Solar Energy Research Institute evaluated renewable energy policies with ENERGY 2020.

At the semi-annual ENERGY 2020/COMPLEAT Conference, users present new model enhancements, developments, and analyses. While the 1989 conference highlighted new pollution simulation capabilities, the 1991 conference focused on DSM and competition by combining the strengths of ENERGY 2020 and COMPLEAT into a single model.

In 1992 the model was being used for oil and gas resource and industry simulation (Canadian Ministry of Energy) and evaluating the effects of a nuclear shut-down (Illinois DENR).

New clients with new uses and problems for ENERGY 2020 include integrated state and regional energy planning for the New England Governors' Conference and U.S. DOE, aiding the development of the Hawaii Energy Strategy by the Hawaii Department of Business, Economic Development and Tourism, and examining the competitive issues for Public Service Indiana.

Over its history, a large number of professionals at various institutions have contributed to the development of the ENERGY 2020 system, including individuals from Dartmouth College, Purdue University, Los Alamos National Laboratory, Control Data Corp., PROMULA Development Corp., Policy Assessment Corp., and Systematic Solutions, Inc.²³ ENERGY 2020 represents over 250 experience-years of model use and development at the federal, state, and company level. Over fifteen million dollars have been spent on development and testing of the ENERGY 2020 model and its predecessors. The model has been widely disseminated to

²²Anonymous, "DEED Awards \$174,541," Public Power Weekly, April 9, 1990.

²³Backus, G.A., and Amlin, J. S., SUPPLY82: Introduction to the Model, Control Data Corporation, Advanced Modeling and Simulation Group, January 14, 1982.

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