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The IEA/ORAU Long-Term Global Energy-CO_2 Model: Personal Computer Version A84PC

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MANAGED AND OPERATED BY
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THE IEA/ORAU LONG-TERM GLOBAL ENERGY-CO2 MODEL:

PERSONAL COMPUTER VERSION A84PC

Contributed by
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ACKNOWLEDGMENTS

The Carbon Dioxide Information Center (CDIC) is grateful to Jae A. Edmonds and John M. Reilly for their willingness to allow CDIC to serve as the focal point for the compilation and dissemination of the personal computer and mainframe versions of the IEA/ORAU Long-Term Global Energy-CO_2 Model. Their cooperation in preparing these computer model packages has been greatly appreciated. The model was developed for and sponsored by the U.S. Department of Energy, Office of Energy Research, Carbon Dioxide Research Division.

THE IEA/ORAU LONG-TERM GLOBAL ENERGY-CO_2 MODEL: PERSONAL COMPUTER VERSION A84PC
ABSTRACT

DOI: 10.3334/CDIAC/ess.cmp002

1. **MODEL PACKAGE NAME**

IEA/ORAU Long-Term Global Energy-CO_2 Model:
Personal Computer Version A84PC

2. **CONTRIBUTORS**

J.A. Edmonds* and J.M. Reilly*
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Oak Ridge Associated Universities
Washington, DC 20036

3. **BACKGROUND HISTORY**

The IEA/ORAU Long-Term Global Energy-CO_2 Model was developed for and supported by the U.S. Department of Energy (DOE), Office of Energy Research, Carbon Dioxide Research Division. The model, which was developed by J.A. Edmonds and J.M. Reilly, was originally adapted for a main frame environment, with the computer code written in FORTRAN IV. The Carbon Dioxide Information Center (CDIC) packaged the main frame version in 1984 (Edmonds and Reilly, 1984). In the summer of 1985, the mainframe version was modified for use on an IBM personal computer (PC) as part of a joint venture between the Institute for Energy Analysis, Oak Ridge Associated Universities (IEA/ORAU) and CDIC. This PC version was presented for the first time at a conference in Villach, Austria, on October 10, 1985. Because of the positive response received at the conference and the large number of requests for the PC version, a user's guide was written (Edmonds 1986) and the PC version was packaged. At present, both the mainframe version and the PC version of the model are available from CDIC. Differences between the mainframe version and the PC version are discussed in the user's guide and the pertinent literature provided in this document.

4. **FEATURES OF THE PC VERSION**

The PC version of the IEA/ORAU Long-Term Global Energy-CO_2 Model offers the user several new features that the main frame version did not provide. It enables the user to modify interactively a total of 39 different major assumptions from 12 categories (e.g., population, labor productivity, and synthetic fuel costs) through the use of an internal data editor. As in the main frame version, modifications to the data, source

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code, or other assumptions can still be made with any text editor. The internal data editor provides a way to temporarily change assumptions and to identify default values of the model. The PC version also provides the interactive capability of displaying graphical or tabular results on a graphics monitor and printing listings of the results. Another feature is the ease with which the model is executed. Only three commands are needed to execute the model after preparation and installation on the user's PC:

RUNMODEL - This command initiates the model run. All subsequent procedures are directed by a menu-driven interactive set of commands.

VIEWRUN - This command initiates an interactive graphical display program. Output can be displayed in either tabular or graphical form.

PRINTRUN - This command sends tabular output to the printer. All tables available in VIEWRUN are printed. Graphs cannot be printed.

This package includes the user's guide (Edmonds 1986), pertinent background literature, and three floppy diskettes containing the source codes and files needed to execute the model. The PC version of the model can be obtained in two forms: (1) ready-to-run (executive load module) and (2) uncompiled FORTRAN code.

5. MINIMUM COMPUTER HARDWARE REQUIRED TO RUN THE MODEL

(1) PC with a minimum of 520K memory
(2) Two floppy disk drives

For graphics:

(3) Monochrome or color graphics monitor
(4) Graphics adapter

Recommended hardware:

(1) PC with a minimum of 520K memory
(2) One floppy disk drive and one hard disk drive
(3) Math co-processor
(4) Enhanced graphics display monitor
(5) Enhanced graphics adapter

The system on which the PC version was developed was an IBM XT with a math co-processor and an enhanced graphics adapter.

6. MINIMUM SOFTWARE REQUIREMENTS

(1) IBM DOS 3.0 or a more recent version

7. TYPICAL RUNNING TIME

Running times will vary according to the PC environment and the number of modifications to the input assumptions that are made. For the basic model, running times can vary from 30 seconds to greater than 30 minutes. For cases where numerous modifications have been made, the running time may exceed 1 hour. As long as the message "The Program is Running" appears on the screen, the model is being executed, and the user should not be concerned that the model has failed.

8. SCOPE OF THE MODEL

The IEA/ORAU Long-Term Global Energy-CO_2 Model is a mathematical model which integrates economic, demographic, technological, and geological factors to make long-term projections about global energy and CO_2 emissions. The model can make projections through the year 2100, with the benchmark years being 2000, 2025, 2050, 2075, and 2100. The data base provided contains median values for key variables and was developed as part of a study of the uncertainty associated with future CO_2 emissions (Edmonds, Reilly, Gardner, and Brenkert 1985). The model divides the world into nine global regions: 1) the United States, 2) Western Europe and Canada, 3) Japan, Australia, and New Zealand, 4) USSR and Eastern Europe, 5) China and other Asian Centrally Planned Economies, 6) Mideast, 7) Africa, 8) Latin America, and 9) Southeast Asia, and consists primarily of four parts: (1) demand, (2) supply, (3) energy balance, and (4) CO_2 emissions.

The model computes energy demand for each of six major sources of energy for each of the nine regions. The six major energy sources are: (1) oil, (2) gas, (3) solids (e.g., coal, and biomass), (4) resource-constrained renewables (i.e., hydroelectric power), (5) nuclear, and (6) solar. Energy demand is a function of the population, labor productivity, economic activity, technological change, energy prices, and energy taxes and tariffs in each of the nine global regions.

Energy supply is disaggregated into two categories, renewable and non renewable, and is dependent upon resource constraints, behavioral assumptions, and energy prices for the various regions.

The energy balance module is a set of rules for choosing energy prices, which, on successive attempts, brings global energy supply and demand nearer a system wide balance. Successive energy prices are chosen until energy markets balance within prespecified bounds.

The CO_2 emissions component of the model applies appropriate carbon coefficients to the points in the energy flow where carbon is released after an energy balance has been reached. Carbon releases are associated with the consumption of coal, oil, and gas. The carbon coefficients, expressed in teragrams per exajoules, used in the model for liquids, gases, solids, and carbonate rock mining are 19.2, 13.7, 23.8, and 27.9, respectively.

Further details about the model are provided in the references at the back of this document.

9. METHOD OF SOLUTION

The computer program is controlled by the main program, which calls subroutines to perform major tasks and subtasks. The supply and demand modules determine the supply and demand estimates for each of the six major energy sources for each of the nine separate regions. If energy supply and demand match when summed across all trading regions in each group for each energy source, then the global energy system balances. Such a result is unlikely at any arbitrary setting of energy prices. The energy balance component of the model contains a set of rules for choosing energy prices that, on successive iterations, brings supply and demand nearer a system wide balance. Successive energy prices are chosen until energy markets balance within prespecified bounds. After the system balances, CO_2 emissions are calculated for regions where oil, gas, and coal are consumed.

10. RESTRICTIONS OR LIMITATIONS

The data set provided with the computer code was developed as part of a study of the uncertainty associated with future CO_2 emissions. No attempt was made to ensure that the regionally disaggregated pattern of energy supply was accurate. As a consequence, numerous anomalous regional disaggregates appear, and the user should therefore be cautious in using regionally disaggregated results, particularly in the area of energy supply. One minor discrepancy exists in the way the output is listed for energy demand. In the OECD (Organization for Economic Co-operation and Development) regions, energy consumption is broken into three end-use sectors: (1) residential/commercial, (2) industrial, and (3) transport whereas in the remaining six regions, final energy consumption is grouped into a single aggregate sector.

In some cases where several of the default values are changed to either extremely high or extremely low values, the model will be unable to attain an equilibrium and consequently will not produce any results. A shortcoming of the PRINTRUN command is that it prints the tables or graphs that the model has created but does not provide a listing of the default values or changed values that have been used to obtain the results. To obtain a listing of these values, the user must print the assumption screen or manually record the values **before** running the model. A screen listing can be obtained by pressing [Shift] [PrtSc]. For users with Professional Graphics Display monitors, occasionally when the graph option of VIEWRUN is in use, the message " *ERROR* unable to open device*" will appear. This is the result of a problem with the IBM Virtual Device Interface, which seems to occur at random and has only been encountered with the Professional Graphics Display monitors. If this happens, type VIEWRUN and try the graph option again.

11. REFERENCES

Included in the package:

Edmonds, J. A. 1986. User's guide to the IEA/ORAU Long-Term Global Energy Economic Model with Carbon Dioxide Emissions: Personal Computer Version A84PC. Institute for Energy Analysis, Oak Ridge Associated Universities, Washington, D.C.

Edmonds, J. A., and J. M. Reilly. 1982. An introduction to the use of the IEA/ORAU Long-Term, Global, Energy Model. Institute for Energy Analysis Working Paper, Contribution No. 82-9. Institute for Energy Analysis, Oak Ridge Associated Universities, Washington, D.C.

Edmonds, J. A., and J. M. Reilly. 1983. A long-term global energy-economic model of carbon dioxide release from fossil fuel use. Energy Economics 5(2): 74-88.

Background information:

Edmonds, J. A. 1983. The Long-Term Global Energy-CO_2 Model: Software description, Institute for Energy Analysis, Oak Ridge Associated Universities, Washington, D.C.

Edmonds, J. A., J. M. Reilly, J. R. Trabalka, and D. E. Reichle. 1983. An analysis of possible future atmospheric retention of fossil fuel CO_2, TR013 DOE/OR/21400-1. U.S. Department of Energy, Washington, D.C.

Edmonds, J. A., and J. M. Reilly. 1983. Global energy productions and use to the year 2050, Energy (Oxford) 8(6): 419-432.

Edmonds, J. A., and J. M. Reilly. 1984. The IEA/ORAU Long-Term Global-CO_2 Model. CMP-002. Carbon Dioxide Information Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Edmonds, J., J. Reilly, R. Gardner, and A. Brenkert. 1985. Uncertainty in carbon emissions, 1975-2075. Report prepared for and submitted to the U. S. Department of Energy. Institute for Energy Analysis, Oak Ridge Associated Universities, Washington, D.C.

Wahl, D., and J. A. Edmonds. 1983. A User's guide for the IEA/ORAU Long-Term Energy-CO_2 Model (Version V.11.22.82.B). Institute for Energy Analysis, Oak Ridge Associate Universities, Washington, D.C.

12. KEYWORDS

ENERGY ANALYSIS, ENERGY BALANCE, ENERGY CONSUMPTION, ENERGY DEMAND, ENERGY ECONOMICS, ENERGY SCENARIOS, FORECASTING, GLOBAL MODEL, REGIONAL ANALYSIS.

13. HOW TO OBTAIN THE PACKAGE

The package may be requested from

Carbon Dioxide Information Center
Oak Ridge National Laboratory
Oak Ridge, TN 37831-6050
Telephone: (615) 574-0390
FTS 624-0390

14. COMPUTER MODEL PACKAGE PREPARED BY:

Thomas A. Boden - package coordination
Steven E. Reynolds - computer programming and graphics

It should be noted that each computer model package (CMP) and numeric data package (NDP) assembled by CDIC is subjected to a process for ensuring the quality of the model or the data. This process includes reviews by the contributors of the data to ensure that, in compiling the data or model, CDIC does not misrepresent or inaccurately describe the model or data. Neither NDPs or CMPs are distributed by CDIC without the written consent of the contributors.

PC PREPARATION AND INSTALLATION

The PC version of the IEA/ORAU Long-Term Global-Energy CO_2 Model can be run on most graphics monitors and adapters. This is done by using the Virtual Device Interface developed by IBM. The device driver for this interface is installed in the CONFIG.SYS file and is initialized in the AUTOEXEC.BAT file. All of the installation and initialization is done by the CO2INSTL.EXE program. To begin, follow the steps listed below under either Floppy Disk System or Hard Disk System.

Floppy Disk System

Step 1: Make duplicate or backup copies of the three diskettes provided in the package.

Step 2: Place disk A into drive A and disk B into drive B and start the installation procedure on the system either by turning the PC on or, if it is already on, by pressing [Ctrl], [Alt], and [Del] simultaneously. Note that diskette C is not used in floppy disk systems. This diskette contains the source code for the model.

Step 3: If the Virtual Device Interface driver has not already been installed, then the CO2INSTL.EXE program is started and the user is prompted for the type of installation, as illustrated below. The correct response is F or f, followed by a carriage return.

```
---------------------------------------------------
Type of Disk Installation
---------------------------------------------------

[H]ard disk drive

[F]loppy disk drive

[Q]uit the installation procedure


Enter H, F, or Q for your type of disk: f
```

Step 4: After selecting the type of disk installation, the user is asked for the type of display for his/her system. The user then selects the appropriate display from the choices given, followed by a carriage return.

```
-------------------------------------------------------
Type of Display
-------------------------------------------------------

[M]onochrome graphics adapter

[C]olor graphics adapter

[E]nhanced graphics adapter

[P]rofessional graphics adapter

[Q]uit the installation procedure

Enter M, C, E, P, or Q for your type of display:
```

Step 5: Next, the user must restart the system by simultaneously pressing [Ctrl], [Alt], and [Del]. The installation is now complete, and the model is ready to be run. From this point forward, whenever the model is to be run, the user must insert disks A and B into drives A and B, respectively, followed by a restart of the system (either turn your PC on or, if already on, press [Ctrl], [Alt], and [Del] simultaneously).

Step 6: The user is now ready to run the model. For instructions on running the model, refer to page 15 of the user's guide (Edmonds 1986) provided in this package. Directions on how to alter assumptions, print results, or view tables and graphs are provided in the user's guide.

Hard Disk System

Step 1: Make duplicate or backup copies of the three diskettes provided in the package.

Step 2: Create a new subdirectory on the hard disk (e.g., MD\CO2MODEL).

Step 3: Copy all three diskettes (A, B, and C) to the new subdirectory.

Step 4: Make the new subdirectory the default or active directory (e.g., CD\CO2MODEL), and type CO2INSTL, followed by a carriage return.

Step 5: The user will be prompted for the type of installation. The correct response is H or h for hard disk followed by a carriage return.

```
-------------------------------------------------------
Type of Disk Installation
-------------------------------------------------------

[H]ard disk drive

[F]loppy disk drive

[Q]uit the installation procedure

Enter H, F, or Q for your type of disk: h
```

Step 6: The user will then be prompted for the disk drive letter of the boot drive. The correct response depends on how many floppy drives the user has installed. If two floppy drives were installed, the correct response is C. If there are three floppy drives then the correct answer is D, and so on.

```
Enter the drive letter (probably C or D):
```

Step 7: The user is then asked for the type of system display.

```
------------------------------------------------------------
Type of Display
------------------------------------------------------------

[M]onochrome graphics adapter

[C]olor graphics adapter

[E]nhanced graphics adapter

[P]rofessional graphics adapter

[Q]uit the installation procedure

Enter M, C, E, P, or Q for your type of display:
```

Step 8: When the installation is complete, the user must restart the system by simultaneously pressing [Ctrl], [Alt], and [Del]. The installation is now complete, and the model is ready to be run.

Step 9: The user is now ready to run the model. For instructions on running the model, refer to page 15 of the user's guide (Edmonds 1986) provided in this package. Directions on how to alter assumptions, print results, or view tables and graphs are provided in the user's guide.

USER'S GUIDE TO THE MODEL

Edmonds, J. A. 1986. User's Guide to the IEA/ORAU Long-Term Global Energy Economic Model with Carbon Dioxide Emissions: Personal Computer Version A84PC, Institute for Energy Analysis, Oak Ridge Associated Universities.

USER'S GUIDE TO THE IEA/ORAU LONG-TERM GLOBAL ENERGY ECONOMIC MODEL WITH CARBON DIOXIDE EMISSIONS: PERSONAL COMPUTER VERSION A84PC

by

Jae Edmonds

June 1, 1986

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CONTENTS

ACKNOWLEDGMENTS

The user's guide represents a major investment in time and effort to make available to the broader global climate change and sea level rise research community a tool of analysis for the study of future fossil fuel CO_2 emissions. Authorship alone does not reflect the contributions to this document.

To begin with the whole idea of outreach originated with Fred Koomanoff, whose desire to open up the results of researchers' endeavors to the widest possible audience, and to make those results available to all interested parties, motivated and guided the entire endeavor. I would also like to express my appreciation to Roger Dahlman who encouaged me to make this effort a priority item on my work agenda. Without the support of Fred and Roger the guide would not have been possible.

Special thanks and appreciation go to Kim Yamane. Kim, a college intern from Whitman College under the American University Washington Semester Program, learned to run the program, then wrote, edited, and drew artwork for the guide. Kim showed uncommon ability for her young age and made it possible to produce a high quality manuscript in record time. I deeply appreciate Kim's contributions.

This guide was prepared in cooperation with the Carbon Dioxide Information Center at the Oak Ridge National Laboratory. Mike Farrell, the Center's director, has been extremely helpful and cooperative in preparing this model for distribution. I appreciate his efforts and those of his staff, particularly those of Steve Reynolds.

Finally, there is Fay Kidd who, with her trusty wordprocessor "Bertha," turned a mess of scribbles into legible text and worked with me through numerous revisions to mold the guide into its final form. Without Fay none of this would have seen the light of day. I am deeply appreciative of Fay's multitudinous contributions.

PREFACE

The personal computer version of the IEA/ORAU long-term global energy-economic model with CO_2 emissions was unveiled at the Villach Conference on October 10, 1985. The model had been transferred from the main frame environment in which it had been previously resident to an IBM PC during the summer of 1985. This work proceeded as a joint venture between the Oak Ridge Associated Universities, Institute for Energy Analysis (ORAU/IEA) and the Oak Ridge National Laboratory, Carbon Dioxide Information Center (ORNL/CDIC). Mike Farrell coordinated the effort for ORNL. Steve Reynolds applied computer magic.

The response at the meeting was overwhelming. I left the meeting with a long list of persons requesting a copy of the PC version of the model. This user's guide is a direct outgrowth of the demand for a usable model of future global fossil fuel CO_2 emissions.

CHAPTER I
INTRODUCTION

This document is intended to enable a user to use the personal computer version of the IEA/ORAU Long-Term Global Energy-Economic Model with fossil fuel CO_2 emissions. It provides the user with a brief introduction to the model, its nature and its capabilities (Chapters I, II, III). Its main objective is to enable the user to run the model and obtain output. This discussion is conducted at two levels: general user (Chapters IV and V) and technical specialist (Chapters VI and VII).

> NOTE: To obtain a copy of the model contact the
> Carbon Dioxide Information Center
> P.O. Box X
> Oak Ridge, TN 37831
> The model is available in two forms: (1) ready to run (executive load module) and (2) uncompiled FORTRAN code. Users who wish to obtain the Fortran code must have access to their own compiler to modify and/or run the model.

This guide assumes that the user has already installed the model, as delivered from CDIC, on their IBM personal computer. To run the model, the following hardware is necessary:

IBM PC with > 520K

To run the color graphics output module the user also needs to have access to

IBM Color Monitor
Color Graphics Board

> Note: The program will display tabular but not graphical output on any monitor.

Another useful piece of hardware is a printer.

The model was developed for the U.S. Department of Energy, Office of Energy Research, Carbon Dioxide Research Division to assist them in their study of energy and global climate change. This model analyzes the relationship between economic, technological, demographic, and geological factors influencing the long-term production, consumption and trade of energy on a global scale. An additional module computes the emission of CO_2 as a function of fossil fuel use.

Time Scale: The model is a long-term forecast. It can be run as far into the future as the year 2100. Benchmark years are, 2000, 2025, 2050, 2075, and 2100.

Geopolitical Scale: The model covers energy production and use for the entire world. The world is divided into nine global regions (Figure 1.1):

1 USA
2 Western Europe and Canada
3 Japan, Australia, and New Zealand
4 USSR and Eastern Europe
5 China and other Asian Centrally Planned Economies
6 Mideast
7 Africa
8 Latin America
9 South and East Asia

Other aggregates that will be referred to in this user's guide are:

Aggregate	Regions Included
OECD (Organization for Economic Co-operation and Development)	1 + 2 + 3
North	1 + 2 + 3 + 4
South	5 + 6 + 7 + 8 + 9
CPE (Centrally Planned Economies)	4 + 5

The Data Base: The data base provided with this code is one which contains median (best guess) values for key variables. This data set was developed as part of a study of uncertainty in future CO_2 emissions. The researchers felt comfortable with the resulting global aggregate forecasts generated by this data set and model. No attempt was made to insure that the regionally disaggregated pattern of energy supply was reasonable. As a consequence numerous anomolous regional disaggregates appear. The user is cautioned to take care in the use of regionally disaggregated results particularly in the area of energy supply. Neither the authors nor the Oak Ridge Associated Universities, nor CDIC, nor the U.S. Department of Energy, nor the U.S. Government make any warranty, expressed or implied or assume completeness or usefulness of any information contained in this document or in the model it describes.

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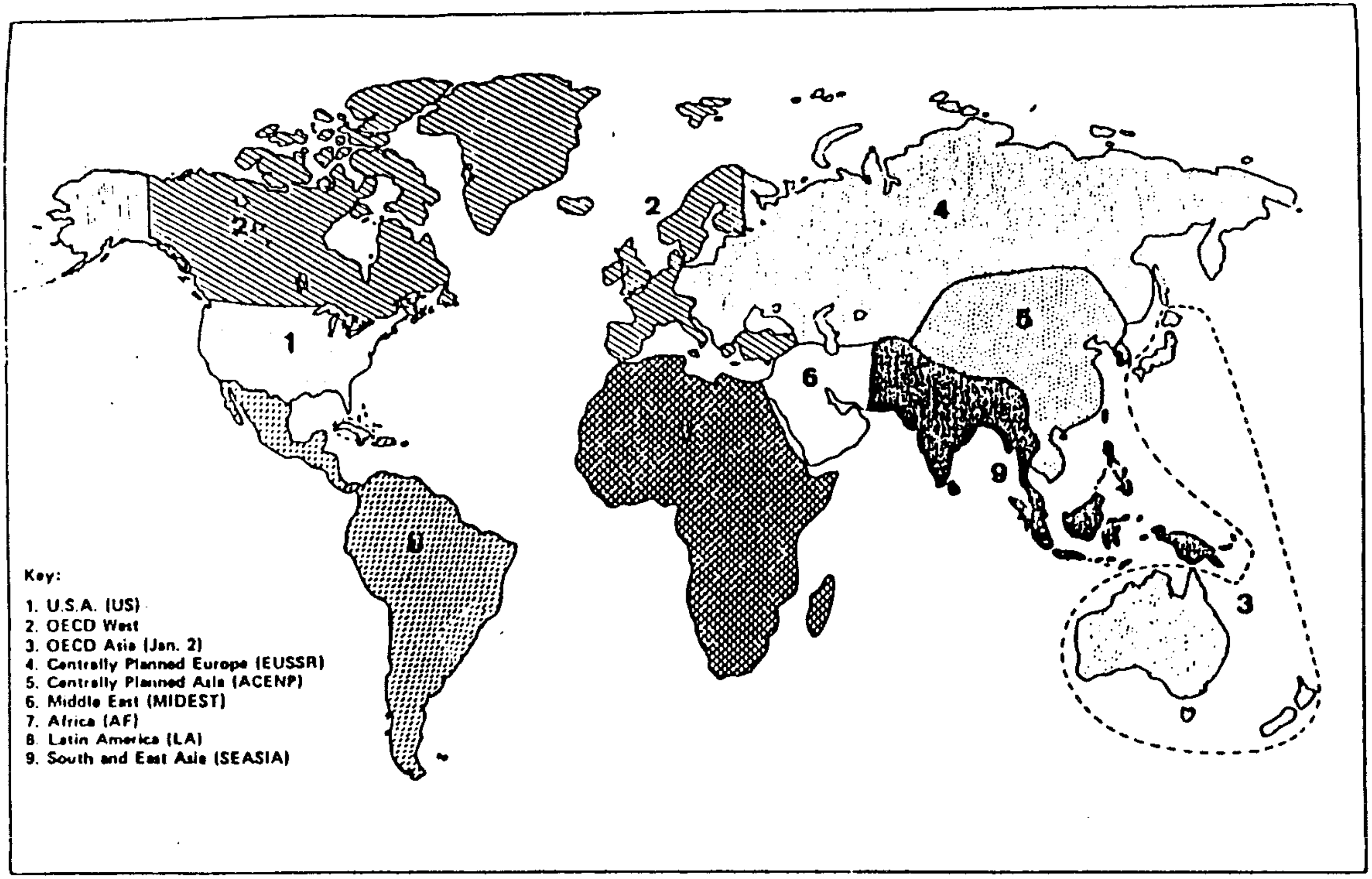

Figure 1.1. Regional Disaggregation of the IEA/ORAU Long-Term, Global, Energy-CO_2 Model

CHAPTER II
MODEL STRUCTURE: AN OVERVIEW

This chapter discusses the general workings of the model and is included for those users who are not familiar with the model's structure. A complete understanding of the model is not an essential prerequisite for using the model.

The model can be thought of as consisting of four parts: demand, supply, energy balance, and CO_2 emissions. The first two modules determine the demand of and supply for each of six major primary energy categories (listed in Table 2.1.) and in each of the nine global regions (discussed in Chapter I). The energy balance module ensures model equilibrium in each global fuel market. (Primary electricity is assumed to be untraded, thus supply and demand balance in each region.) The CO_2 emissions module is a post-processor. Five benchmark years were chosen for scenarios--2000, 2025, 2050, 2075 and 2100.

TABLE 2.1. PRIMARY FUEL TYPES IN THE IEA/ORAU ASSESSMENT FRAMEWORK

1.0 Oil
1.1 Conventional oil
1.2 Enhanced recovery, shale oil, and tar sands

2.0 Gas
2.1 Conventional gas

3.0 Solids
3.1 Coal
3.2 Biomass

4.0 Resource-constrained renewables
4.1 Hydro, geothermal

5.0 Nuclear

6.0 Solar (ex. Biomass)
6.1 Solar electric (other solar is associated with conservation), wind, and tidal power, ocean thermal energy conversion, fusion and other advanced renewable technologies.

Energy Demand

Energy demand for each of the six major fuel types is developed for each of the nine regions separately. Four major exogenous inputs determine energy demand: population, labor productivity, exogenous end-use energy efficiency improvement, and energy prices. (Note: While prices are exogenous to the Energy Demand Module they are endogenous to the full model.)

The model calculates base GNP directly as a product of labor force and labor productivity. An estimate of base GNP for each region is used both as a proxy for the overall level of economic activity and as an index of income. The base GNP is, in turn, modified within the model to be consistent with energy-economy interactions. The GNP feedback elasticity is regional, allowing the model to distinguish energy supply dominant regions, such as the Mideast where energy prices and GNP are positively related, from the rest of the world where the relationship is inverse.

The exogenous end-use energy efficiency improvement parameter is a time-dependent index of energy productivity. It measures the annual rate of growth of energy productivity which would go on independent of such other factors as energy prices and real incomes. In the past, technological progress and other nonprice factors have had an important influence on energy use in the manufacturing sector of advanced economies. The inclusion of an exogenous end-use energy efficiency improvement parameter allows scenarios to be developed that incorporate either continued improvements or technological stagnation assumptions as an integral part of scenarios.

The final major energy factor influencing demand is energy prices. Each region has a unique set of energy prices derived from world prices (determined in the energy balance component of the model) and region-specific taxes and tariffs. The model can be modified to accommodate nontrading regions for any fuel or set of fuels. It is assumed that no trade is carried on between regions in solar, nuclear, or hydroelectric power, but all regions trade fossil fuels.

The energy-demand module performs two functions: it establishes the demand for energy and its services and it maintains a set of energy flow accounts for each region. Oil and gas are transformed into secondary liquids and gases used either directly in end-use sectors or indirectly as electricity. The solid primary fuels, coal and biomass, can either be used in their solid forms or may be transformed into secondary liquids and gases or electricity. Hydro, nuclear, and solar electric are accounted directly as electricity. Nonelectric solar is included with conservation technologies as a reduction in the demand for marketed fuels.

The four secondary fuels are consumed to produce energy services. In the three Organization for Economic Co-Operation and Development (OECD) regions, energy is consumed by three end-use sectors: residential/commercial, industrial, and transport. In the remaining regions, final energy is consumed by a single aggregate sector.

The demand for energy services in each region's end-use sector(s) is determined by the cost of providing these services and by the levels of income and population. The mix of secondary fuels used to provide these services is determined by the relative costs of providing these services using each alternative fuel. The demand for fuels to provide electric power is then determined by the relative costs of production, as is the share of oil and gas transformed from coal and biomass.

Energy Supply

Energy supply is disaggregated into two categories, renewable and non-renewable. This categorization is given in Table 2.2.

TABLE 2.2. RENEWABLE AND NON-RENEWABLE ENERGY SUPPLY TECHNOLOGIES IN THE IEA/ORAU LONG-TERM ENERGY ECONOMIC MODEL

Non-Renewable	Renewable
Conventional Oil	Hydro
Unconventional Oil	Solar Electric
Natural Gas	Biomass
Coal	
Nuclear*	

*Note that if the breeder reactor is assumed, this technology becomes a renewable one.

Energy supply from all fossil fuels is related directly to the resource base by grade, the cost of production (both technical and environmental) and to the historical production capacity. The introduction of a graded resource base for fossil fuel (and nuclear) supply allows the model to explicitly test the importance of fossil fuel resource constraints as well as to represent fuels such as shale oil in which only small amounts are likely available at low costs but for which large amounts are potentially available at high cost.

Note here that nuclear is treated in the same category as fossil fuels. Nuclear power is constrained by a resource base as long as light-water reactors are the dominant producers of power. Breeder reactors, by producing more fuel than they consume are modeled as an essentially unlimited source of fuel available at higher cost.

A rate of technological change is now introduced on the supply side. This rate varies by fuel and is expected to be both higher and less certain for emerging technologies.

Energy Balance

The supply and demand modules each generate energy supply and demand estimates based on exogenous input assumptions and energy prices. If energy supply and demand match when summed across all trading regions in each group for each fuel, then the global energy system balances. Such a result is unlikely at any arbitrary set of energy prices. The energy balance component of the model is a set of rules for choosing energy prices which, on successive attempts, brings supply and demand nearer a system-wide balance. Successive energy price vectors are chosen until energy markets balance within a prespecified bound. Figure 2.1 graphically depicts the process by which global energy balance is achieved.

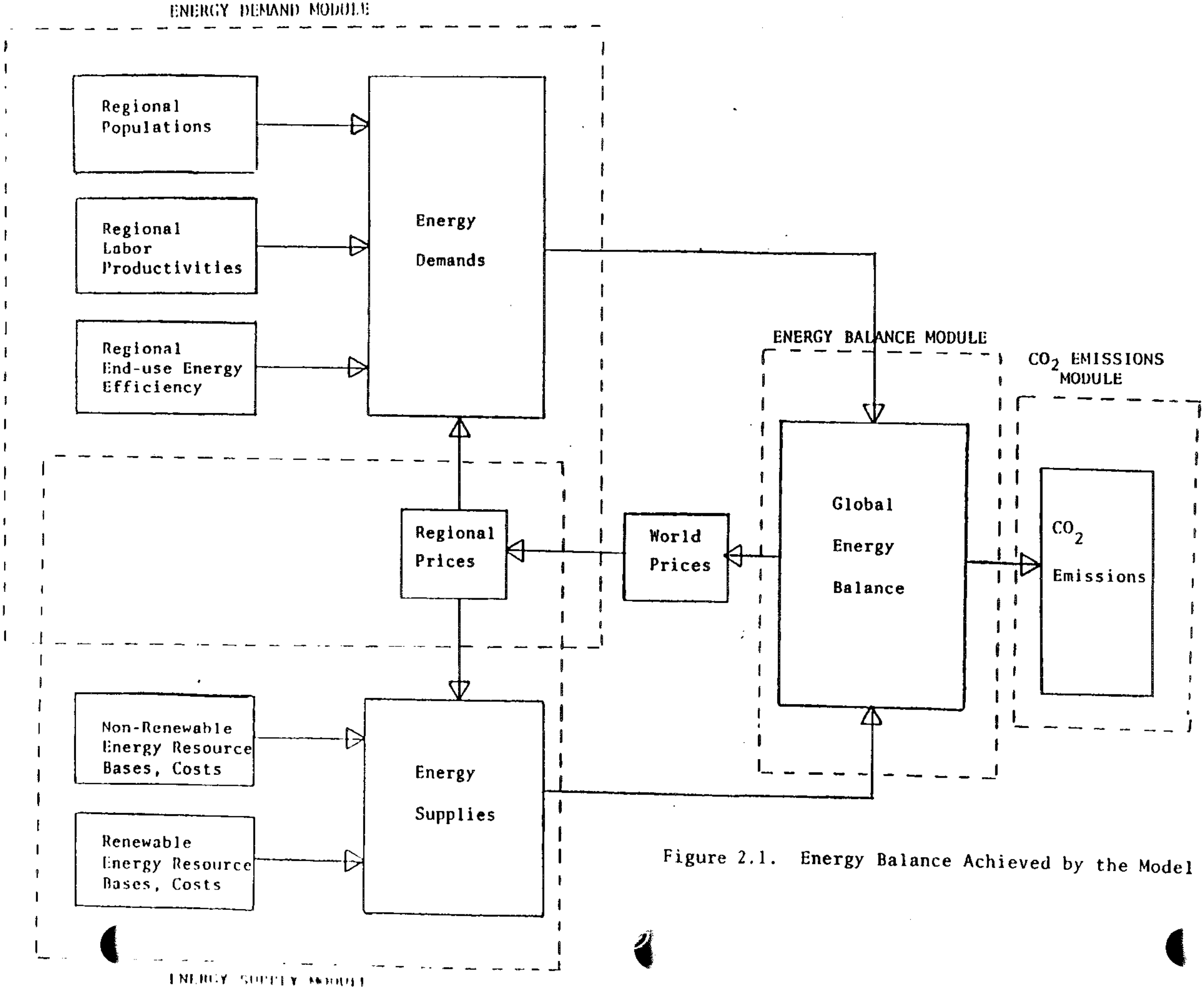

Figure 2.1. Energy Balance Achieved by the Model

CO_2 Release

Given the solution from the energy balance component of the model, the calculation of CO_2 emissions rates is conceptually straightforward. The problem merely requires the application of appropriate carbon coefficients (carbon release per unit of energy) at the points in the energy flow where carbon is released. Carbon release is associated with the consumption of oil, gas, and coal. Significant carbon release is also associated with production of shale oil from carbonate rock. A direct zero carbon release coefficient is implicitly assigned to nuclear, hydro, and solar power and to conservation. Actual calculation of CO_2 emissions is made somewhat more complex by the need to appropriately account for flows of carbon that are not oxidized (see Figure 2.2).

Considerable literature exists concerning appropriate values for CO_2 coefficients. Those in Table 2.3 were calculated at IEA/ORAU by Gregg Marland and Ralph Rotty. The coefficients are representative of average global fuel of a given type and are consistent with the model's CO_2 accounting conventions as indicated by Figure 2.2.

TABLE 2.3. CO_2 COEFFICIENTS IN THE IEA/ORAU, LONG-TERM ENERGY-CO_2 MODEL (in Tg/EJ)

Fuel	Carbon
Liquids	19.2
Gases	13.7
Solids	23.8
Carbonate rock mining	27.9

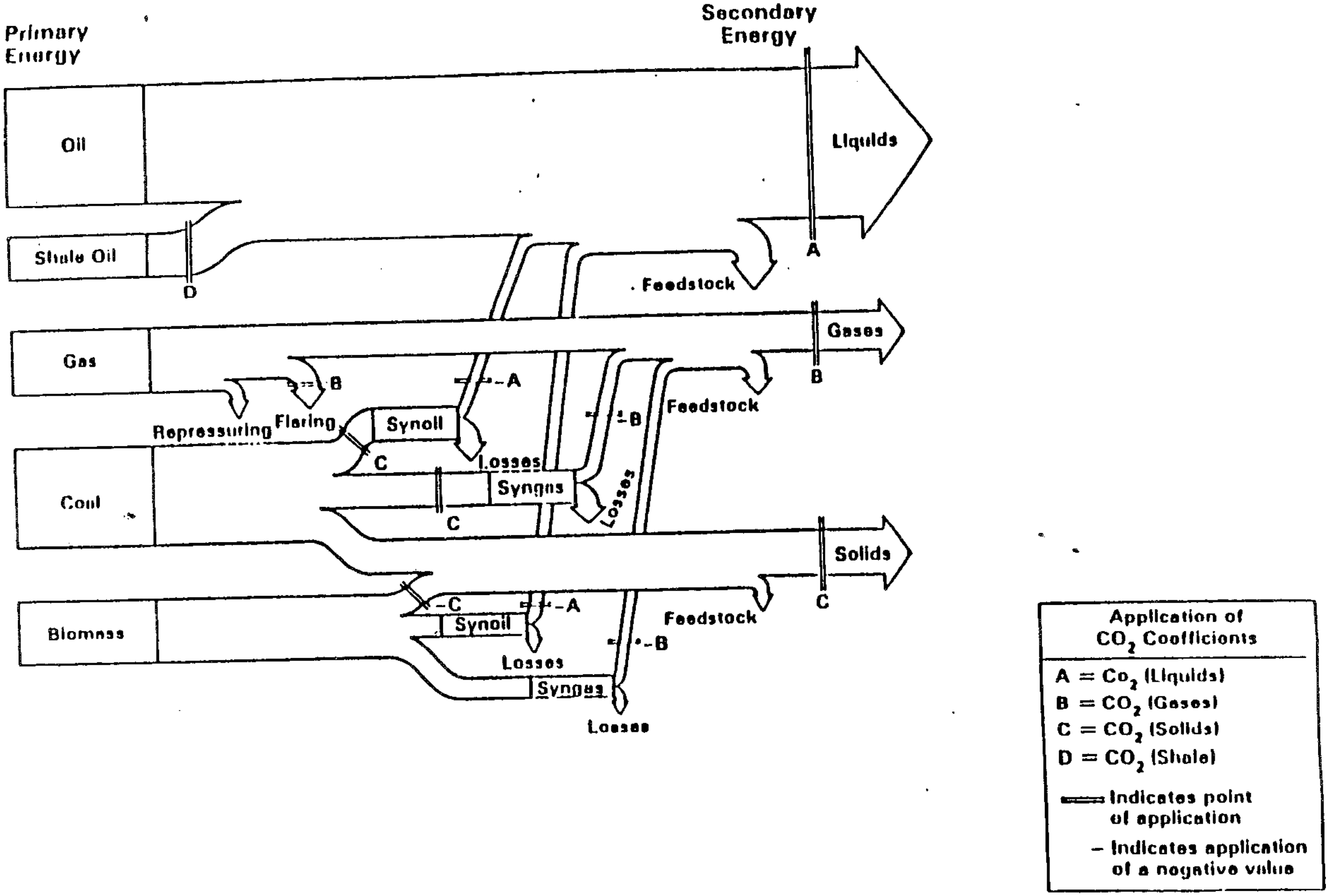

Figure 2.2. Energy-CO_2 Accounting Diagram for the IEA/ORAU Long-Term, Global Energy-CO_2 Model

CHAPTER III

RUNNING THE MODEL: AN OVERVIEW

The following four chapters are designed to cover basic skills necessary to run the model. Any model has three elements: 1) assumptions, 2) the model, and 3) results. For the purposes of the user's guide the model is taken as given. (For the advanced user, the model code is available from CDIC and can be modified.)

The four chapters that follow discuss how to generate assumptions for the model and the different forms of output available. Material covered in those four chapters is summarized in Table 3.1 and Figure 3.1.

TABLE 3.1. SUMMARY OF MATERIAL IN CHAPTERS IV, V, VI, and VII

<table>
<tr><th>Chapter</th><th colspan="2">Material Covered</th></tr>
<tr><td>IV</td><td colspan="2">Basic steps necessary to determine values for major assumption parameters and to run the model. A single command, RUNMODEL, initiates an interactive program. Summary results of the model run are written to a file called RESULTS.DAT.</td></tr>
<tr><td>V</td><td colspan="2">Two commands that generate summary output are discussed:</td></tr>
<tr><td></td><td>VIEWRUN:</td><td>Initiates an interactive video display program. Output can be viewed in either tabular or graphic form.</td></tr>
<tr><td></td><td>PRINTRUN:</td><td>Orders tabular output to printer. All tables available in VIEWRUN are printed. Graphs are not printed.</td></tr>
<tr><td>VI</td><td colspan="2">Documents procedures by which a user can modify any assumption. All assumptions are specified in tabular form in a file called NIEA.DAT. Procedures assume the user has his own text editor program.</td></tr>
<tr><td>VII</td><td colspan="2">Procedures are discussed which allow the user to print detailed output from each run. The procedures require the user to supply their own text editor to modify specific items in the file NIEA.DAT.</td></tr>
</table>

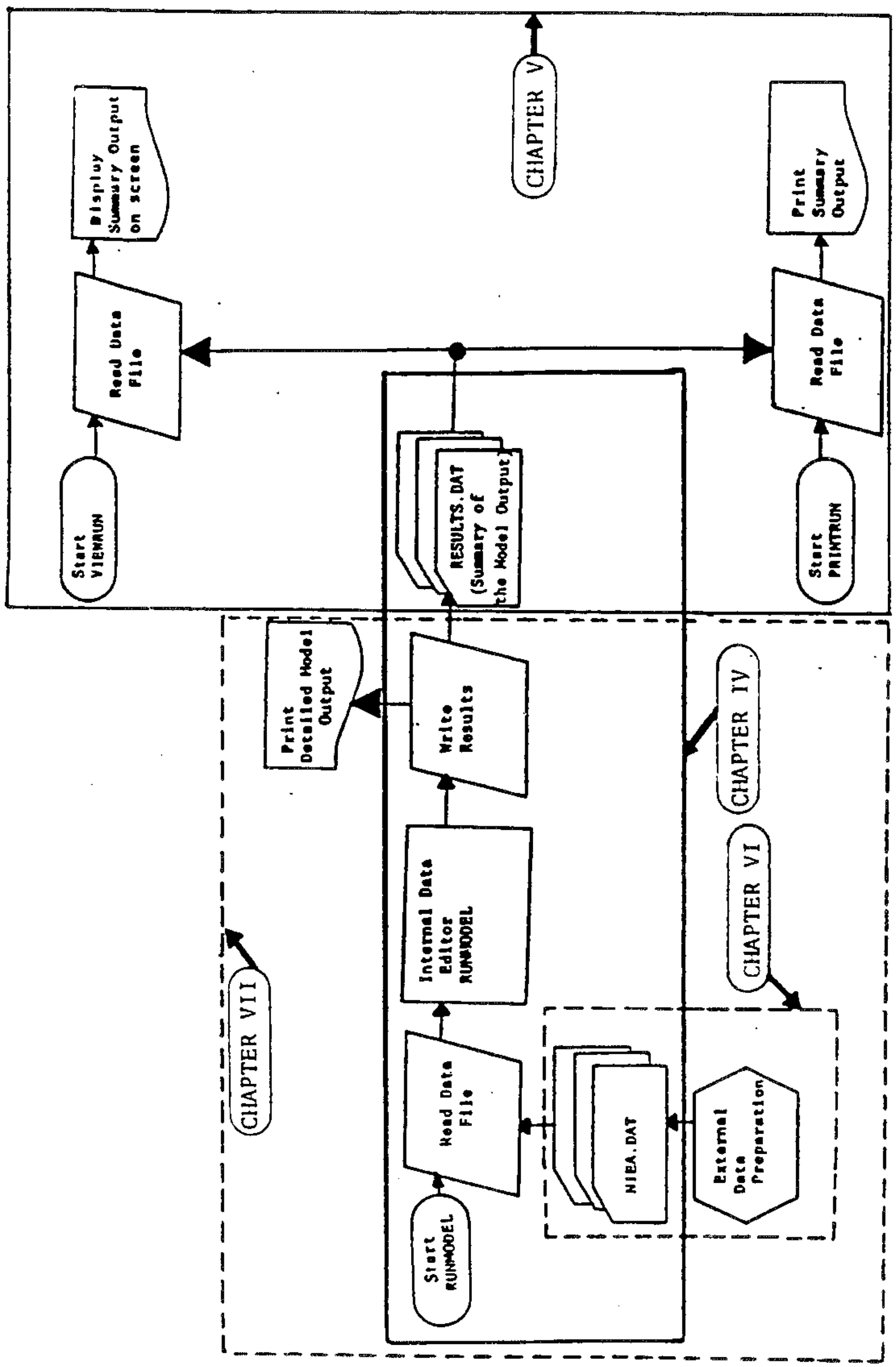

Figure 3.1. Flowchart of the Model

The general flow of the model is displayed in Figure 3.1, moving from left to right across the page:

(1) RUNMODEL: a single command initiates the model run. All subsequent procedures are directed by an interactive set of commands.

(2) Read Data Files: the master data file NIEA.DAT is read. Advanced users may modify NIEA.DAT to generate scenarios based on specific assumptions. The general user has access to 39 major assumptions through an interactive data editor.

(3) Internal Data Editor: the model next calls an internal data editor. This interactive program allows a user to inspect and/or change any of 39 different major assumptions. When the user has finished inspecting and/or modifying assumptions, the model continues to compute the energy and CO_2 emissions consequences of that set of assumptions.

(4) Print Results: if the model was instructed to print detailed outputs, detailed outputs are sent to the printer, which is the only place they are recorded. Special modifications to the NIEA.DAT data base are necessary to cause detailed output to be recorded. (See Chapter VII.) In all cases summary output is written to a file (either floppy disk or hard disk) under the name RESULTS.DAT. The first program then terminates.

To obtain either a visual display on the video screen or a printout of the summary output, one types either VIEWRUN (to initiate an interactive output display) or PRINTRUN (to print all tables available in VIEWRUN).

CHAPTER IV
RUNNING THE MODEL: BASIC TOOLS

This chapter is intended for a general audience to demonstrate how to run the model. The principal command involved is the RUNMODEL command. RUNMODEL allows the user to select assumptions and run the model. The process is outlined in Figure 4.1.

RUNMODEL: SETTING ASSUMPTIONS AND RUNNING THE MODEL

<u>Overview</u>

To inspect and/or modify input assumptions:

    Type: RUNMODEL
    Press: Return key

- Wait for the main assumptions menu to appear
- Select the category you wish to inspect and/or modify and return
- If necessary, select the sub-category you wish to inspect and/or modify and return
- Inspect and/or modify default assumptions
- Run the model

EXAMPLES

We will run two cases as examples of how to run the model.

Example 1: Running the base case;
Example 2: Running a case with a revised nuclear resource assumption.

Example 1: The Base Case

The model comes with a set of default assumptions. To simply run the model with those assumptions.

    Type: RUNMODEL
    Press: Return key

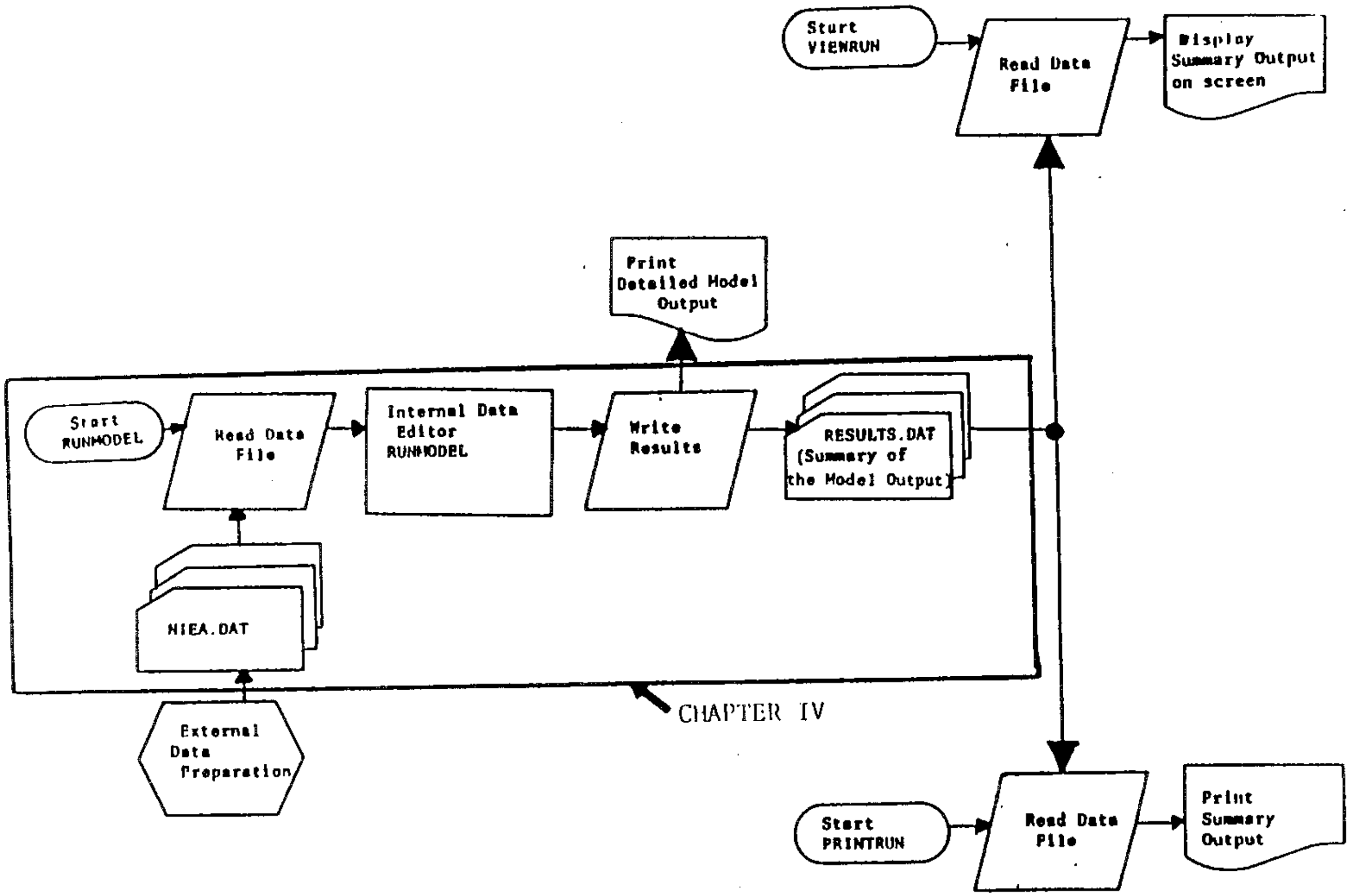

Figure 4.1. Flowchart of the Model

Result: Credits screen appears (Figure 4.2a). This figure may remain on the screen for a minute or more while the model reads data.

```
THE IEA/ORAU LONG-TERM
GLOBAL ENERGY-ECONOMIC MODEL
WITH CO2 EMISSIONS

BY
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FOR
CARBON DIOXIDE RESEARCH DIVISION
U.S. DEPARTMENT OF ENERGY

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OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TN  37831

UNDER CONTRACT NO:  DE-AC05-76OR00033

COPYRIGHT 1985
THE PROGRAM IS RUNNING
```

Figure 4.2a. Credits Screen

The Input Assumptions screen (Figure 4.2b) automatically appears when the program is ready to run.

```
            ****************************
            ***                      ***
            ***  INPUT ASSUMPTIONS   ***
            ***                      ***
            ****************************

THERE ARE TWELVE INPUT ASSUMPTION CATEGORIES OPEN
TO USER INSPECTION AND/OR MODIFICATION.  SELECT ONE
OF THE FOLLOWING:
            1   POPULATION
            2   LABOR PRODUCTIVITY
            3   END-USE ENERGY EFFICIENCY
            4   INCOME EFFECTS
            5   PRICE EFFECTS
            6   RESOURCE BASE
            7   TECHNOLOGICAL CHANGE IN ENERGY PRODUCTION
            8   ENVIRONMENTAL COSTS OF ENERGY PRODUCTION
            9   MARKET PENETRATION SUPPLY TECHNOLOGY
            10  SOLAR AND BIOMASS ENERGY COSTS
            11  SYNFUEL COSTS
            12  NUMBER OF FORECAST PERIODS

            0   NONE OF THE ABOVE.  RUN THE MODEL.

ENTER YOUR CHOICE, THEN PRESS RETURN ----->
```

Figure 4.2b. Input Assumptions Screen

In this example we wish to run the base case. We therefore select choice Ø.

Type: Ø
Press: Return key
Result: The credits screen will reappear (Figure 4.2a).

At the conclusion of the model run, the program will write on your screen:

"WRITING COMPLETE..."
"Stop--Program terminated." (Figure 4.3.)

> NOTE: Basic Model Run Times. Run times will vary according to the particular PC environment, from as short as 30 seconds to as long as 20 minutes. When assumptions are modified run times will be extended even further.

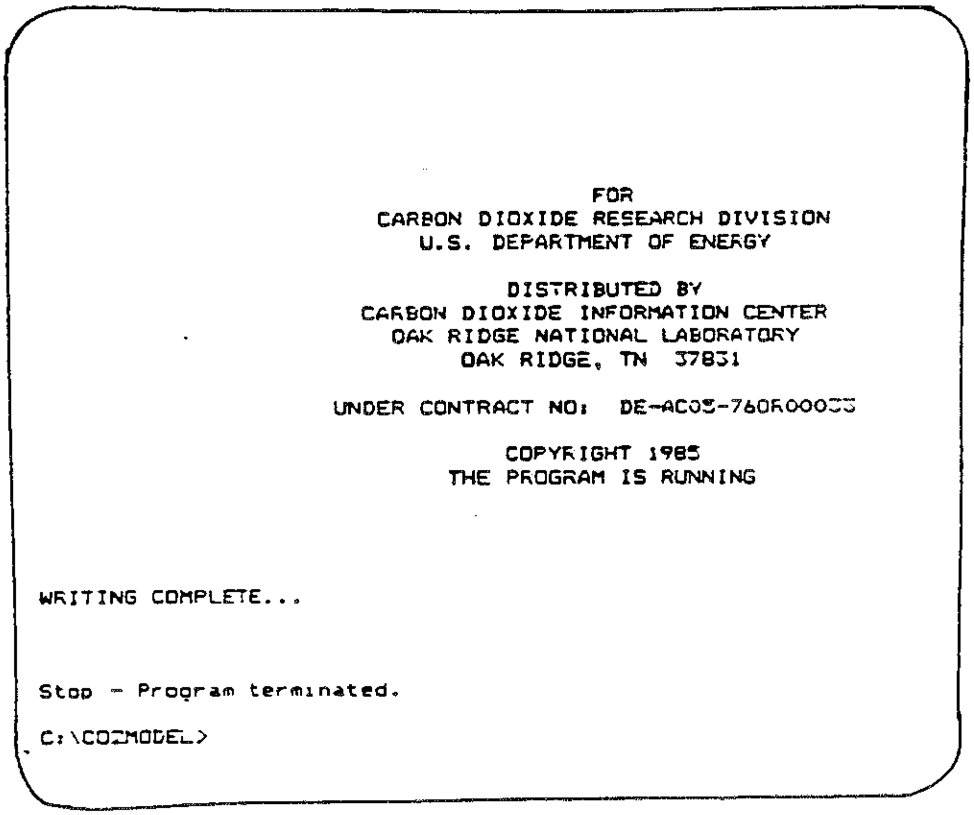


Figure 4.3. Program Termination

We have successfully run the model.

Example 2: Creating a New Case

In this example we would like to see the effect of two assumptions on the model.

1. A small uranium resource base (5000 exajoules), and
2. No breeder reactors

To do that we will need to change some assumptions:

1. Start the model

   Type: RUNMODEL
   Press: Return key
   Result: Credits screen (Figure 4.4) appears for approximately a minute; Input Assumptions Menu (Figure 4.5a) appears next.

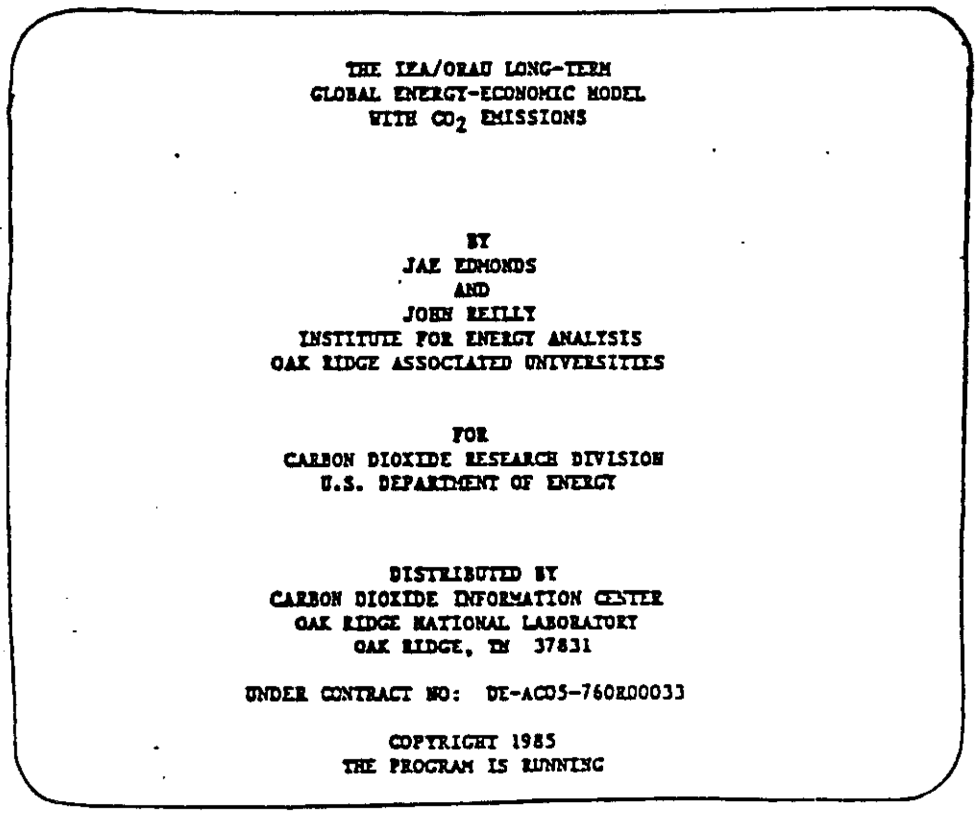


Figure 4.4. Credits Screen

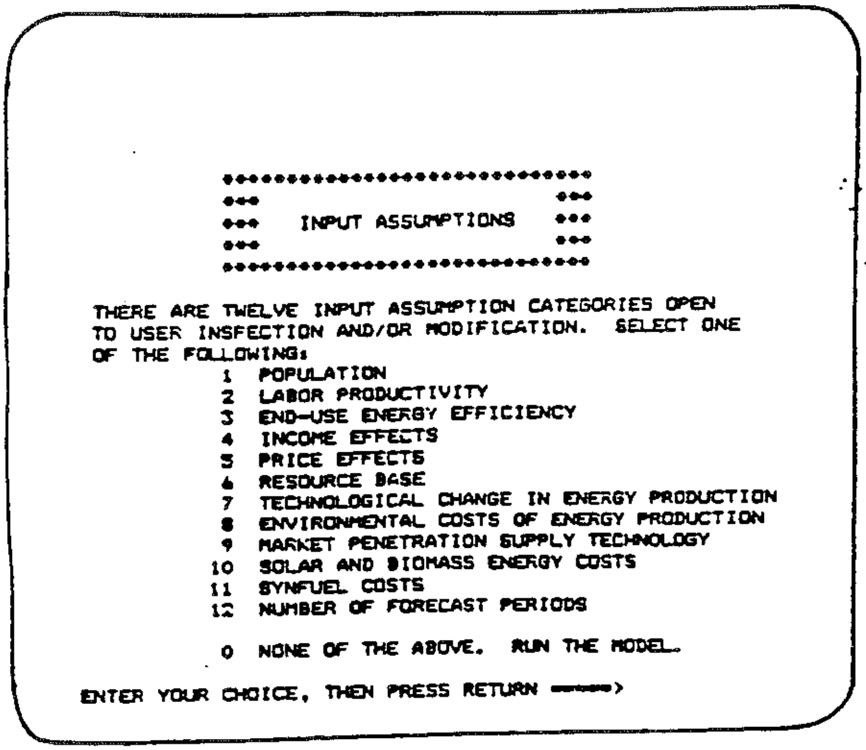


Figure 4.5a. Inputs Assumptions Screen

2. Find the uranium resource and nuclear technology assumptions

Type: 6 (for RESOURCE BASE) (Figure 4.5b)
Press: Return key
Result: Screen changes to "ENERGY SUPPLY ASSUMPTIONS: RESOURCE BASE FOR ENERGY SUPPLY."

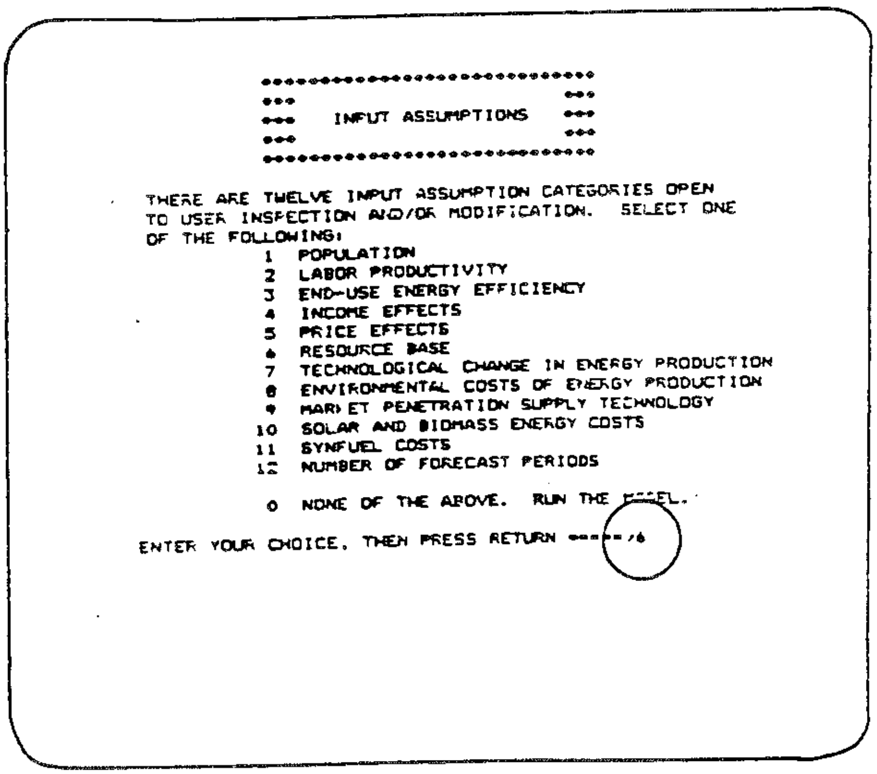


Figure 4.5b. Selecting the Resource Base Assumption Category

Type: 5 (for NUCLEAR POWER) (Figure 4.6)
Press: Return key
Result: Screen changes to "RESOURCE BASE:
NUCLEAR POWER" (Figure 4.7).

```
                ENERGY SUPPLY ASSUMPTIONS:
          *** RESOURCE BASE FOR ENERGY SUPPLY ***

 YOU MAY EXAMINE AND/OR CHANGE ASSUMPTIONS FOR ANY OF 5 ENERGY
 SUPPLY CATEGORIES ONE AT A TIME. IN ANY ORDER.  SELECT ONE
 OF THE FOLLOWING:
                  1= CONVENTIONAL OIL
                  2= NATURAL GAS
                  3= COAL
                  4= SHALE OIL
                  5= NUCLEAR POWER
 OR
                  0= NONE OF THE ABOVE.  RETURN TO MAIN MENU
TYPE YOUR CHOICE:  1,2,3,4,5 OR 0. THEN PRESS RETURN.  ***5
```

Figure 4.6. The Resource Base Screen: Choosing the Nuclear Option

```
 RESOURCE BASE:  NUCLEAR POWER

 NOTE:  FOR NUCLEAR POWER TWO ASSUMPTIONS MUST BE SPECIFIED:
      1. THE ELECTRIC POWER EQUIVALENT RESOURCE/BASE OF
         URANIUM AVAILABLE WITH CONVENTIONAL LIGHTWATER
         REACTOR TECHNOLOGY
      2. WHETHER OR NOT TO INTRODUCE BREEDER REACTORS.
 CONCEPT= TOTAL RECOVERABLE RESOURCES REMAINING, INCLUDING
          DISCOVERED AND UNDISCOVERED RESOURCES OVER ALL
          COST GRADATIONS, UNPRODUCED AS OF 1975, BUT
          PRODUCIBLE WITH KNOWN TECHNOLOGIES.
 UNITS= EXAJOULES
 REGION= GLOBAL

                LOW ESTIMATE--------(     0.)
                MEDIAN ESTIMATE-----(14500.)
                HIGH ESTIMATE-------(27000.)
                DEFAULT ASSUMPTION  14422.

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ***>
```

Figure 4.7. The Nuclear Assumption Screen

3. Change the Default Assumptions

"The Resource Base: Nuclear Power" screen (Figure 4.7).

(1) describes the concept for the assumptions
(2) gives units
(3) gives geographical aggregation
(4) shows low, median, and high values for the assumption
(5) shows the default assumptions

We are now asked: "Do you wish to accept the default assumption? Type either 'yes' or 'no.' Then press return."

> NOTE: The Default Assumption. The default assumption is the assumption (supplied in the base data set) the program will use this assumption unless you specifically change it. Once changed, the revised assumption becomes the new default for that run, but that run only. Each time you begin a new model run by typing RUNMODEL you return to the original base case assumption. The program gives you an opportunity to examine and/or change most of the major assumptions in the base data set.

> NOTE: Pressing the Return Key. Pressing the return key leaves assumptions unaltered and will return you to a previous screen. At this point in the example you can press the return key. This takes you to the "Energy Supply Assumptions: Resource Base for Energy Supply" screen (Figure 4.6). To return to the "Resource Base: Nuclear Power" screen (Figure 4.7), type 5 and press the return key.

Since we wish to change the uranium resource base assumption our response to the question "DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?" is no.

Type: No (Figure 4.8)
Press: Return key
Result: Program prompts us to enter the desired assumption (Figure 4.9)

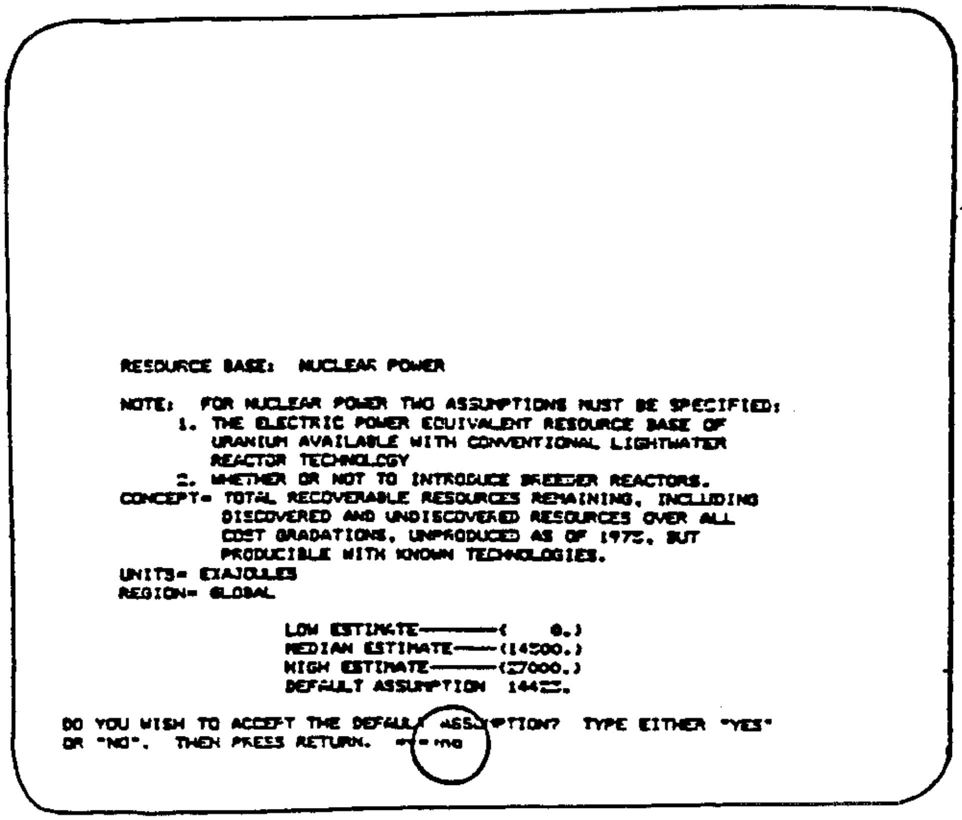


Figure 4.8. Rejecting the Default Assumption

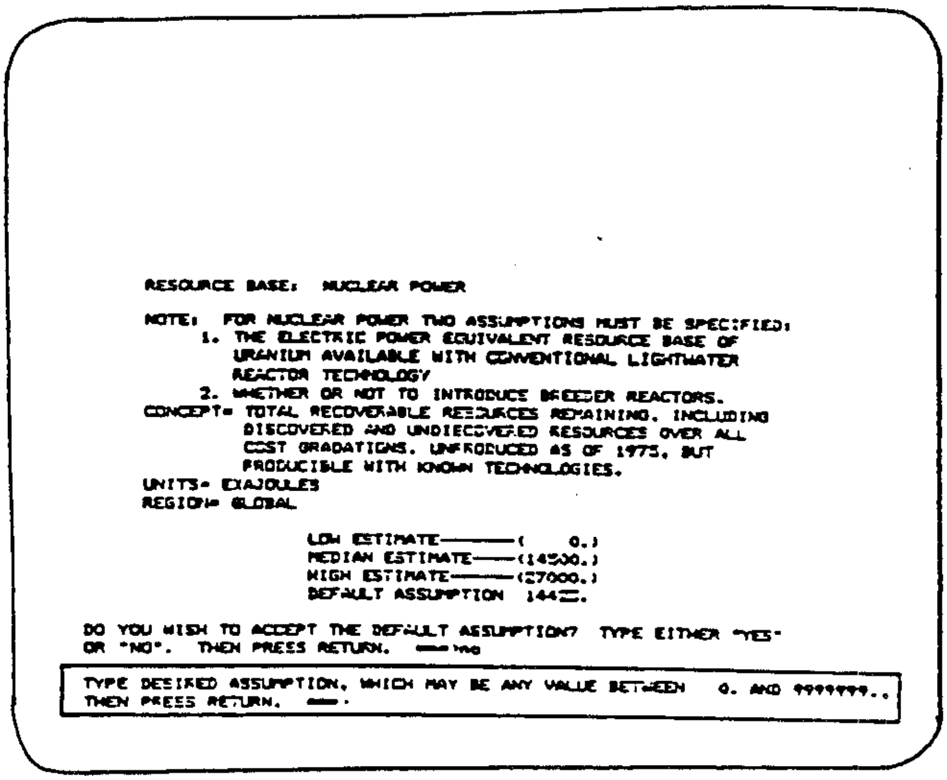
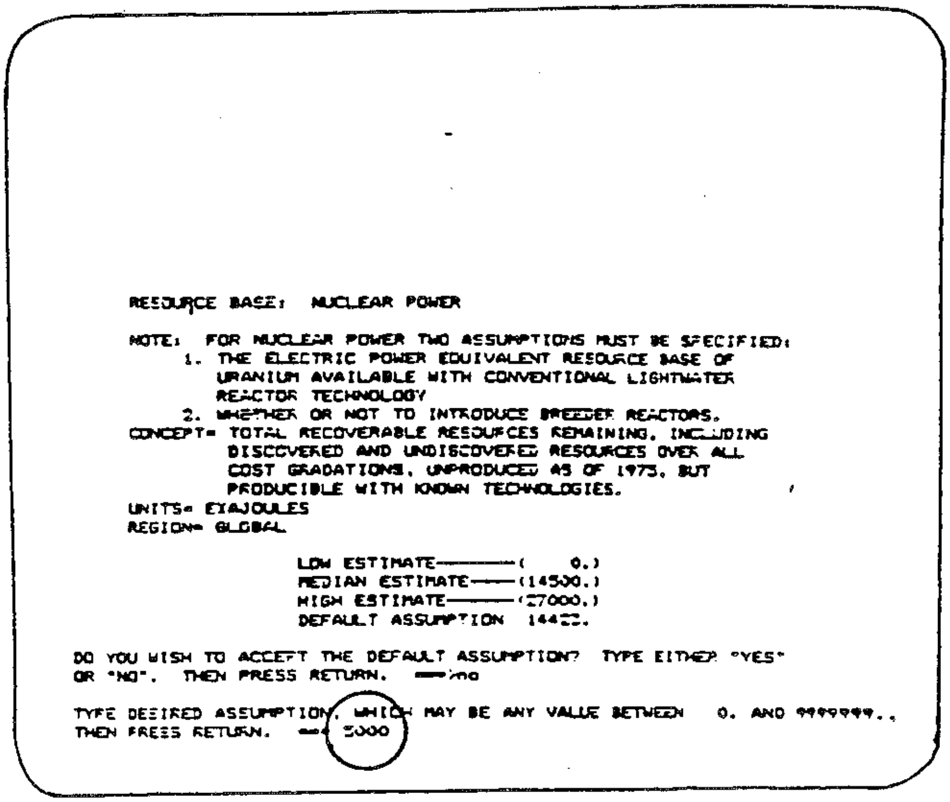


Figure 4.9. Prompt to Enter Nuclear Resource Assumption

> NOTE: Assumption Prompt. The assumption prompt tells you to enter a new assumption and gives bounds on the values the new assumption can take. For example, in Figure 4.7 the bounds Ø-9999999 are given. Here it makes no sense to have a negative value for the resource base, so a lower bound of zero is given. If a value is typed that lies outside these bounds, the program will write "!!! ILLEGAL ENTRY!!! TRY AGAIN!!!" and the program automatically returns to the beginning of step 3, Figure 4.7.

We wish to use a resource base of 5000.

Type: 5000 (Figure 4.10)
Press: Return key
Result: Program repeats the assumption it was given and asks if the value is correct (Figure 4.11).



```
RESOURCE BASE:  NUCLEAR POWER

NOTE:  FOR NUCLEAR POWER TWO ASSUMPTIONS MUST BE SPECIFIED:
     1. THE ELECTRIC POWER EQUIVALENT RESOURCE BASE OF
        URANIUM AVAILABLE WITH CONVENTIONAL LIGHTWATER
        REACTOR TECHNOLOGY
     2. WHETHER OR NOT TO INTRODUCE BREEDER REACTORS.
CONCEPT= TOTAL RECOVERABLE RESOURCES REMAINING, INCLUDING
         DISCOVERED AND UNDISCOVERED RESOURCES OVER ALL
         COST GRADATIONS, UNPRODUCED AS OF 1975, BUT
         PRODUCIBLE WITH KNOWN TECHNOLOGIES.
UNITS= EXAJOULES
REGION= GLOBAL

              LOW ESTIMATE---------(     0.)
              MEDIAN ESTIMATE------(14500.)
              HIGH ESTIMATE--------(27000.)
              DEFAULT ASSUMPTION  14422.

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ==>no

TYPE DESIRED ASSUMPTION, WHICH MAY BE ANY VALUE BETWEEN   0. AND 9999999.,
THEN PRESS RETURN.  ==> 5000
```

Figure 4.10. Entering New Resource Base Assumption

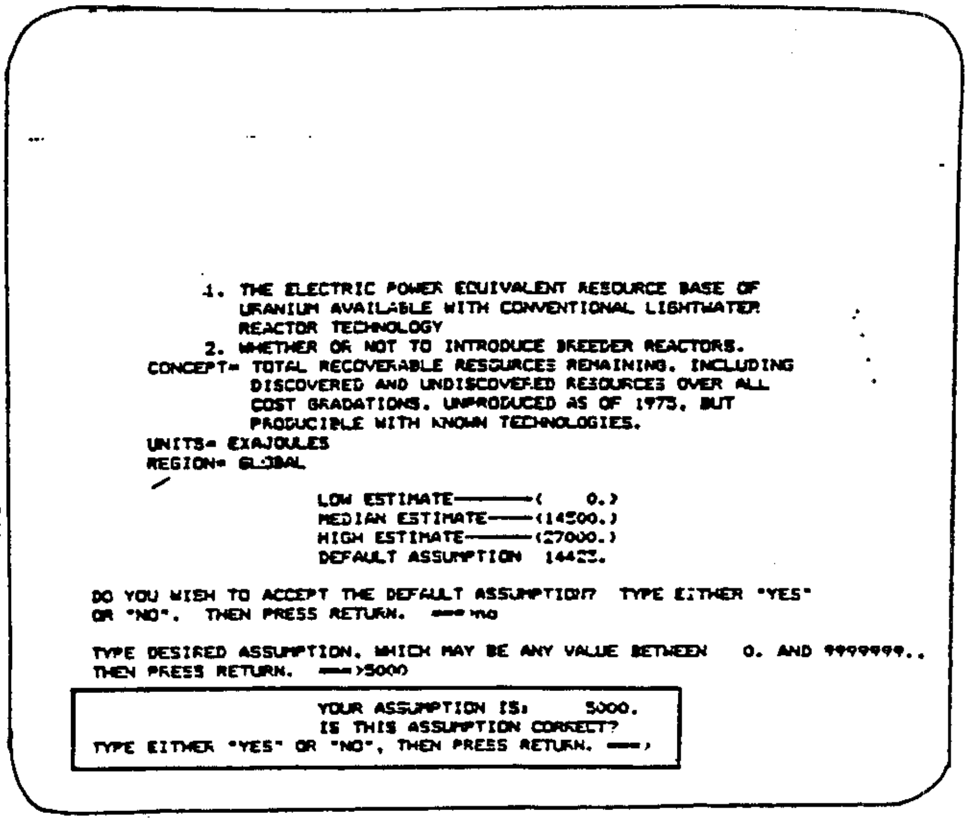


Figure 4.11. Prompt for Validation of New Assumption

Since this assumption is indeed correct, we respond affirmatively.

Type: Yes (Figure 4.12)
Press: Return key
Result: Program automatically advances to ask whether or not breeder reactors are an available technology (Figure 4.13).

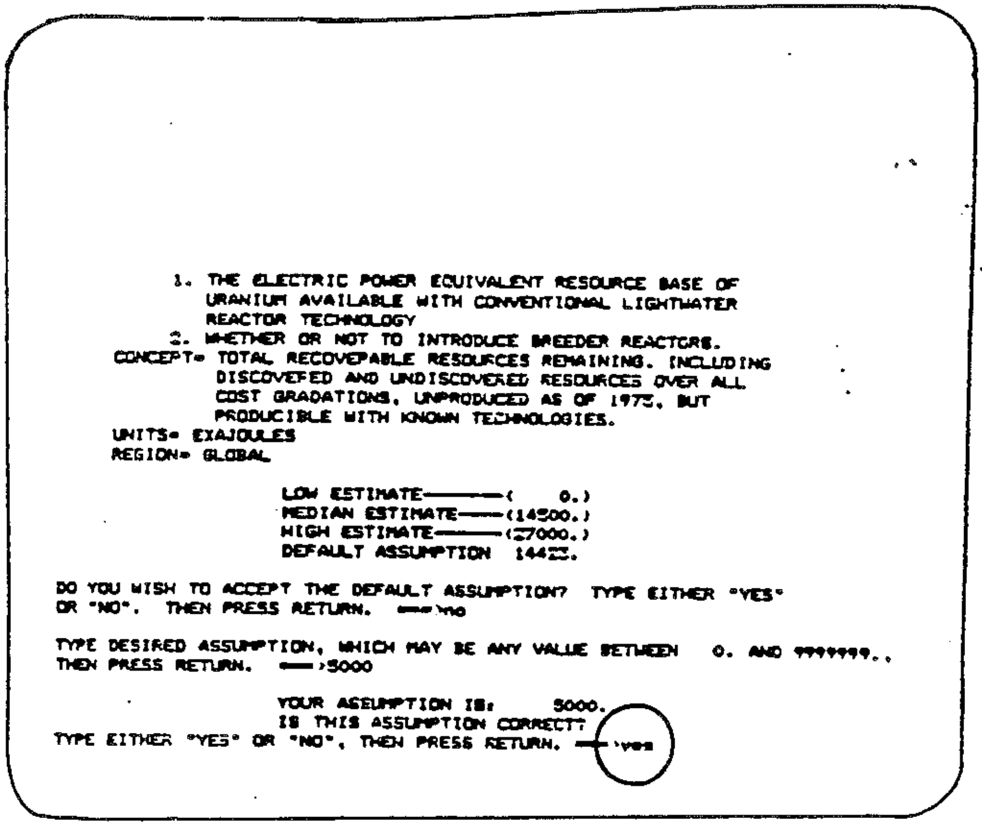


Figure 4.12. Validating New Assumption

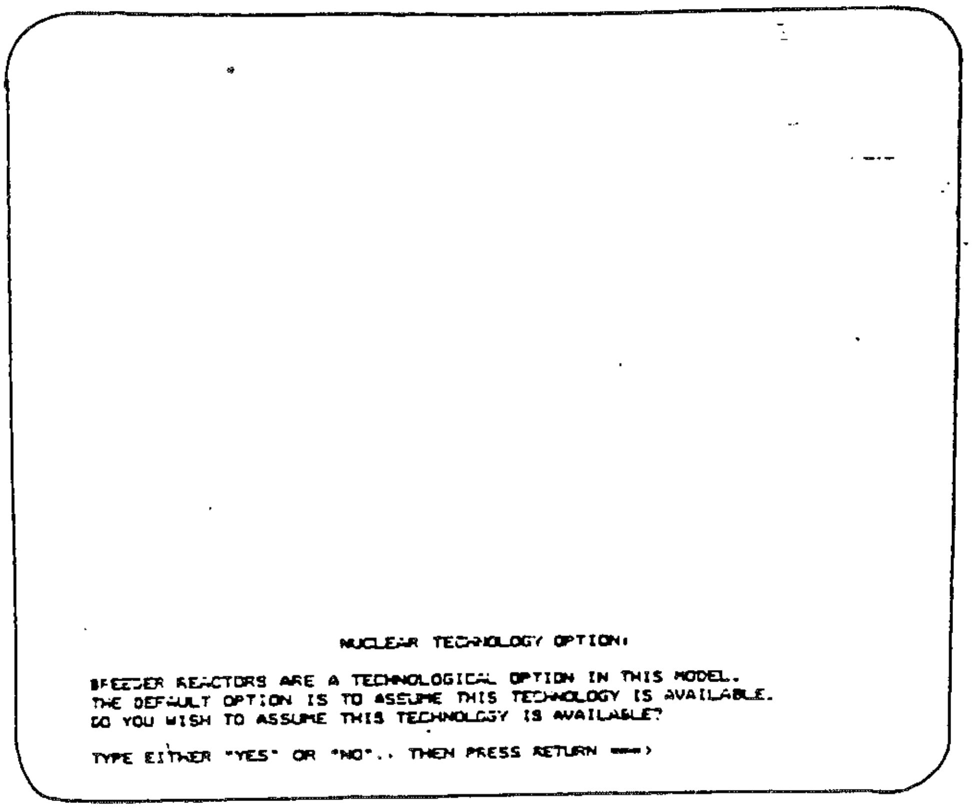


Figure 4.13. Nuclear Option: Breeder Reactors

NOTE: Incorrect Assumption Entry. In some cases an assumption may be mis-entered. For example, if the value is not typed immediately after the prompt arrow as below:

```
RESOURCE BASE:  NUCLEAR POWER

NOTE:  FOR NUCLEAR POWER TWO ASSUMPTIONS MUST BE SPECIFIED:
          1. THE ELECTRIC POWER EQUIVALENT RESOURCE BASE OF
             URANIUM AVAILABLE WITH CONVENTIONAL LIGHTWATER
             REACTOR TECHNOLOGY
          2. WHETHER OR NOT TO INTRODUCE BREEDER REACTORS.
CONCEPT= TOTAL RECOVERABLE RESOURCES REMAINING, INCLUDING
         DISCOVERED AND UNDISCOVERED RESOURCES OVER ALL
         COST GRADATIONS, UNPRODUCED AS OF 1975, BUT
         PRODUCIBLE WITH KNOWN TECHNOLOGIES.
UNITS= EXAJOULES
REGION= GLOBAL

                  LOW ESTIMATE-------(    0.)
                  MEDIAN ESTIMATE----(14500.)
                  HIGH ESTIMATE------(27000.)
                  DEFAULT ASSUMPTION  14500.

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.   ===>no

TYPE DESIRED ASSUMPTION, WHICH MAY BE ANY VALUE BETWEEN    0. AND 9999999.,
THEN PRESS RETURN.    ===>         5000
```

This will result in a mis-read of the assumption. In this case the program read the value as 5 rather than 5000.

```
          1. THE ELECTRIC POWER EQUIVALENT RESOURCE BASE OF
             URANIUM AVAILABLE WITH CONVENTIONAL LIGHTWATER
             REACTOR TECHNOLOGY
          2. WHETHER OR NOT TO INTRODUCE BREEDER REACTORS.
CONCEPT= TOTAL RECOVERABLE RESOURCES REMAINING, INCLUDING
         DISCOVERED AND UNDISCOVERED RESOURCES OVER ALL
         COST GRADATIONS, UNPRODUCED AS OF 1975, BUT
         PRODUCIBLE WITH KNOWN TECHNOLOGIES.
UNITS= EXAJOULES
REGION= GLOBAL

                  LOW ESTIMATE-------(    0.)
                  MEDIAN ESTIMATE----(14500.)
                  HIGH ESTIMATE------(27000.)
                  DEFAULT ASSUMPTION  14500.

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.   ===>no

TYPE DESIRED ASSUMPTION, WHICH MAY BE ANY VALUE BETWEEN    0. AND 9999999.,
THEN PRESS RETURN.    ===>         5000

                  YOUR ASSUMPTION IS:        5.
                  IS THIS ASSUMPTION CORRECT?
TYPE EITHER "YES" OR "NO", THEN PRESS RETURN. ===>
```

(Continued)

In this case the program has incorrectly reproduced an assumption and we do not validate it.

Type: no
Press: Return key

```
        1. THE ELECTRIC POWER EQUIVALENT RESOURCE BASE OF
           URANIUM AVAILABLE WITH CONVENTIONAL LIGHTWATER
           REACTOR TECHNOLOGY
        2. WHETHER OR NOT TO INTRODUCE BREEDER REACTORS.
   CONCEPT= TOTAL RECOVERABLE RESOURCES REMAINING, INCLUDING
            DISCOVERED AND UNDISCOVERED RESOURCES OVER ALL
            COST GRADATIONS, UNPRODUCED AS OF 1975, BUT
            PRODUCIBLE WITH KNOWN TECHNOLOGIES.
   UNITS= EXAJOULES
   REGION= GLOBAL

                  LOW ESTIMATE--------(    0.)
                  MEDIAN ESTIMATE-----(14500.)
                  HIGH ESTIMATE-------(27000.)
                  DEFAULT ASSUMPTION  14500.

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".   THEN PRESS RETURN.   ===>no

TYPE DESIRED ASSUMPTION, WHICH MAY BE ANY VALUE BETWEEN   0. AND 9999999..
THEN PRESS RETURN.   ===>        5000

                  YOUR ASSUMPTION IS:          5.
                  IS THIS ASSUMPTION CORRECT?
TYPE EITHER "YES" OR "NO", THEN PRESS RETURN. ===>no
```

Result: The program will immediately take you to step 3, Figure 4.7.

4. Since we do not want to allow breeder reactors as an option we:

Type: No (Figure 4.14)
Press: Return key

<u>NOTE</u>: <u>The Return Key</u>. Simply striking the return key without typing "no" or "yes" first has the same result as typing "no."

Result: The program confirms our assumption (Figure 4.15) and then automatically returns to the Resource Base for Energy Supply menu (Figure 4.16).

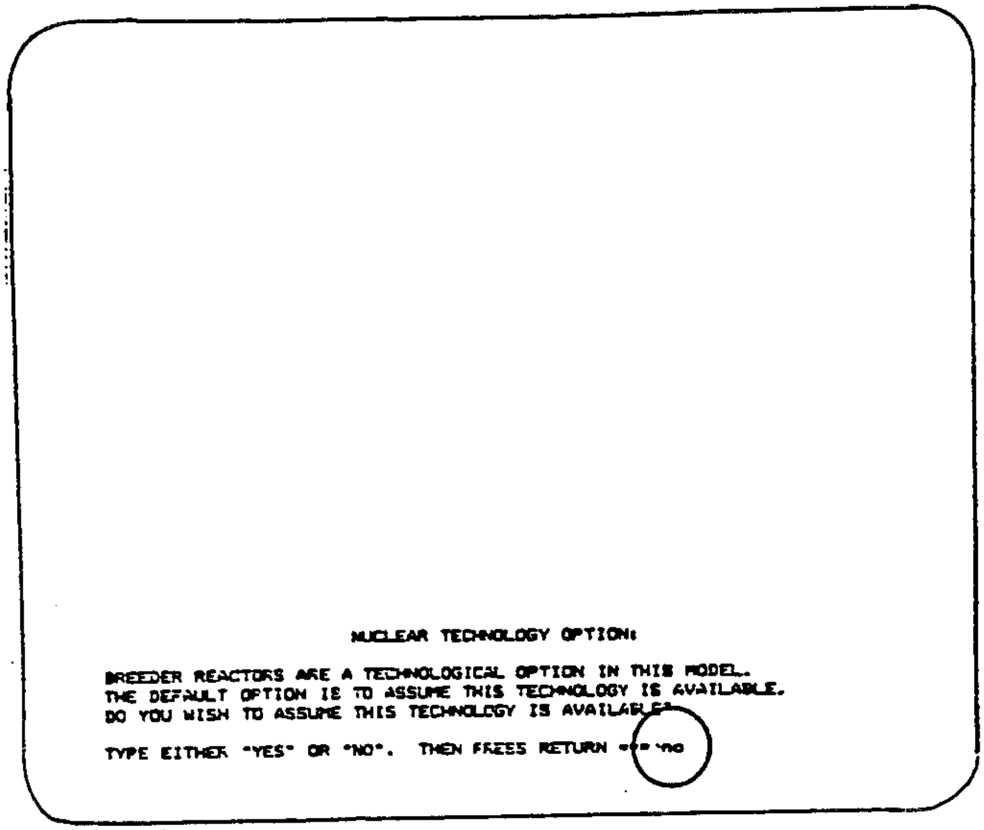


Figure 4.14. Rejecting the Breeder Option

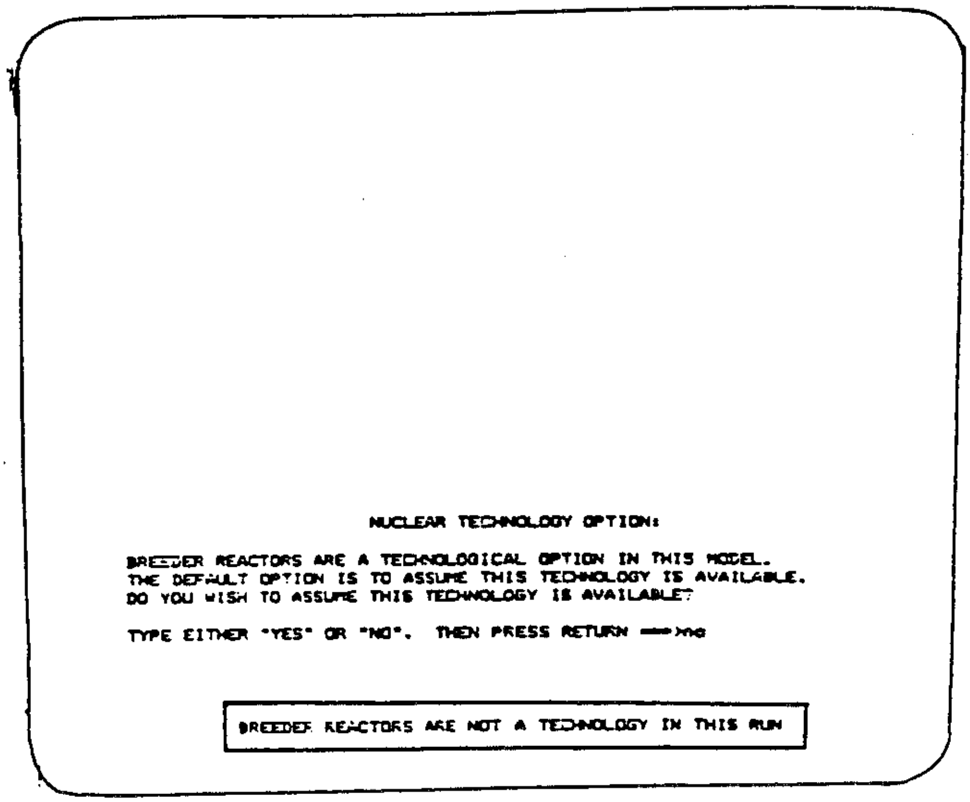


Figure 4.15. Program Confirmation of Our Assumption Selection

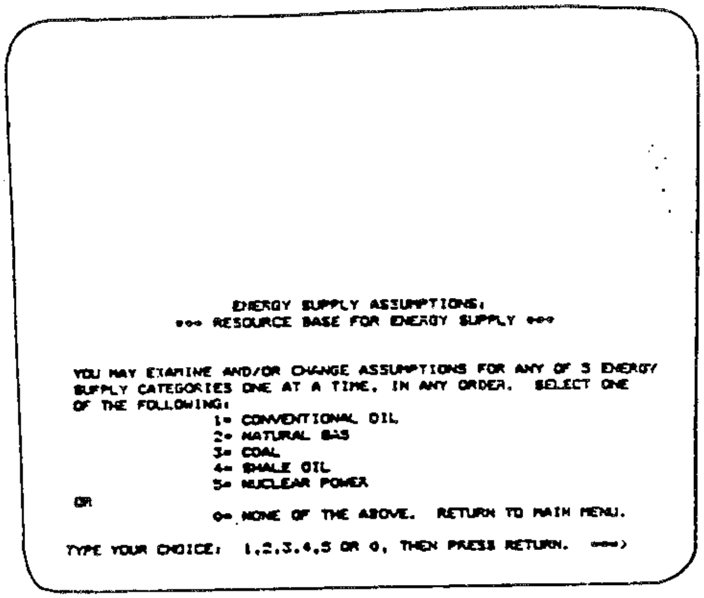


Figure 4.16. Resource Base for Energy Supply Menu

5. Having made our desired changes, we

Type: Ø (Figure 4.17)
Press: Return key
Result: Main Assumptions Menu appears

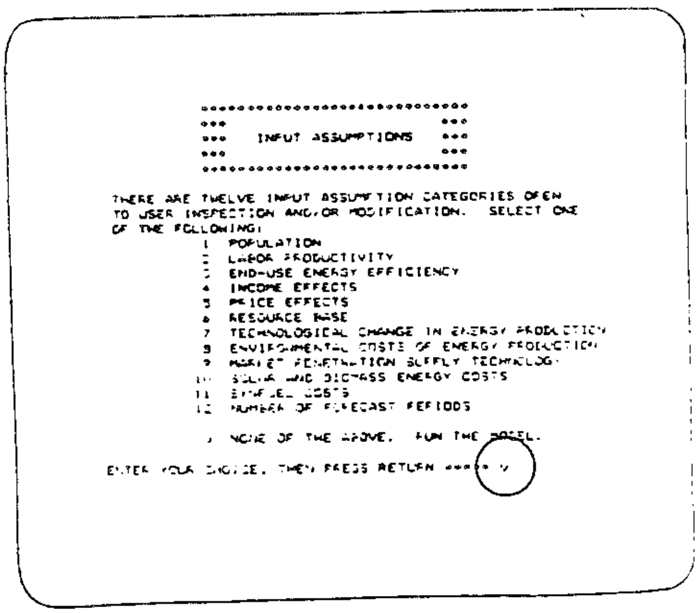


Figure 4.17. Starting the Model Run

To run the model

Type: Ø
Press: Return key
Result: Credits Screen appears (Figure 4.18a). At the conclusion of the model run "WRITING COMPLETE ... STOP--PROGRAM TERMINATED" appears. (Figure 4.18b)

```
THE IEA/ORAU LONG-TERM
GLOBAL ENERGY-ECONOMIC MODEL
WITH CO2 EMISSIONS

BY
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WASHINGTON D.C.  20036

FOR
CARBON DIOXIDE RESEARCH DIVISION
U.S. DEPARTMENT OF ENERGY

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OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TN  37831

UNDER CONTRACT NO:  DE-AC05-76OR00033

COPYRIGHT 1985
THE PROGRAM IS RUNNING
```

Figure 4.18a. Credits Screen

```
                              FOR
              CARBON DIOXIDE RESEARCH DIVISION
                 U.S. DEPARTMENT OF ENERGY

                       DISTRIBUTED BY
              CARBON DIOXIDE INFORMATION CENTER
               OAK RIDGE NATIONAL LABORATORY
                   OAK RIDGE, TN  37831

          UNDER CONTRACT NO:  DE-AC05-76OR00033

                      COPYRIGHT 1985
                  THE PROGRAM IS RUNNING

WRITING COMPLETE...

Stop - Program terminated.

C:\CO2MODEL>
```

Figure 4.18b. Program Termination

We have successfully run the model.

DETAILED DISCUSSION OF INPUT MODIFICATION

Having worked through two examples in which the model was run, we examine the menu choices in more detail.

Main Menu

The main input assumption menu is displayed in Figure 4.19.

```
                    ******************************
                    ***                        ***
                    ***   INPUT ASSUMPTIONS    ***
                    ***                        ***
                    ******************************

        THERE ARE TWELVE INPUT ASSUMPTION CATEGORIES OPEN
        TO USER INSPECTION AND/OR MODIFICATION.  SELECT ONE
        OF THE FOLLOWING:
                    1   POPULATION
                    2   LABOR PRODUCTIVITY
                    3   END-USE ENERGY EFFICIENCY
                    4   INCOME EFFECTS
                    5   PRICE EFFECTS
                    6   RESOURCE BASE
                    7   TECHNOLOGICAL CHANGE IN ENERGY PRODUCTION
                    8   ENVIRONMENTAL COSTS OF ENERGY PRODUCTION
                    9   MARKET PENETRATION SUPPLY TECHNOLOGY
                   10   SOLAR AND BIOMASS ENERGY COSTS
                   11   SYNFUEL COSTS
                   12   NUMBER OF FORECAST PERIODS

                    0   NONE OF THE ABOVE.  RUN THE MODEL.

        ENTER YOUR CHOICE, THEN PRESS RETURN =====>
```

Figure 4.19. Input Assumption Menu

Thirteen choices are available to the user.

To select a major category for inspection or alteration

Type: Any number between 1 and 12
Press: Return key

To run the model

Type: Ø
Press: Return key

> NOTE: The Return Key. In general, if you simply press the return key without entering a number first, the model will return to the preceding screen. When the main assumptions menu (Figure 4.19) is on the screen, if you press just the return key, the model assumes you have entered a Ø and proceeds to run the model.

Assumption Disaggregation

Each of the menu assumption categories (with the exception of items Ø and 3) are further disaggregated. A total of 39 individual assumptions are available for inspection and/or modification. In addition the user may choose a terminal date for the model forecast run or run the model.

The main menu choices and their associated disaggretates (subchoices) are summarized in Table 4.1. In addition, Figures 4.20 through 4.71, cited in Table 4.1, display all of the basic screens that a user may encounter.

TABLE 4.1. SUMMARY OF INPUT ASSUMPTIONS OPEN TO INSPECTION AND/OR MODIFICATION

Major Assumption	Description	Assumption Disaggregation
1 Population	Population is specified in millions of persons for two global regions. (Figure 4.20)	1. North. (N. America, Europe, USSR, Japan, Australia, New Zealand) (Figure 4.21) 2. South. (China, Mideast, Asia, Africa, Latin America) (Figure 4.22)
2 Labor Productivity	The rate of growth of the labor force plus the rate of growth of labor productivity equals the rate of growth of GNP. The rate of growth of the labor force is determined within the model using population assumptions. Labor productivity is specified as a constant rate for two regions. (Figure 4.23)	1. North. (N. America, Europe, USSR, Japan, Australia, New Zealand) (Figure 4.24) 2. South. (China, Mideast, Asia, Africa, Latin America) (Figure 4.25)
3 End-Use Energy Efficiency	End-use energy efficiency is the rate at which energy use per unit output would decline over time, as a consequence of technological change, process improvements and changes in the mix of goods produced, if population, GNP and prices were constant. (Figure 4.26)	None

TABLE 4.1. SUMMARY OF INPUT ASSUMPTIONS OPEN TO INSPECTION AND/OR MODIFICATION (continued)

Major Assumption	Description	Assumption Disaggregation
4 Income Effects	Income elasticity reflects the effect of income on aggregate end-use energy consumption. It is measured as the percent change in income if other factors such as population, technology, and energy prices are fixed. A value of 1.0 implies a constant energy to GNP ratio. (Figure 4.27)	1. OECD. (N. America, W. Europe, Japan, Australia, New Zealand) (Figure 4.28) 2. USSR & E. Europe. (Figure 4.29) 3. South. (China, Asia, Mideast, Africa, Latin America) (Figure 4.30)
5 Price Effects	Price effects measure the response of energy use (or GNP) to changes in energy prices, other factors remaining unchanged. (Figure 4.31)	1. Aggregate price elasticity. Percentage change in the demand for secondary (end-use) energy for each percentage change in the price of secondary (end-use) energy, with other factors such as population, technology, and income, fixed. (Figure 4.32) 2. Rate of end-use interfuel substitution. A measure of the ease of substitution among end-use fuels (liquids, gases, solids, and electricity), other factors such as income and technology fixed. (Figure 4.33)

TABLE 4.1. SUMMARY OF INPUT ASSUMPTIONS OPEN TO INSPECTION AND/OR MODIFICATION (continued)

Major Assumption	Description	Assumption Disaggregation
5 Price Effects (continued)		3. Rate of utility interfuel substitution. A measure of the ease of substitution among utility fuels (liquids, gases, solids, nuclear and solar electric), other factors such as income and technology fixed. (Figure 4.34) 4. Energy-GNP feedback elasticity. A measure of the percentage change in GNP caused by each percentage change in the average cost of energy services, other factors such as population and technology fixed. (Figure 4.35) Further disaggregation: 1. North. (OECD, USSR, E. Europe) (Figure 4.36) 2. Mideast. (Figure 4.37) 3. South (ex. Mideast). (Asia, Latin America, Africa) (Figure 4.38)

TABLE 4.1. SUMMARY OF INPUT ASSUMPTIONS OPEN TO INSPECTION AND/OR MODIFICATION (continued)

Major Assumption	Description	Assumption Disaggregation
6 Resource Base	The resource bases are comprised of the total recoverable resources remaining, including discovered and undiscovered resources over all cost gradations, unproduced as of 1975, but producible with known technologies. There are five energy supply categories. (Figure 4.39)	1. Conventional oil (Figure 4.40) 2. Natural gas (Figure 4.41) 3. Coal (Figure 4.42) 4. Shale oil (Figure 4.43) 5. Nuclear power (Figure 4.44a) – Nuclear technology (breeder reactors) option (Figure 4.44b)
7 Technological Change in Energy Production	Assumptions are for the rate at which technological change reduces production costs over the forecast. (Figure 4.45)	1. Conventional oil (Figure 4.46) 2. Natural gas (Figure 4.47) 3. Coal (Figure 4.48) 4. Shale oil (Figure 4.49) 5. Nuclear power (Figure 4.50)
8 Environmental Costs of Energy Production	Costs are for the year 2050. These figures include only those costs associated with energy production and not energy use, and only costs in excess of those encountered in 1975. Costs incurred as a result of 1975 regulations are included as part of the base costs of production. (Figure 4.51)	1. Conventional oil (Figure 4.52) 2. Natural gas (Figure 4.53) 3. Coal (Figure 4.54) 4. Shale oil (Figure 4.55) 5. Nuclear power (Figure 4.56)
9 Market Penetration Supply Technology	Market penetration governs the maximum increase in energy supply from one period to the next. Supply is assumed to grow no faster than GNP without increasing costs. (Figure 4.57).	1. Conventional oil (Figure 4.58) 2. Natural gas (Figure 4.59) 3. Coal (Figure 4.60) 4. Shale oil (Figure 4.61)

TABLE 4.1. SUMMARY OF INPUT ASSUMPTIONS OPEN TO INSPECTION AND/OR MODIFICATION (continued)

Major Assumption	Description	Assumption Disaggregation
10 Solar and Biomass Energy Costs	Costs of producing solar and biomass energy. (Figure 4.62)	1. Solar electric power. Numerous solar electric technologies are aggregated into a single parameter including photovoltaics, solar thermal energy conversion, ocean thermal energy conversion, wind, tidal, and such non-solar energy sources as geothermal, and fusion power. (Figure 4.63) 2. Biomass. There are two sources of biomass energy in the model: waste and energy farms. The user controls the minimum cost of energy produced on biomass farms. This assumption is then used as an index of the cost of biomass energy from both sources at all grades. (Figure 4.64)
11 Synfuel Costs	Solid fuels (coal and biomass) can be converted into liquids and gases. Costs are governed by process efficiency and non-energy costs. (Figure 4.65)	1. Non-energy costs of synoil. Average capital, labor and materials costs per gigajoule of output. (Energy costs are calculated in the model itself.) (Figure 4.66)

TABLE 4.1. SUMMARY OF INPUT ASSUMPTIONS OPEN TO INSPECTION AND/OR MODIFICATION (continued)

Major Assumption	Description	Assumption Disaggregation
11 Synfuel Costs (continued)		2. Non-energy costs of syngas. Average capital, labor and materials costs per gigajoule of output. (Energy costs are calculated in the model itself.) (Figure 4.67)
		3. Process efficiency of synoil. Input-output coefficient: number of joules of solids (coal and biomass) required for each joule of synfuel produced. (Figure 4.68)
		4. Process efficiency of syngas. Input-output coefficient: number of joules of solids (coal and biomass) required for each joule of synfuel produced. (Figure 4.69)
12 Number of Forecast Periods	The model is designed to produce forecast scenarios for up to six forecast periods. Any of six terminal years can be selected. (Figure 4.70)	1. 1975 2. 2000 3. 2025 4. 2050 5. 2075 6. 2100
Ø Run the model	Terminates input modification session and proceeds directly to run the model. (Figure 4.71)	none

```
                    POPULATION ASSUMPTIONS

POPULATION IS SPECIFIED IN MILLIONS OF PERSONS IN THE YEAR
2075 FOR TWO DIFFERENT REGIONS.  YOU MAY EXAMINE AND/OR CHANGE
ASSUMPTIONS FOR EITHER REGION, ONE AT A TIME, IN ANY ORDER.
SELECT ONE OF THE FOLLOWING:

          1= NORTH (N.AMER+EUROPE+USSR+JAPAN+AUSTRALIA)
          2= SOUTH (ASIA + AFRICA + L. AMERICA + MIDEAST)
OR
          0= NEITHER.  RETURN TO MAIN ASSUMPTIONS MENU.

CHOOSE 1,2, OR 0, THEN PRESS RETURN.  =====>
```

Figure 4.20. Population Assumptions Screen

```
                         POPULATION ASSUMPTIONS

CONCEPT= REGIONAL POPULATION IN THE YEAR 2075
UNITS= MILLIONS (10**6)PERSONS IN THE YEAR 2075
REGION= NORTH(USA+CANADA+EUROPE+USSR+JAPAN+AUSTRALIA+N.ZEALAND)

                    LOW ESTIMATE-------( 1280.)
                    MEDIAN ESTIMATE----( 1568.)
                    HIGH ESTIMATE------( 1910.)
                    DEFAULT ASSUMPTION   1564.

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.21. Population Assumption for North Region

```
                    POPULATION ASSUMPTIONS

CONCEPT= REGIONAL POPULATION IN THE YEAR 2075
UNITS= MILLIONS (10**6)PERSONS IN THE YEAR 2075
REGION= SOUTH(ASIA + AFRICA + LATIN AMERICA + MIDEAST)


                    LOW ESTIMATE--------( 5632.)
                    MEDIAN ESTIMATE-----( 6882.)
                    HIGH ESTIMATE-------( 8397.)
                    DEFAULT ASSUMPTION    6882.

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.22. Population Assumption for South Region

```
                    LABOR PRODUCTIVITY ASSUMPTIONS

LABOR PRODUCTIVITY -- CLOSELY RELATED TO ECONOMIC GROWTH AND GNP.
    THE RATE OF GROWTH OF THE LABOR FORCE PLUS THE RATE OF GROWTH OF
    LABOR PRODUCTIVITY EQUALS THE RATE OF GROWTH OF GNP.  THE RATE
    OF GROWTH OF THE LABOR FORCE IS DETERMINED WITHIN THE MODEL USING
    POPULATION ASSUMPTIONS.  LABOR PRODUCTIVITY IS SPECIFIED AS A
    CONSTANT RATE FOR TWO DIFFERENT REGIONS.  YOU MAY [illegible] AND/OR
    CHANGE ASSUMPTIONS FOR EITHER REGION, ONE AT A TIME, IN ANY ORDER.
    SELECT ONE OF THE FOLLOWING:

              1= NORTH (N.AMER+EUROPE+USSR+JAPAN+AUSTRALIA)
              2= SOUTH (ASIA + AFRICA + L. AMERICA + MIDEAST)
     OR
              0= NEITHER.  RETURN TO MAIN ASSUMPTIONS MENU.

    CHOOSE 1,2, OR 0, THEN PRESS RETURN  =====.
```

Figure 4.23. Labor Productivity Assumptions Screen

```
                    LABOR PRODUCTIVITY ASSUMPTIONS

CONCEPT= LABOR PRODUCTIVITY IS CLOSELY RELATED TO ECONOMIC GROWTH AND
    GNP.  THE RATE OF GROWTH OF THE LABOR FORCE PLUS THE RATE OF GROWTH
    OF LABOR PRODUCTIVITY EQUALS THE RATE OF GROWTH OF GNP.  THE RATE
    OF GROWTH OF THE LABOR FORCE IS DETERMINED WITHIN THE MODEL USING
    POPULATION ASSUMPTIONS.  LABOR PRODUCTIVITY IS SPECIFIED AS A
    CONSTANT RATE.
UNITS= NONE (RATE PER YEAR)
REGION= NORTH(USA+CANADA+EUROPE+USSR+JAPAN+AUSTRALIA+N.ZEALAND)

                    LOW ESTIMATE--------(-.005)
                    MEDIAN ESTIMATE-----( .017)
                    HIGH ESTIMATE-------( .040)
                    DEFAULT ASSUMPTION    .017

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.24. Labor Productivity Assumptions for North Region

```
                    LABOR PRODUCTIVITY ASSUMPTIONS

CONCEPT= LABOR PRODUCTIVITY IS CLOSELY RELATED TO ECONOMIC GROWTH AND
    GNP.  THE RATE OF GROWTH OF THE LABOR FORCE PLUS THE RATE OF GROWTH
    OF LABOR PRODUCTIVITY EQUALS THE RATE OF GROWTH OF GNP.  THE RATE
    OF GROWTH OF THE LABOR FORCE IS DETERMINED WITHIN THE MODEL USING
    POPULATION ASSUMPTIONS.  LABOR PRODUCTIVITY IS SPECIFIED AS A
    CONSTANT RATE.
UNITS= NONE (RATE PER YEAR)
REGION= SOUTH(ASIA + AFRICA + LATIN AMERICA + MIDEAST)

                    LOW ESTIMATE--------(-.010)
                    MEDIAN ESTIMATE-----( .029)
                    HIGH ESTIMATE-------( .055)
                    DEFAULT ASSUMPTION    .029

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.25. Labor Productivity Assumptions for South Region

```
                 END-USE ENERGY EFFICIENCY ASSUMPTIONS

CONCEPT= RATE AT WHICH ENERGY USE PER UNIT OUTPUT WOULD DECLINE
         OVER TIME, AS A CONSEQUENCE OF TECHNOLOGICAL CHANGE,
         PROCESS IMPROVEMENTS AND CHANGES IN THE MIX OF GOODS
         PRODUCED, IF OTHER THINGS SUCH AS POPULATION, GNP,
         AND PRICES WERE UNCHANGED.
UNITS= NONE (AVERAGE ANNUAL RATE)
REGION= GLOBAL

                    LOW ESTIMATE--------( .000)
                    MEDIAN ESTIMATE-----( .010)
                    HIGH ESTIMATE-------( .030)
                    DEFAULT ASSUMPTION   .010

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.26. End-Use Energy Efficiency Assumption Screen

```
                      INCOME EFFECTS ASSUMPTIONS

INCOME ELASTICITY -- REFLECTS THE EFFECT OF INCOME ON AGGREGATE
    END-USE ENERGY CONSUMPTION.  MEASURED AS THE PERCENTAGE CHANGE
    IN ENERGY USE FOR EACH PERCENTAGE CHANGE IN INCOME WITH OTHER
    FACTORS SUCH AS POPULATION, TECHNOLOGY AND ENERGY PRICES FIXED.

    YOU MAY EXAMINE AND/OR CHANGE ASSUMPTIONS FOR ANY OF THREE REGIONS,
    ONE AT A TIME, IN ANY ORDER.  SELECT ONE OF THE FOLLOWING:

             1= OECD (N.AMER+W.EUROPE+JAPAN+AUSTRALIA+N.Z.)
             2= USSR+E.EUROPE
             3= SOUTH (ASIA+AFRICA+L.AMERICA+MIDEAST)
     OR
             0= NONE OF THE ABOVE.  RETURN TO MAIN ASSUMPTIONS MENU.

    CHOOSE 1,2,3, OR 0, THEN PRESS RETURN.  =====>
```

Figure 4.27. Income Effects Assumption Screen

```
INCOME EFFECTS ASSUMPTIONS

CONCEPT= INCOME ELASTICITY REFLECTS THE EFFECT OF INCOME ON AGGREGATE
     END-USE ENERGY CONSUMPTION.
MEASURE= PERCENTAGE CHANGE IN END-USE ENERGY CONSUMPTION FOR EACH
     PERCENTAGE CHANGE IN INCOME WITH OTHER FACTORS SUCH AS POP-
     ULATION, TECHNOLOGY AND ENERGY PRICES CONSTANT.
UNITS= NONE
REGION= OECD (USA+CANADA+EUROPE+JAPAN+AUSTRALIA+N.ZEALAND)

NOTES:  1. A VALUE OF 1.0 IMPLIES A CONSTANT ENERGY TO GNP RATIO.
        2. VALUE IS CONSTANT OVER ALL PERIODS.

                    LOW ESTIMATE--------( .200)
                    MEDIAN ESTIMATE-----(1.000)
                    HIGH ESTIMATE-------(1.400)
                    DEFAULT ASSUMPTION   1.000

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.28. Income Effects Assumptions for OECD Region

```
INCOME EFFECTS ASSUMPTIONS

CONCEPT= INCOME ELASTICITY REFLECTS THE EFFECT OF INCOME ON AGGREGATE
     END-USE ENERGY CONSUMPTION.
MEASURE= PERCENTAGE CHANGE IN END-USE ENERGY CONSUMPTION FOR EACH
     PERCENTAGE CHANGE IN INCOME WITH OTHER FACTORS SUCH AS POP-
     ULATION, TECHNOLOGY AND ENERGY PRICES CONSTANT.
UNITS= NONE
REGION= USSR+E.EUROPE

NOTES:  1. A VALUE OF 1.0 IMPLIES A CONSTANT ENERGY TO GNP RATIO.
        2. VALUE IS REDUCED BY 20% BETWEEN 1975 AND 2030.

                    LOW ESTIMATE--------( .200)
                    MEDIAN ESTIMATE-----(1.250)
                    HIGH ESTIMATE-------(1.800)
                    DEFAULT ASSUMPTION   1.250

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.29. Income Effects Assumptions for USSR & E. Europe Region

```
                    INCOME EFFECTS ASSUMPTIONS

CONCEPT= INCOME ELASTICITY REFLECTS THE EFFECT OF INCOME ON AGGREGATE
    END-USE ENERGY CONSUMPTION.
MEASURE= PERCENTAGE CHANGE IN END-USE ENERGY CONSUMPTION FOR EACH
    PERCENTAGE CHANGE IN INCOME WITH OTHER FACTORS SUCH AS POP-
    ULATION, TECHNOLOGY AND ENERGY PRICES CONSTANT.
UNITS= NONE
REGION= SOUTH (ASIA+AFRICA+L.AMERICA+MIDEAST)

NOTES:   1. A VALUE OF 1.0 IMPLIES A CONSTANT ENERGY TO GNP RATIO.
         2. VALUE IS REDUCED BY 30% BETWEEN 1975 AND 2050.

                   LOW ESTIMATE--------( .500)
                   MEDIAN ESTIMATE-----(1.400)
                   HIGH ESTIMATE-------(2.200)
                   DEFAULT ASSUMPTION   1.400

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ==>
```

Figure 4.30. Income Effects Assumptions for South Region

```
                    PRICE EFFECT ASSUMPTIONS

  THERE ARE 4 PRICE EFFECT ASSUMPTIONS THAT CAN BE CHANGED.
  CHOOSE ONE OF THE FOLLOWING:

                 1= AGGREGATE PRICE ELASTICITY
                      FOR END-USE ENERGY,
                 2= THE RATE OF INTERFUEL SUB-
                      STITUTION IN END-USE.
                 3= THE RATE OF INTERFUEL SUB-
                      STITUTION FOR ELECTRIC
                      UTILITIES.
                 4= ENERGY-GNP FEEDBACK ELASTICITY.
  OR
                 0= NONE OF THE ABOVE.  RETURN TO MASTER MENU.

 TYPE YOUR CHOICE:  1,2,3,4, OR 0 ===>*
```

Figure 4.31. Price Effects Assumptions Screen

```
                 1= AGGREGATE PRICE ELASTICITY

     CONCEPT= PERCENTAGE CHANGE IN THE DEMAND FOR SECONDARY (END-USE)
              ENERGY FOR EACH PERCENTAGE CHANGE IN THE PRICE OF
              SECONDARY (END-USE) ENERGY, WITH OTHER FACTORS SUCH
              AS POPULATION, TECHNOLOGY, AND INCOME, FIXED.
     UNITS= NONE
     REGIONS= GLOBAL
     SECTORS= ALL END-USE SECTORS

     NOTE:  INPUT VALUES ARE ALWAYS NEGATIVE TO REFLECT THE
            REDUCTION IN ENERGY USE CAUSED BY PRICE INCREASES.
            A VALUE OF ZERO (0.0) INDICATES NO PRICE EFFECTS.

                    LOW ESTIMATE--------( -.05)
                    MEDIAN ESTIMATE-----( -.70)
                    HIGH ESTIMATE-------(-1.30)
                    DEFAULT ASSUMPTION   -.70

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>**
```

Figure 4.32. Price Effects Assumptions for Aggregate Price Elasticity

```
              2= RATE OF END-USE INTERFUEL SUBSTITUTION

CONCEPT= A MEASURE OF THE EASE OF SUBSTITUTION AMONG END-USE FUELS
         (LIQUIDS, GASES, SOLIDS, AND ELECTRICITY), OTHER THINGS
         SUCH AS INCOME AND TECHNOLOGY FIXED.
THEORETICAL BOUNDS= INDEX IS NEGATIVE OR ZERO
         0.0        ==> NO SUBSTITUTION--FIXED MARKET SHARES.
         -INFINITY==> PERFECT SUBSTITUTION--LEAST COST OPTION
                      GETS 100% OF MARKET.
UNITS= NONE
REGION= GLOBAL
SECTORS= ALL END-USE SECTORS
NOTE:  INDEX IS NEGATIVE TO REFLECT THE LOSS OF MARKET SHARE CAUSED
       BY AN INCREASE IN THE RELATIVE COST OF ANY FUEL.

                 LOW ESTIMATE--------( -.40)
                 MEDIAN ESTIMATE-----(-3.00)
                 HIGH ESTIMATE-------(-7.50)
                 DEFAULT ASSUMPTION  -2.50

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.33. Price Effects Assumptions for Rate of End-Use Interfuel Substitution

```
                3= RATE OF UTILITY INTERFUEL SUBSTITUTION

CONCEPT= A MEASURE OF THE EASE OF SUBSTITUTION AMONG UTILITY FUELS
         (LIQUIDS, GASES, SOLIDS, NUCLEAR AND SOLAR ELECTRIC),
         OTHER THINGS SUCH AS INCOME AND TECHNOLOGY FIXED.
THEORETICAL BOUNDS= INDEX IS NEGATIVE OR ZERO
         0.0       ==> NO SUBSTITUTION--FIXED MARKET SHARES.
         -INFINITY==> PERFECT SUBSTITUTION--LEAST COST OPTION
                      GETS 100% OF MARKET.
UNITS= NONE
REGION= GLOBAL
SECTOR= ELECTRIC UTILITIES
NOTE:   INDEX IS NEGATIVE TO REFLECT THE LOSS OF MARKET SHARE CAUSED
        BY AN INCREASE IN THE RELATIVE COST OF ANY FUEL.

                     LOW ESTIMATE--------(  -.40)
                     MEDIAN ESTIMATE----( -3.00)
                     HIGH ESTIMATE-------(-12.00)
                     DEFAULT ASSUMPTION   -3.00

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>*
```

Figure 4.34. Price Effects Assumptions for Rate of Utility Inter uel Substitution

```
                4= ENERGY-GNP FEEDBACK ELASTICITY

CONCEPT= A MEASURE OF THE PERCENTAGE CHANGE IN THE GNP CAUSED BY
         EACH PERCENTAGE CHANGE IN THE AVERAGE COST OF ENERGY SERVICES.
         OTHER THINGS SUCH AS POPULATION AND TECHNOLOGY FIXED.

DISAGGREGATION:  THIS PARAMETER IS SPECIFIED FOR THREE REGIONS.  YOU
MAY SELECT ANY ONE OF THEM:

           1.NORTH=OECD+USSR+E.EUROPE
           2.MIDEAST
           3.SOUTH(EX.MIDEAST)=ASIA+L.AMER.+AFRICA

           0. NONE OF THE ABOVE.  RETURN TO MAIN PRICE ASSUMPTIONS MENU.

SELECT 1,2,3, OR 0, THEN PRESS RETURN.  ===>
```

Figure 4.35. Price Effects Assumptions for Energy-GNP Feedback Elasticity

```
                    4= ENERGY-GNP FEEDBACK ELASTICITY

REGION= 1.NORTH=OECD+USSR+E.EUROPE
CONCEPT= A MEASURE OF THE PERCENTAGE CHANGE IN THE GNP CAUSED BY
         EACH PERCENTAGE CHANGE IN THE AVERAGE COST OF ENERGY SERVICES.
         OTHER THINGS SUCH AS POPULATION AND TECHNOLOGY FIXED.

NOTE:  A NEGATIVE VALUE (THE NORM) INDICATES THAT INCREASED ENERGY
  COSTS REDUCE ECONOMIC PRODUCTION.  A POSITIVE VALUE (MAJOR
  ENERGY PRODUCERS ONLY) INDICATES THAT INCREASED ENERGY COSTS
  RAISE THE VALUE OF ENERGY PRODUCTION MORE THAN IT REDUCES
  THE VALUE OF NON-ENERGY PRODUCTION.

                    LOW ESTIMATE--------( -.01)
                    MEDIAN ESTIMATE-----( -.15)
                    HIGH ESTIMATE-------( -.30)
                    DEFAULT ASSUMPTION    -.15

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.36. Price Effects Assumptions for Energy-GNP Feedback Elasticity for North Region

```
                    4= ENERGY-GNP FEEDBACK ELASTICITY

REGION= 2.MIDEAST
CONCEPT= A MEASURE OF THE PERCENTAGE CHANGE IN THE GNP CAUSED BY
         EACH PERCENTAGE CHANGE IN THE AVERAGE COST OF ENERGY SERVICES.
         OTHER THINGS SUCH AS POPULATION AND TECHNOLOGY FIXED.

NOTE:  A NEGATIVE VALUE (THE NORM) INDICATES THAT INCREASED ENERGY
  COSTS REDUCE ECONOMIC PRODUCTION.  A POSITIVE VALUE (MAJOR
  ENERGY PRODUCERS ONLY) INDICATES THAT INCREASED ENERGY COSTS
  RAISE THE VALUE OF ENERGY PRODUCTION MORE THAN IT REDUCES
  THE VALUE OF NON-ENERGY PRODUCTION.

                    LOW ESTIMATE--------( -.05)
                    MEDIAN ESTIMATE-----(  .05)
                    HIGH ESTIMATE-------(  .20)
                    DEFAULT ASSUMPTION     .05

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.37. Price Effects Assumptions for Energy-GNP Feedback Elasticity for Mideast Region

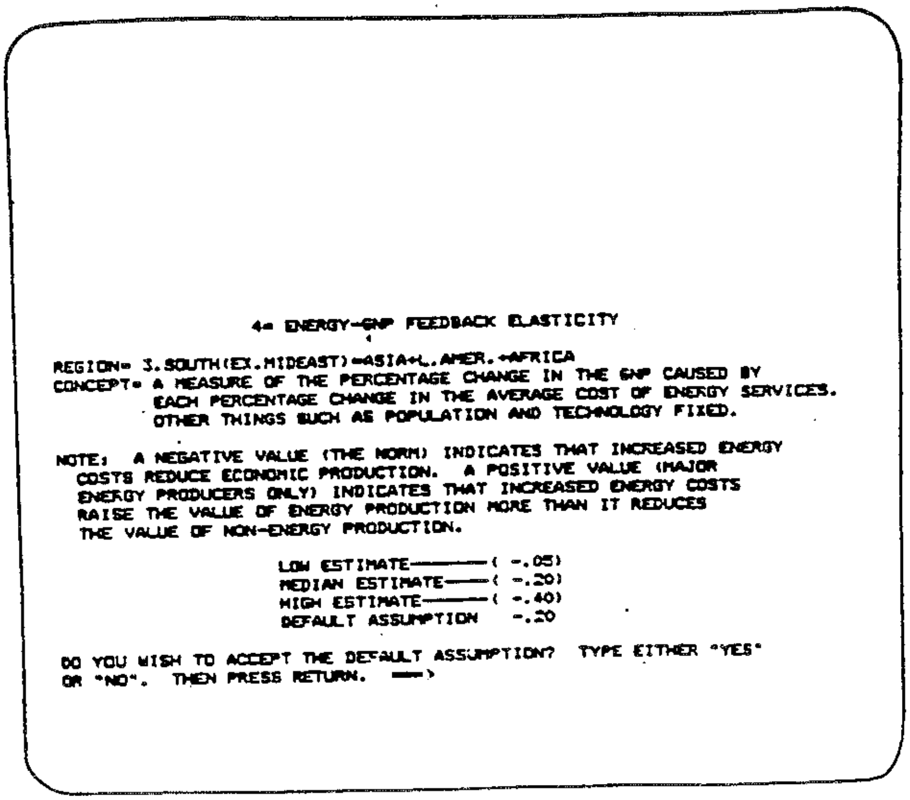


Figure 4.38. Price Effects Assumptions for Energy-GNP Feedback Elasticity for South Region

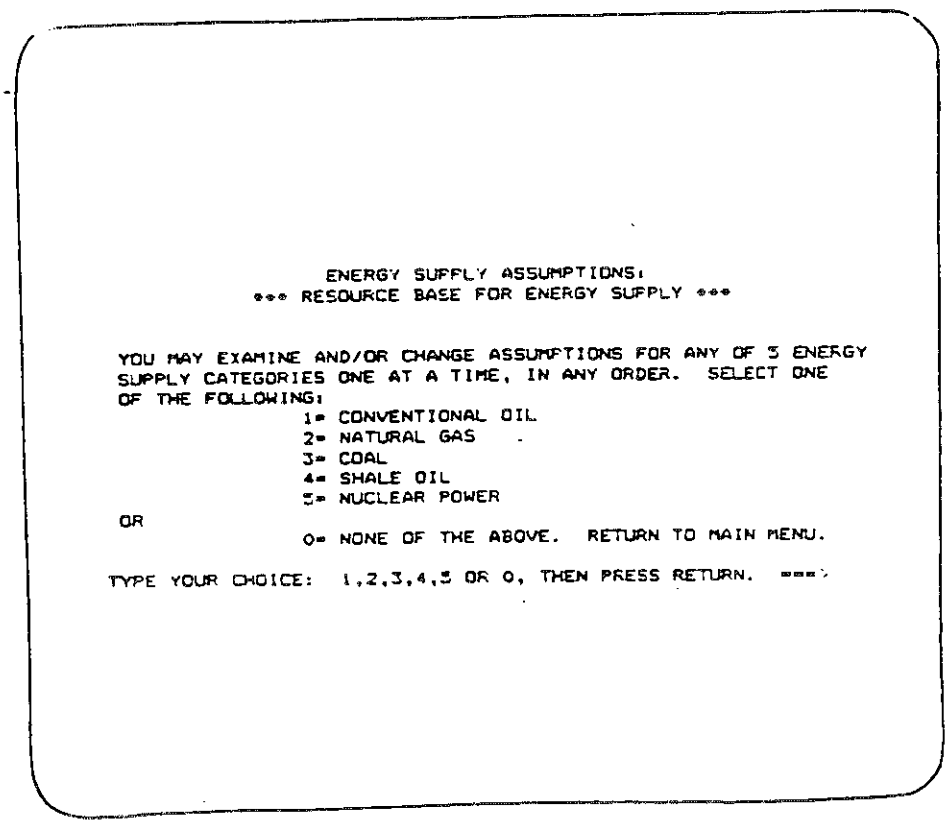


Figure 4.39. Resource Base Assumptions Screen

```
RESOURCE BASE:  CONVENTIONAL OIL

CONCEPT= TOTAL RECOVERABLE RESOURCES REMAINING, INCLUDING
         DISCOVERED AND UNDISCOVERED RESOURCES OVER ALL
         COST GRADATIONS, UNPRODUCED AS OF 1975, BUT
         PRODUCIBLE WITH KNOWN TECHNOLOGIES.
UNITS= EXAJOULES
REGION= GLOBAL

               LOW ESTIMATE--------(12660.)
               MEDIAN ESTIMATE-----(19950.)
               HIGH ESTIMATE-------(36741.)
               DEFAULT ASSUMPTION  21250.

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.40. Resource Assumptions for Conventional Oil

```
RESOURCE BASE:  NATURAL GAS

CONCEPT= TOTAL RECOVERABLE RESOURCES REMAINING, INCLUDING
         DISCOVERED AND UNDISCOVERED RESOURCES OVER ALL
         COST GRADATIONS, UNPRODUCED AS OF 1975, BUT
         PRODUCIBLE WITH KNOWN TECHNOLOGIES.
UNITS= EXAJOULES
REGION= GLOBAL

               LOW ESTIMATE--------( 4990.)
               MEDIAN ESTIMATE-----(14000.)
               HIGH ESTIMATE-------(66990.)
               DEFAULT ASSUMPTION  13950.

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.41. Resource Base Assumptions for Natural Gas

```
RESOURCE BASE:  COAL

CONCEPT= TOTAL RECOVERABLE RESOURCES REMAINING, INCLUDING
         DISCOVERED AND UNDISCOVERED RESOURCES OVER ALL
         COST GRADATIONS, UNPRODUCED AS OF 1975, BUT
         PRODUCIBLE WITH KNOWN TECHNOLOGIES.
UNITS= EXAJOULES
REGION= GLOBAL

                 LOW ESTIMATE--------(  52500.)
                 MEDIAN ESTIMATE-----( 271000.)
                 HIGH ESTIMATE-------( 683000.)
                 DEFAULT ASSUMPTION   271000.

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.42. Resource Base Assumptions for Coal

```
RESOURCE BASE:  SHALE OIL

CONCEPT= TOTAL RECOVERABLE RESOURCES REMAINING, INCLUDING
         DISCOVERED AND UNDISCOVERED RESOURCES OVER ALL
         COST GRADATIONS, UNPRODUCED AS OF 1975, BUT
         PRODUCIBLE WITH KNOWN TECHNOLOGIES.
UNITS= EXAJOULES
REGION= GLOBAL

                 LOW ESTIMATE--------(       0.)
                 MEDIAN ESTIMATE-----(2079000.)
                 HIGH ESTIMATE-------(4602000.)
                 DEFAULT ASSUMPTION  2078605.

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.43. Resource Base Assumptions for Shale Oil

```
RESOURCE BASE:  NUCLEAR POWER

NOTE:  FOR NUCLEAR POWER TWO ASSUMPTIONS MUST BE SPECIFIED:
     1. THE ELECTRIC POWER EQUIVALENT RESOURCE BASE OF
        URANIUM AVAILABLE WITH CONVENTIONAL LIGHTWATER
        REACTOR TECHNOLOGY
     2. WHETHER OR NOT TO INTRODUCE BREEDER REACTORS.
CONCEPT= TOTAL RECOVERABLE RESOURCES REMAINING, INCLUDING
         DISCOVERED AND UNDISCOVERED RESOURCES OVER ALL
         COST GRADATIONS, UNPRODUCED AS OF 1975, BUT
         PRODUCIBLE WITH KNOWN TECHNOLOGIES.
UNITS= EXAJOULES
REGION= GLOBAL

               LOW ESTIMATE---------(     0.)
               MEDIAN ESTIMATE-----(14500.)
               HIGH ESTIMATE-------(27000.)
               DEFAULT ASSUMPTION  14423.

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.44a. Resource Base Assumptions for Nuclear Power

```
                    NUCLEAR TECHNOLOGY OPTION:

BREEDER REACTORS ARE A TECHNOLOGICAL OPTION IN THIS MODEL.
THE DEFAULT OPTION IS TO ASSUME THIS TECHNOLOGY IS AVAILABLE.
DO YOU WISH TO ASSUME THIS TECHNOLOGY IS AVAILABLE?

TYPE EITHER "YES" OR "NO".. THEN PRESS RETURN ===>
```

Figure 4.44b. Resource Base Assumption; Nuclear Technology Option

```
              ENERGY SUPPLY ASSUMPTIONS:
     *** TECHNOLOGICAL CHANGE IN ENERGY SUPPLY ***


YOU MAY EXAMINE AND/OR CHANGE ASSUMPTIONS FOR ANY OF 5 ENERGY
SUPPLY CATEGORIES ONE AT A TIME, IN ANY ORDER.  SELECT ONE
OF THE FOLLOWING:
                1= CONVENTIONAL OIL
                2= NATURAL GAS
                3= COAL
                4= SHALE OIL
                5= NUCLEAR POWER
OR
                0= NONE OF THE ABOVE.  RETURN TO MAIN MENU.

TYPE YOUR CHOICE:  1,2,3,4,5 OR 0, THEN PRESS RETURN.  ===>
```

Figure 4.45. Technological Change in Energy Production Assumptions

```
RATE OF TECHNOLOGICAL CHANGE IN ENERGY PRODUCTION:
CONVENTIONAL OIL

CONCEPT= RATE AT WHICH TECHNOLOGICAL CHANGE REDUCES PRODUCTION
         COSTS OVER THE FORECAST.
UNITS= RATE PER YEAR

                    LOW ESTIMATE---------( .000)
                    MEDIAN ESTIMATE------( .005)
                    HIGH ESTIMATE--------( .010)
                    DEFAULT ASSUMPTION    .005

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.46. Assumptions for Technological change in Energy Production of Conventional Oil

```
RATE OF TECHNOLOGICAL CHANGE IN ENERGY PRODUCTION:
NATURAL GAS

CONCEPT= RATE AT WHICH TECHNOLOGICAL CHANGE REDUCES PRODUCTION
         COSTS OVER THE FORECAST.
UNITS= RATE PER YEAR

                    LOW ESTIMATE--------( .000)
                    MEDIAN ESTIMATE-----( .005)
                    HIGH ESTIMATE-------( .010)
                    DEFAULT ASSUMPTION    .005

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.47. Assumptions for Technological Change in Energy Production of Natural Gas

```
RATE OF TECHNOLOGICAL CHANGE IN ENERGY PRODUCTION:
COAL

CONCEPT= RATE AT WHICH TECHNOLOGICAL CHANGE REDUCES PRODUCTION
         COSTS OVER THE FORECAST.
UNITS= RATE PER YEAR

                    LOW ESTIMATE--------(-.005)
                    MEDIAN ESTIMATE-----( .005)
                    HIGH ESTIMATE-------( .020)
                    DEFAULT ASSUMPTION    .005

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.48. Assumptions for Technological change in Energy Production of Coal

RATE OF TECHNOLOGICAL CHANGE IN ENERGY PRODUCTION:
SHALE OIL

CONCEPT= RATE AT WHICH TECHNOLOGICAL CHANGE REDUCES PRODUCTION
COSTS OVER THE FORECAST.
UNITS= RATE PER YEAR

LOW ESTIMATE-------(-.005)
MEDIAN ESTIMATE----(.005)
HIGH ESTIMATE------(.025)
DEFAULT ASSUMPTION .005

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION? TYPE EITHER "YES"
OR "NO". THEN PRESS RETURN. ===>

Figure 4.49. Assumptions for Technological Change in Energy Production of Shale Oil

RATE OF TECHNOLOGICAL CHANGE IN ENERGY PRODUCTION:
NUCLEAR POWER

CONCEPT= RATE AT WHICH TECHNOLOGICAL CHANGE REDUCES PRODUCTION
COSTS OVER THE FORECAST.
UNITS= RATE PER YEAR

LOW ESTIMATE-------(.000)
MEDIAN ESTIMATE----(.005)
HIGH ESTIMATE------(.010)
DEFAULT ASSUMPTION .005

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION? TYPE EITHER "YES"
OR "NO". THEN PRESS RETURN. ===>

Figure 4.50. Assumptions for Technological change in Energy Production for Nuclear Power

```
               ENERGY SUPPLY ASSUMPTIONS:
       *** ENVIRONMENTAL COSTS OF ENERGY SUPPLY ***


YOU MAY EXAMINE AND/OR CHANGE ASSUMPTIONS FOR ANY OF 5 ENERGY
SUPPLY CATEGORIES ONE AT A TIME, IN ANY ORDER.  SELECT ONE
OF THE FOLLOWING:
                  1= CONVENTIONAL OIL
                  2= NATURAL GAS
                  3= COAL
                  4= SHALE OIL
                  5= NUCLEAR POWER
OR
                  0= NONE OF THE ABOVE.  RETURN TO MAIN MENU.

TYPE YOUR CHOICE:  1,2,3,4,5 OR 0, THEN PRESS RETURN.  ===>
```

Figure 4.51. Assumptions for Environmental Cost of Energy Production

```
     ENVIRONMENTAL COSTS OF ENERGY PRODUCTION:
     CONVENTIONAL OIL


     CONCEPT= ENVIRONMENTAL COSTS OF ENERGY PRODUCTION IN THE YEAR
              2050.  INCLUDES ONLY THOSE COSTS ASSOCIATED WITH ENERGY
              PRODUCTION AND NOT ENERGY USE.  INCLUDES ONLY COSTS
              IN EXCESS OF THOSE ENCOUNTERED IN 1975.  COSTS INCURRED
              AS A RESULT OF 1975 REGULATIONS ARE INCLUDED AS PART
              OF THE BASE COSTS OF PRODUCTION.
     UNITS= 1975 US $ PER GIGAJOULE
     REGION= GLOBAL

                   LOW ESTIMATE--------(  .00)
                   MEDIAN ESTIMATE-----(  .00)
                   HIGH ESTIMATE-------( 3.00)
                   DEFAULT ASSUMPTION     .00

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>*
```

Figure 4.52. Assumptions for Environmental Cost of Conventional Oil Production

```
ENVIRONMENTAL COSTS OF ENERGY PRODUCTION:
NATURAL GAS

CONCEPT= ENVIRONMENTAL COSTS OF ENERGY PRODUCTION IN THE YEAR
         2050.  INCLUDES ONLY THOSE COSTS ASSOCIATED WITH ENERGY
         PRODUCTION AND NOT ENERGY USE.  INCLUDES ONLY COSTS
         IN EXCESS OF THOSE ENCOUNTERED IN 1975.  COSTS INCURRED
         AS A RESULT OF 1975 REGULATIONS ARE INCLUDED AS PART
         OF THE BASE COSTS OF PRODUCTION.
UNITS= 1975 US $ PER GIGAJOULE
REGION= GLOBAL
                   LOW ESTIMATE--------(  .00)
                   MEDIAN ESTIMATE-----(  .00)
                   HIGH ESTIMATE-------( 3.00)
                   DEFAULT ASSUMPTION    .00

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===,
```

Figure 4.53. Assumptions for Environmental Cost of Gas Production

```
ENVIRONMENTAL COSTS OF ENERGY PRODUCTION:
COAL

CONCEPT= ENVIRONMENTAL COSTS OF ENERGY PRODUCTION IN THE YEAR
         2050.  INCLUDES ONLY THOSE COSTS ASSOCIATED WITH ENERGY
         PRODUCTION AND NOT ENERGY USE.  INCLUDES ONLY COSTS
         IN EXCESS OF THOSE ENCOUNTERED IN 1975.  COSTS INCURRED
         AS A RESULT OF 1975 REGULATIONS ARE INCLUDED AS PART
         OF THE BASE COSTS OF PRODUCTION.
UNITS= 1975 US $ PER GIGAJOULE
REGION= GLOBAL
                   LOW ESTIMATE--------(  .00)
                   MEDIAN ESTIMATE-----( 1.60)
                   HIGH ESTIMATE-------( 8.00)
                   DEFAULT ASSUMPTION   1.60

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===/*
```

Figure 4.54. Assumptions for Environmental Cost of Coal Production

```
ENVIRONMENTAL COSTS OF ENERGY PRODUCTION:
SHALE OIL


CONCEPT= ENVIRONMENTAL COSTS OF ENERGY PRODUCTION IN THE YEAR
         2050.  INCLUDES ONLY THOSE COSTS ASSOCIATED WITH ENERGY
         PRODUCTION AND NOT ENERGY USE.  INCLUDES ONLY COSTS
         IN EXCESS OF THOSE ENCOUNTERED IN 1975.  COSTS INCURRED
         AS A RESULT OF 1975 REGULATIONS ARE INCLUDED AS PART
         OF THE BASE COSTS OF PRODUCTION.
UNITS= 1975 US $ PER GIGAJOULE
REGION= GLOBAL

                LOW ESTIMATE--------(  .00)
                MEDIAN ESTIMATE----( 1.30)
                HIGH ESTIMATE------(13.00)
                DEFAULT ASSUMPTION   1.30

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>*
```

Figure 4.55. Assumptions for Environmental Cost of Shale Oil Production

```
ENVIRONMENTAL COSTS OF ENERGY PRODUCTION:
NUCLEAR POWER

CONCEPT= ENVIRONMENTAL COSTS OF ENERGY PRODUCTION IN THE YEAR
         2050.  INCLUDES ONLY THOSE COSTS ASSOCIATED WITH ENERGY
         PRODUCTION AND NOT ENERGY USE.  INCLUDES ONLY COSTS
         IN EXCESS OF THOSE ENCOUNTERED IN 1975.  COSTS INCURRED
         AS A RESULT OF 1975 REGULATIONS ARE INCLUDED AS PART
         OF THE BASE COSTS OF PRODUCTION.
UNITS= 1975 US $ PER GIGAJOULE
REGION= GLOBAL

                LOW ESTIMATE--------(   .00)
                MEDIAN ESTIMATE----( 10.00)
                HIGH ESTIMATE------(100.00)
                DEFAULT ASSUMPTION   10.00

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.56. Assumptions for Environmental Cost of Nuclear Power Production

```
                 ENERGY SUPPLY ASSUMPTIONS:
        *** MARKET PENETRATION OF ENERGY SUPPLY ***


YOU MAY EXAMINE AND/OR CHANGE ASSUMPTIONS FOR ANY OF 4 ENERGY
SUPPLY CATEGORIES ONE AT A TIME, IN ANY ORDER.  SELECT ONE
OF THE FOLLOWING:
               1= CONVENTIONAL OIL
               2= NATURAL GAS
               3= COAL
               4= SHALE OIL
OR
               0= NONE OF THE ABOVE.  RETURN TO MAIN MENU.

TYPE YOUR CHOICE:  1,2,3,4 OR 0, THEN PRESS RETURN.  ***:4
```

Figure 4.57. Market Penetration Supply Technology Assumptions Screen

```
   MARKET PENETRATION OF ENERGY PRODUCTION:
   CONVENTIONAL OIL


   CONCEPT= PRESCRIBES THE MAXIMUM INCREASE IN ENERGY SUPPLY FROM
            ONE PERIOD TO THE NEXT.  SUPPLY IS ASSUMED TO GROW NO
            FASTER THAN GNP WITHOUT INCREASING COSTS.
   MEASURE= MAXIMUM PERCENTAGE INCREASE IN SUPPLY (OVER PREVIOUS PERIOD
            PLUS ALLOWANCE FOR GNP GROWTH) FOR EACH PERCENTAGE INCREASE
            IN COSTS.
   UNITS= NONE
   REGION= GLOBAL

                  LOW ESTIMATE---------(  .00)
                  MEDIAN ESTIMATE------( 1.00)
                  HIGH ESTIMATE--------( 2.00)
                  DEFAULT ASSUMPTION     1.00

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ***?
```

Figure 4.58. Assumptions for Market Penetration of Energy Production for Conventional Oil

```
MARKET PENETRATION OF ENERGY PRODUCTION:
NATURAL GAS

CONCEPT= PRESCRIBES THE MAXIMUM INCREASE IN ENERGY SUPPLY FROM
         ONE PERIOD TO THE NEXT.  SUPPLY IS ASSUMED TO GROW NO
         FASTER THAN GNP WITHOUT INCREASING COSTS.
MEASURE= MAXIMUM PERCENTAGE INCREASE IN SUPPLY (OVER PREVIOUS PERIOD
         PLUS ALLOWANCE FOR GNP GROWTH) FOR EACH PERCENTAGE INCREASE
         IN COSTS.
UNITS= NONE
REGION= GLOBAL

                LOW ESTIMATE---------(  .00)
                MEDIAN ESTIMATE----( 1.00)
                HIGH ESTIMATE-------( 2.00)
                DEFAULT ASSUMPTION    1.00

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.59. Assumptions for Market Penetration of Energy Production for Natural Gas

```
MARKET PENETRATION OF ENERGY PRODUCTION:
COAL

CONCEPT= PRESCRIBES THE MAXIMUM INCREASE IN ENERGY SUPPLY FROM
         ONE PERIOD TO THE NEXT.  SUPPLY IS ASSUMED TO GROW NO
         FASTER THAN GNP WITHOUT INCREASING COSTS.
MEASURE= MAXIMUM PERCENTAGE INCREASE IN SUPPLY (OVER PREVIOUS PERIOD
         PLUS ALLOWANCE FOR GNP GROWTH) FOR EACH PERCENTAGE INCREASE
         IN COSTS.
UNITS= NONE
REGION= GLOBAL

                LOW ESTIMATE---------(  .00)
                MEDIAN ESTIMATE----( 1.00)
                HIGH ESTIMATE-------( 2.00)
                DEFAULT ASSUMPTION    1.00

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.60. Assumptions for Market Penetration of Energy Production for Coal

```
MARKET PENETRATION OF ENERGY PRODUCTION:
SHALE OIL


CONCEPT= PRESCRIBES THE MAXIMUM INCREASE IN ENERGY SUPPLY FROM
         ONE PERIOD TO THE NEXT.  SUPPLY IS ASSUMED TO GROW NO
         FASTER THAN GNP WITHOUT INCREASING COSTS.
MEASURE= MAXIMUM PERCENTAGE INCREASE IN SUPPLY (OVER PREVIOUS PERIOD
         PLUS ALLOWANCE FOR GNP GROWTH) FOR EACH PERCENTAGE INCREASE
         IN COSTS.
UNITS= NONE
REGION= GLOBAL

                LOW ESTIMATE--------(  .00)
                MEDIAN ESTIMATE-----( 2.00)
                HIGH ESTIMATE-------( 5.00)
                DEFAULT ASSUMPTION    1.00

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.61. Assumptions for Market Penetration of Energy Production for Shale Oil

```
                    SOLAR/BIOMASS ASSUMPTIONS

THERE ARE TWO SOLAR ENERGY TECHNOLOGY CATEGORIES.  YOU MAY
EXAMINE AND/OR CHANGE EITHER, ONE AT A TIME, IN ANY ORDER.
SELECT ONE OF THE FOLLOWING:
           1= SOLAR ELECTRIC POWER
           2= BIOMASS
OR
           0= NEITHER.  RETURN TO MAIN ASSUMPTIONS MENU.

CHOOSE 1,2, OR 0, THEN PRESS RETURN.  =====
```

Figure 4.62. Solar and Biomass Energy Costs Assumptions Screen

```
                    SOLAR ELECTRIC POWER TECHNOLOGIES

CONCEPT= NUMEROUS SOLAR ELECTRIC TECHNOLOGIES ARE AGGREGATED INTO A
         SINGLE PARAMETER INCLUDING PHOTOVOLTAICS, SOLAR THERMAL ENERGY
         CONVERSION, OCEAN THERMAL ENERGY CONVERSION, WIND, TIDAL, AND
         SUCH NON-SOLAR ENERGY SOURCES AS GEOTHERMAL, AND FUSION POWER
VARIABLE= GLOBAL AVERAGE COST OF SOLAR ELECTRIC POWER IN THE YEAR 2050
UNITS= 1975 US $ PER GIGAJOULE
REGION= GLOBAL

                    LOW ESTIMATE-------(  1.00)
                    MEDIAN ESTIMATE----( 15.00)
                    HIGH ESTIMATE------(100.00)
                    DEFAULT ASSUMPTION   14.85

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.63. Solar Electric Power Assumptions

```
                         BIOMASS ASSUMPTIONS

CONCEPT= THERE ARE 2 SOURCES OF BIOMASS ENERGY IN THE MODEL, WASTE
         AND ENERGY FARMS.  THE USER CONTROLS THE MINIMUM COST OF
         ENERGY PRODUCED ON BIOMASS FARMS.  THIS ASSUMPTION IS THEN
         USED AS AN INDEX OF THE COST OF BIOMASS ENERGY FROM BOTH
         SOURCES AT ALL GRADES.
REGION= GLOBAL
UNITS= 1975 US $ PER GIGAJOULE

                    LOW ESTIMATE-------(  .40)
                    MEDIAN ESTIMATE----( 2.10)
                    HIGH ESTIMATE------( 9.00)
                    DEFAULT ASSUMPTION  2.10

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.64. Biomass Energy Assumptions

```
                    SYNFUEL ASSUMPTIONS

SOLID FUELS (COAL AND BIOMASS) CAN BE TRANSFORMED INTO LIQUIDS
AND GASES.  THIS TRANSFORMATION IS GOVERNED BY 4 PARAMETERS.
YOU MAY EXAMINE AND/OR MODIFY ANY OR ALL OF THEM IN ANY ORDER.
SELECT ONE OF THE FOLLOWING:

          1= NON-ENERGY COSTS OF SYNOIL
          2= NON-ENERGY COSTS OF SYNGAS
          3= PROCESS EFFICIENCY OF SYNOIL
          4= PROCESS EFFICIENCY OF SYNGAS
OR
          0= NONE OF THE ABOVE.  RETURN TO MAIN ASSUMPTIONS MENU.

CHOOSE 1,2,3,4 OR 0, THEN PRESS RETURN.  =====>
```

Figure 4.65. Synfuel Assumptions Screen

```
                    NON-ENERGY COSTS OF SYNOIL

CONCEPT= AVERAGE CAPITAL, LABOR AND MATERIALS COSTS PER GIGAJOULE OF
         OUTPUT.  (ENERGY COSTS ARE CALCULATED IN THE MODEL ITSELF.)
UNITS= 1975 US $ PER GIGAJOULE OF SYNFUEL PRODUCED
REGION= GLOBAL

                 LOW ESTIMATE---------( 3.50)
                 MEDIAN ESTIMATE------( 4.50)
                 HIGH ESTIMATE--------(20.00)
                 DEFAULT ASSUMPTION    4.55

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.66. Synfuel Assumptions for Non-Energy Costs of Synoil

```
                    NON-ENERGY COSTS OF SYNGAS

CONCEPT= AVERAGE CAPITAL, LABOR AND MATERIALS COSTS PER GIGAJOULE OF
         OUTPUT.  (ENERGY COSTS ARE CALCULATED IN THE MODEL ITSELF.)
UNITS= 1975 US $ PER GIGAJOULE OF SYNFUEL PRODUCED
REGION= GLOBAL

                    LOW ESTIMATE--------( 2.56)
                    MEDIAN ESTIMATE-----( 3.29)
                    HIGH ESTIMATE-------(14.60)
                    DEFAULT ASSUMPTION    3.30

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===>
```

Figure 4.67. Synfuel Assumptions for Non-Energy Costs of Syngas

```
                    PROCESS EFFICIENCY OF SYNOIL

CONCEPT= INPUT-OUTPUT COEFFICIENT;  NUMBER OF JOULES OF SOLIDS (COAL
         AND BIOMASS) REQUIRED FOR EACH JOULE OF SYNFUEL PRODUCED
UNITS= NONE
REGION= GLOBAL

                    LOW ESTIMATE--------( 1.25)
                    MEDIAN ESTIMATE-----( 2.00)
                    HIGH ESTIMATE-------( 3.30)
                    DEFAULT ASSUMPTION    1.50

DO YOU WISH TO ACCEPT THE DEFAULT ASSUMPTION?  TYPE EITHER "YES"
OR "NO".  THEN PRESS RETURN.  ===
```

Figure 4.68. Synfuel Assumptions for Process Efficiency of Synoil

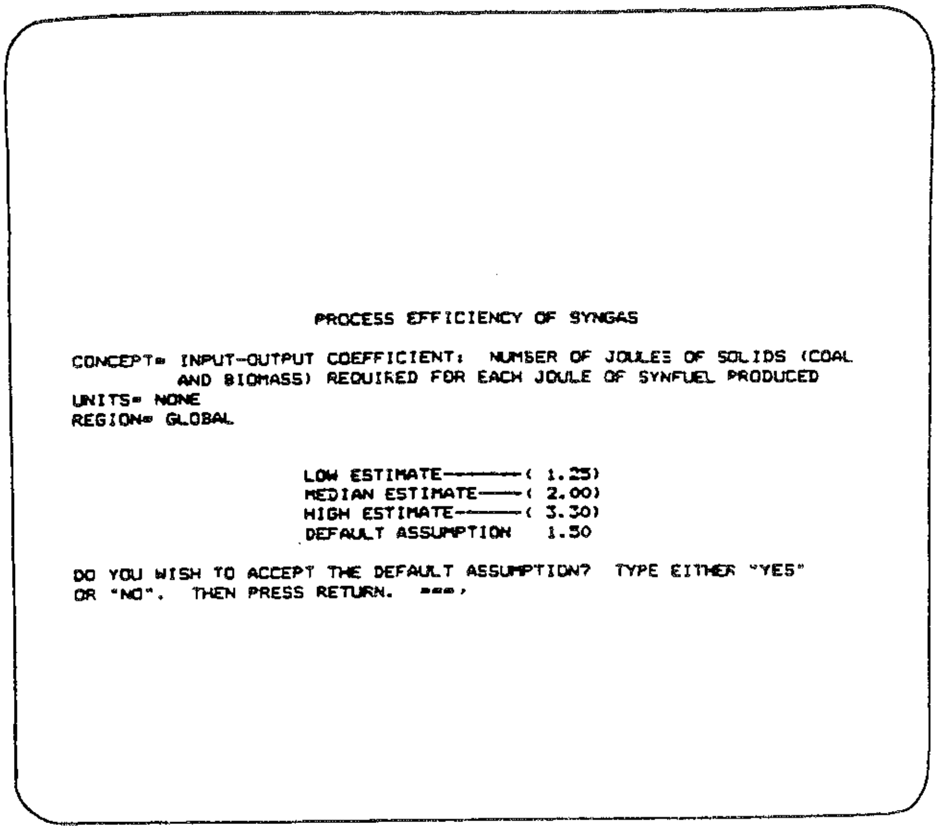


Figure 4.69. Synfuel Assumptions for Process Efficiency of Syngas

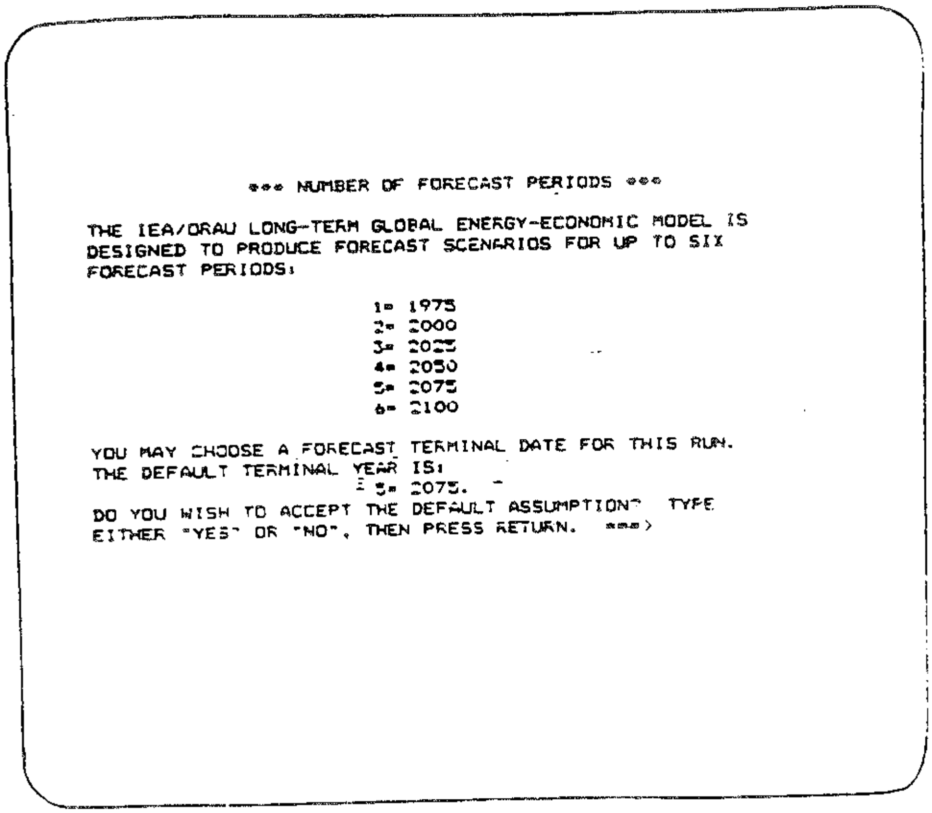


Figure 4.70. Forecast Periods Assumption Screen

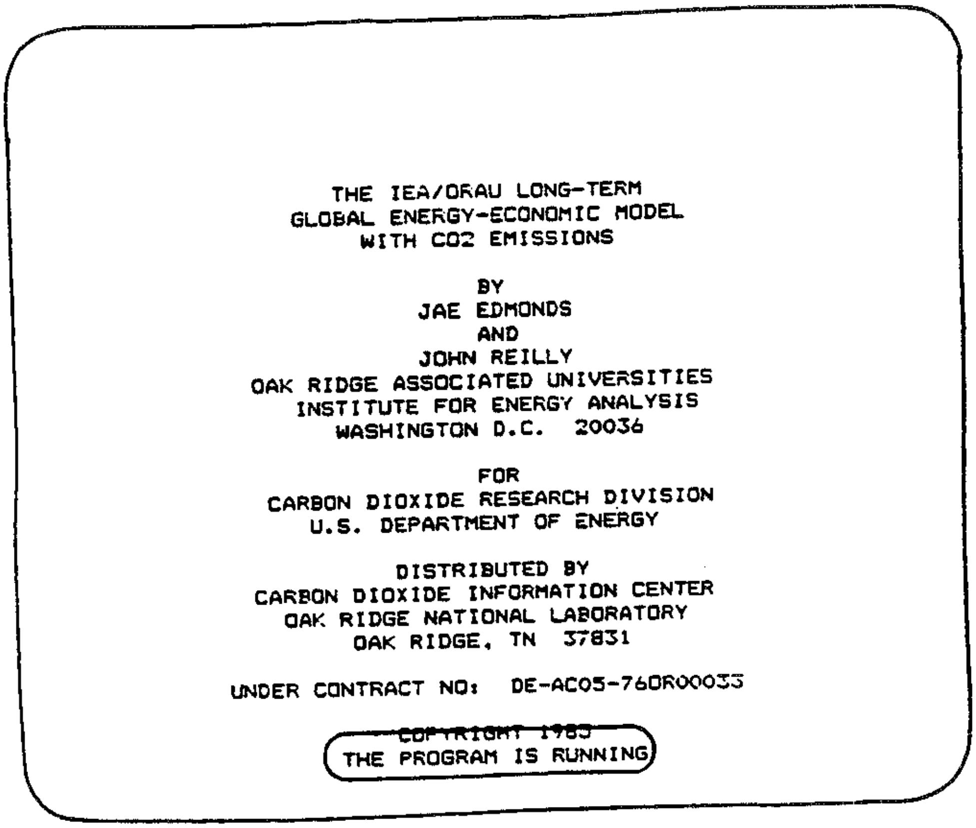


Figure 4.71. Running the Model

CHAPTER V
EXAMINING OUTPUT

This chapter discusses the basics of examining output from a model run. It is assumed that procedures such as those discussed in the preceding chapter have been followed and that a model run has been successfully completed.

> NOTE: You may examine output immediately after a run run has been made, or even days later after the PC has been turned off. At the conclusion of a model run output is stored as a data file, RESULTS.DAT.

The portion of the model that this chapter deals with is shown in Figure 5.1.

The model can produce two different forms of general output: on-screen output and hard copy printed output. The two commands corresponding to these forms are VIEWRUN and PRINTRUN. Use VIEWRUN to view output in tabular or graphical form on the monitor. Use PRINTRUN to obtain printed tabular output. Both of these output commands are discussed below.

VIEWRUN: ON-SCREEN OUTPUT

> Overview
>
> To examine the on-screen output of the model:
>
> Type: VIEWRUN
>
> Press: Return key
>
> - Select the output category you wish to examine and press return key
> - Select the form in which you wish to have the output displayed (tabular or graphical) and press return key
> - Return to main output menu and select another category or quit session

The model generates forecast data in 10 different categories for interactive analysis. These are listed in Table 5.1. The model user can view output on his monitor in these categories either in the form of tables or as graphs.

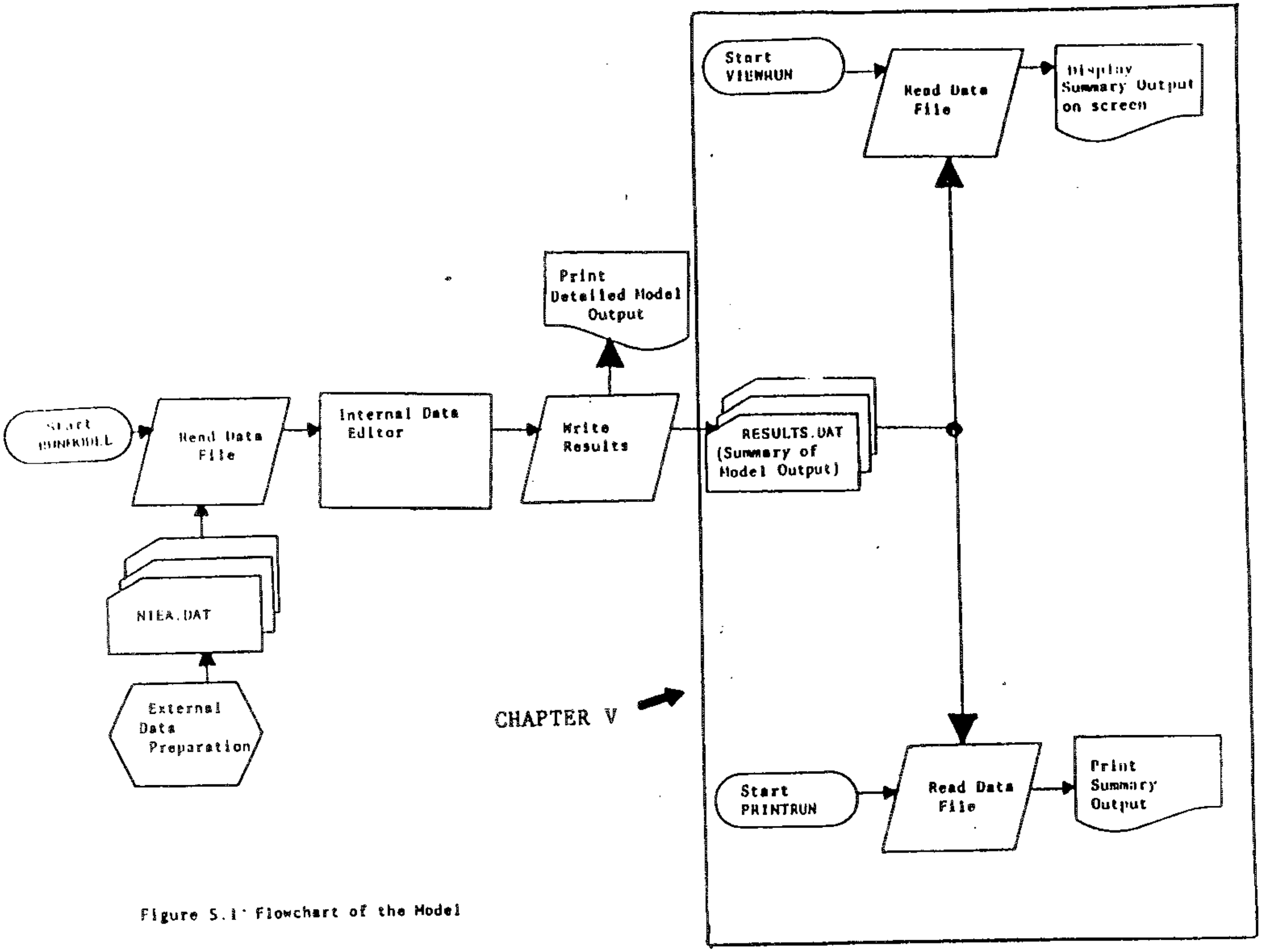


Figure 5.1 Flowchart of the Model

CHAPTER V

Figure 5.1. Flowchart of the Model

TABLE 5.1 CATEGORIES FOR INTERACTIVE ANALYSIS

1. CO_2 Emissions
2. Primary Energy Supply
3. Secondary Energy Supply
4. Oil Supply
5. Gas Supply
6. Solid Fuels Supply
7. Electric Utility Energy Consumption
8. World Energy Prices
9. Final GNP
10. Global Population

EXAMPLE

We will run an example of examining output. In this example we wish to examine the model's output on CO_2 emissions in tabular form. To do this we need to:

Type: VIEWRUN (Figure 5.2a)
Press: Return key
Result: Main output menu (Figure 5.2b) appears on the screen

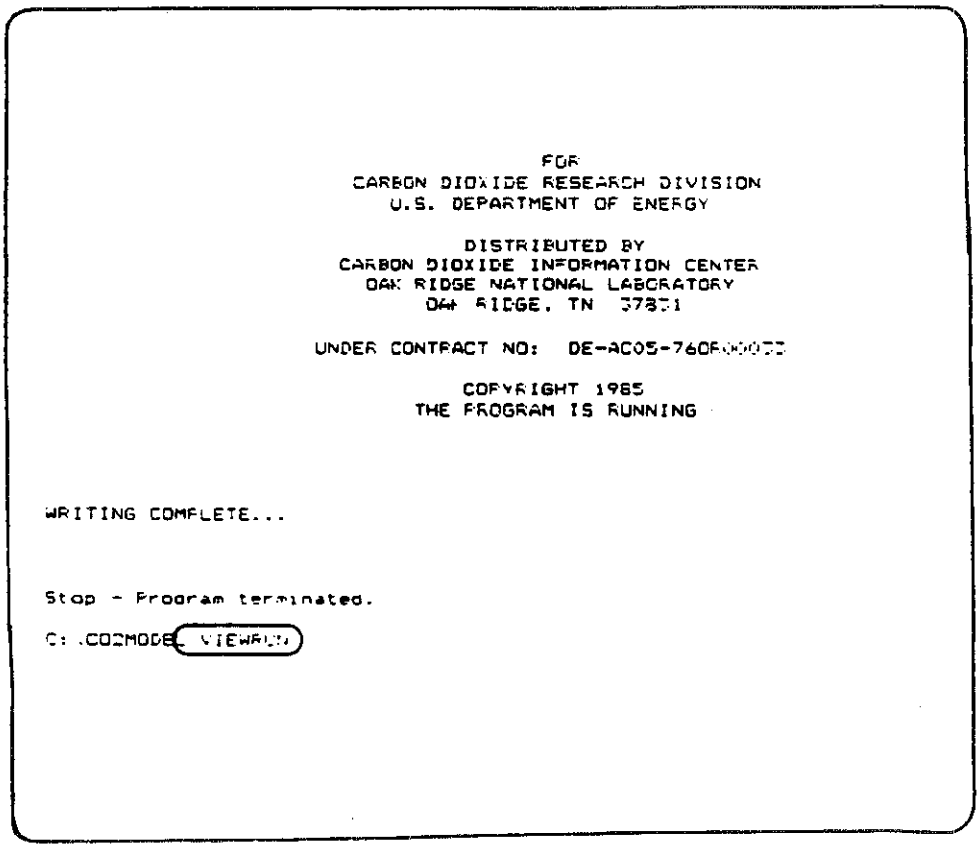


Figure 5.2a. Entering Output Command

```
                    OUTPUT   MENU

CO2 EMISSIONS----------------------------> 1
PRIMARY ENERGY SUPPLY--------------------> 2
SECONDARY ENERGY DEMAND------------------> 3
OIL SUPPLY-------------------------------> 4
GAS SUPPLY-------------------------------> 5
SOLIDS SUPPLY----------------------------> 6
SOLIDS USE-------------------------------> 7
UTILITY ENERGY CONSUMPTION---------------> 8
WORLD ENERGY PRICES----------------------> 9
FINAL GNP--------------------------------> 10
GLOBAL POPULATION------------------------> 11

QUIT-------------------------------------> 0

CHOOSE ANY OUTPUT NUMBER (0-11).
```

Figure 5.2b. Main Output Menu

To view the CO_2 emissions output in tabular form:

Type: 1 (for CO_2 emissions)
Press: Return key
Result: Program prompts you to select output format (Figure 5.3a).

> <u>NOTE</u>: <u>Output Format</u>. The model can display output on the screen in two different formats: tabular form and graphic form. You are given the option to select one of these formats or to return to the main output menu. Enter the letter corresponding to the desired option and press the return key. The graphic format will not be displayed unless you have an IBM color monitor.

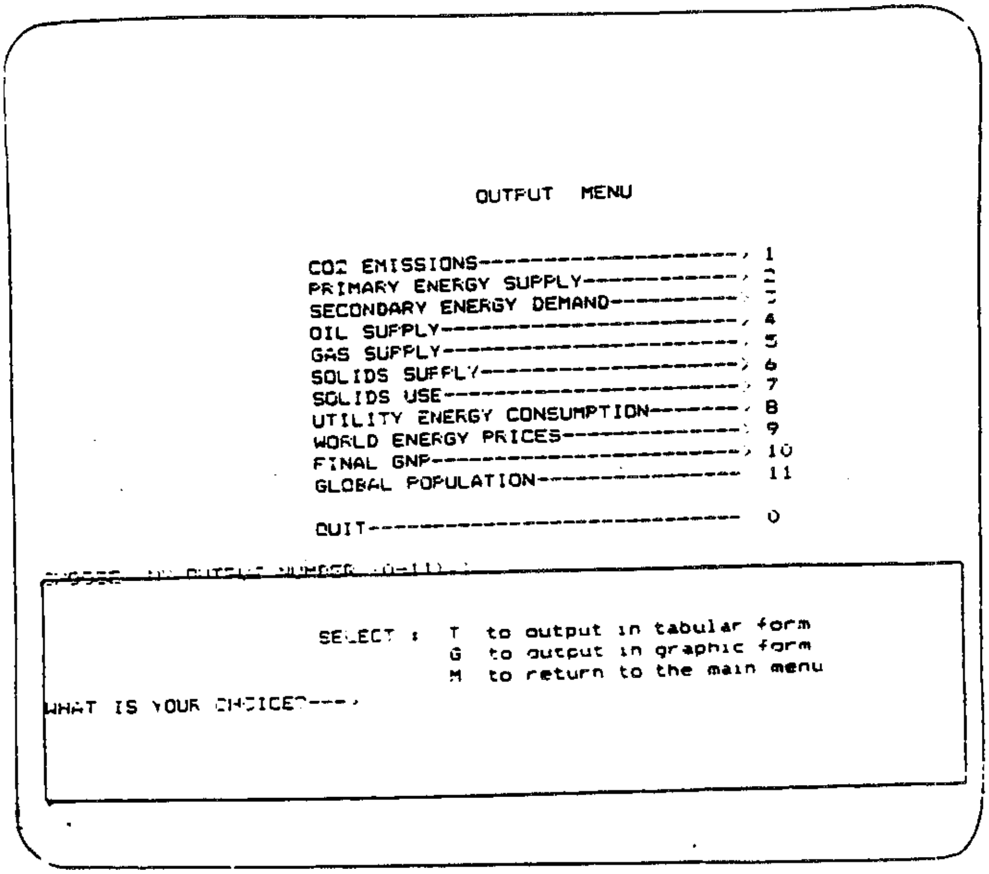


Figure 5.3a. Output Format Selection

Since we wish to examine output in tabular form

Type: T
Press: Return key
Result: CO_2 emissions output appears in tabular form (Figure 5.3b).

CARBON DIOXIDE EMISSIONS
10**6 TONNES OF CARBON PER YEAR

PERIOD	CONV. OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
1975	2125.0	.0	.0	1792.1	.0	590.1	4507.2
2000	2693.7	.0	19.1	3145.3	.1	661.8	6520.0
2025	3167.4	8.6	327.9	4132.4	5.1	1412.7	9054.0
2050	3196.1	28.4	1294.5	5864.2	91.9	1977.8	12453.0
2075	2750.0	54.0	2781.0	7897.4	893.1	1431.7	15807.1

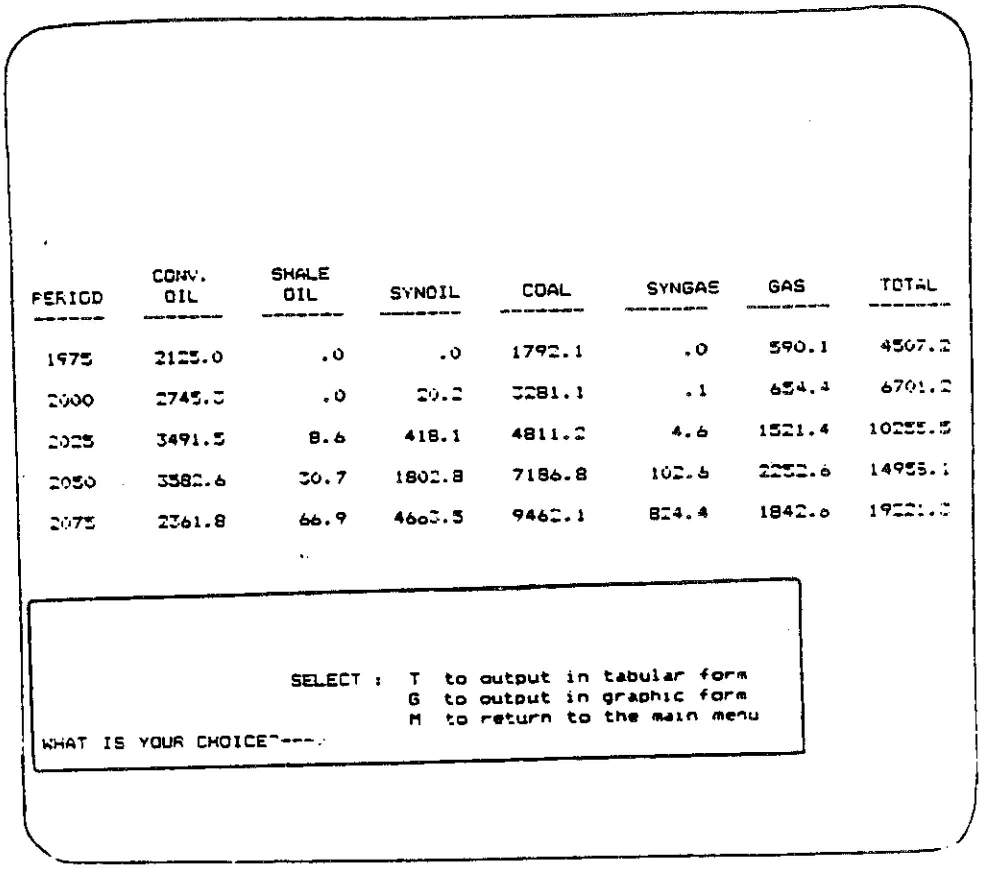
Figure 5.3b. CO_2 Emissions Output

We next examine the output and quit

Output is displayed in tabular form for the periods between 1975 and the forecast terminal year.

After examining the desired output

Press: Return key
Result: Program prompts you to select output format (Figure 5.4)



PERIOD	CONV. OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
1975	2125.0	.0	.0	1792.1	.0	590.1	4507.2
2000	2745.3	.0	20.2	3281.1	.1	654.4	6701.2
2025	3491.5	8.6	418.1	4811.2	4.6	1521.4	10255.5
2050	3582.6	30.7	1802.8	7186.8	102.6	2252.6	14955.1
2075	2361.8	66.9	4663.5	9462.1	824.4	1842.6	19221.2

SELECT : T to output in tabular form
G to output in graphic form
M to return to the main menu

WHAT IS YOUR CHOICE?---.

Figure 5.4. Output Format Selection

Since we have examined the desired output

Type: M (to return to main menu)
Press: Return key
Result: Program returns to main menu (Figure 5.5)

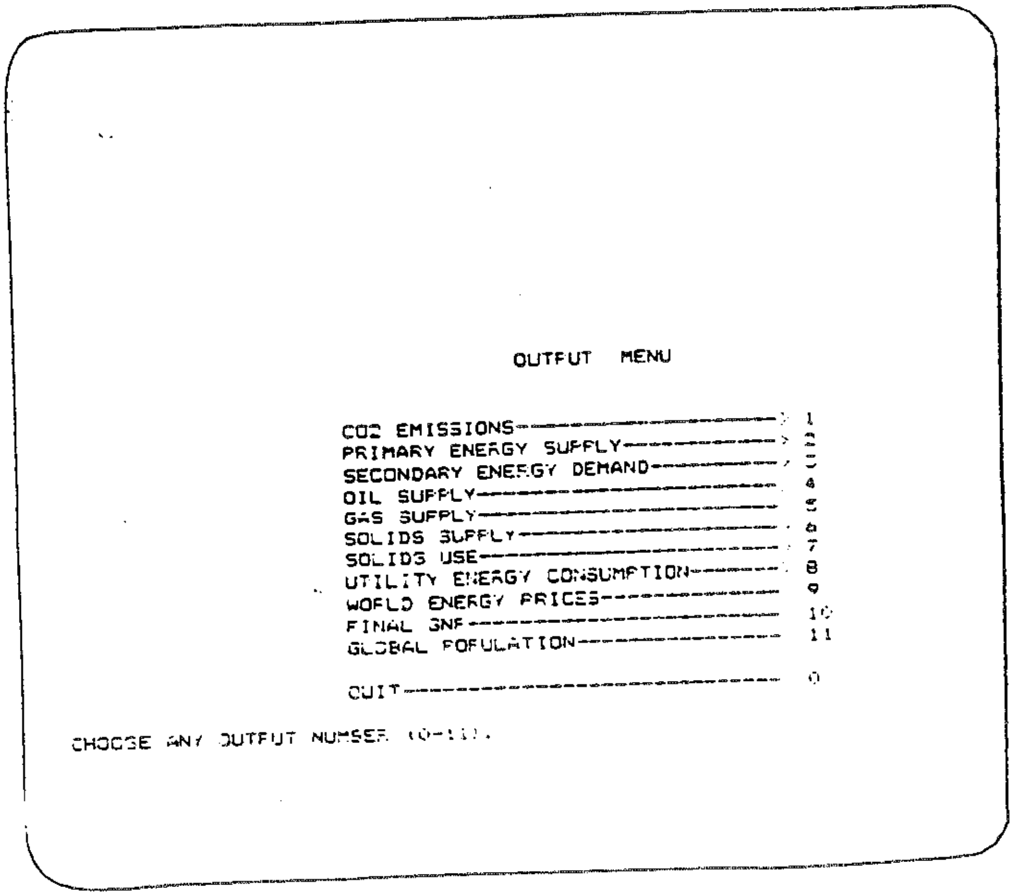


Figure 5.5. Main Output Menu

Since we have examined the desired output

Type: Ø
Press: Return key
Result: "STOP-PROGRAM TERMINATED" appears on the screen (Figure 5.6).

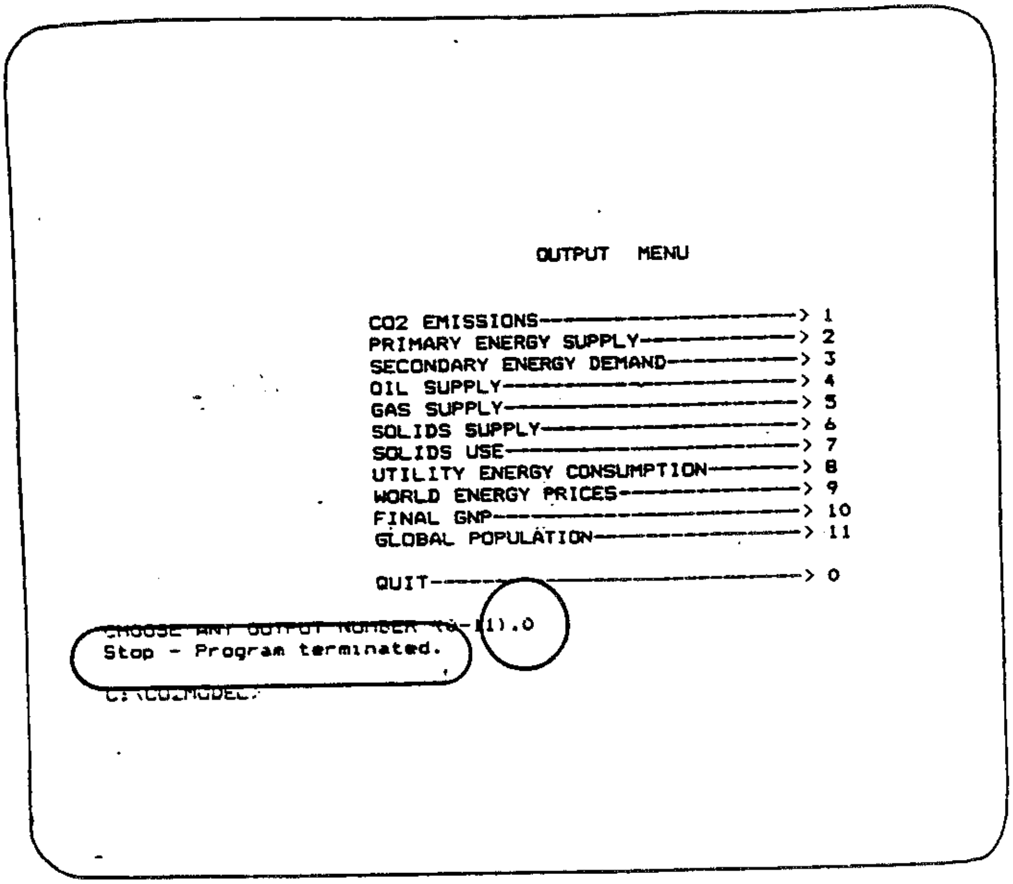


Figure 5.6. Examination Terminated

We have completed examination of the CO_2 emissions output.

DETAILED DISCUSSION OF ON-SCREEN OUTPUT EXAMINATION

Having worked through an example of on-screen output examination, we examine the program in more detail. This output examination program has four steps. These steps are summarized in Table 5.2.

TABLE 5.2. STEPS IN ON-SCREEN OUTPUT EXAMINATION

Step	Description/Action
1: Initiate Session	Type: VIEWRUN Press: Return key Result: Proceed to Step 2
2: Main Menu Options	Type: Ø -> Session ends Any number from 1-11 -> Proceed to step 3
3: Viewing Mode	Type: T, G, or M Press: Return key Result: T -> Output displayed in tabular form; proceed to Step 4 G -> Output displayed in graphical form; proceed to Step 4 M -> No output displayed; return to Step 2.
4: End Screen After Output Examination	Press: Return key Result: On-Screen output disappears; return to Step 3.

Initiate Session

To begin

Type: VIEWRUN
Press: Return key
Result: Main menu screen appears

Main Menu

The main output menu is displayed in Figure 5.7.

```
                         OUTPUT  MENU

          CO2 EMISSIONS--------------------> 1
          PRIMARY ENERGY SUPPLY------------> 2
          SECONDARY ENERGY DEMAND----------> 3
          OIL SUPPLY-----------------------> 4
          GAS SUPPLY-----------------------> 5
          SOLIDS SUPPLY--------------------> 6
          SOLIDS USE-----------------------> 7
          UTILITY ENERGY CONSUMPTION-------> 8
          WORLD ENERGY PRICES--------------  9
          FINAL GNP------------------------  10
          GLOBAL POPULATION----------------  11

          QUIT-----------------------------  0

CHOOSE ANY OUTPUT NUMBER (0-11).
```

Figure 5.7. Main Output Menu

Twelve choices are available to the user. These choices are summarized in Table 5.3. To select a category for on-screen output examination

Type: Any number between 1 and 11
Press: Return key
Result: Output viewing mode selection is requested (see Viewing Mode, below)

To terminate output examination

Type: Ø
Press: Return key
Result: Session ends "STOP—PROGRAM TERMINATED" appears on the screen.

TABLE 5.3. SUMMARY OF OUTPUT AVAILABLE FOR EXAMINATION

Output Menu Number	Title	Description
1	Carbon Dioxide Emissions	Global totals are displayed for conventional oil,shale oil, synoil, coal, syngas, gas, and for their total emissions.
2	Primary Energy	Global totals are displayed for oil, gas, solids, nuclear, solar, hydroelectric energy, and for their total supply. Primary energy counts electricity as the rate of consumption of conventional fossil fuel power plants for generation rather than the direct thermal value of electricity.
3	Secondary Energy Demand	Global totals are displayed for liquids, gases, solids, electric energy, and for their total demand.
4	Oil Supply	Global totals are displayed for conventional oil, shale oil, total primary oil supply, synoil, and for the total available supply.
5	Gas Supply	Global totals are displayed for conventional gas, syngas, and for their total supply.
6	Solids Supply	Global totals are displayed for coal, biomass, and for their total supply.
7	Solids Use	Global totals are displayed for synoil, syngas, electric utility consumption, end-use, and total use for all solids (coal plus biomass).
8	Utility Energy Consumption	Global totals are displayed for liquids, solids, gas,as, nuclear, hydroelectric energy, and for total utility consumption. Note that nuclear, solar and hydro are accounted on a fossil fuel equivalent basis.
9	World Energy Prices	Global totals are displayed for oil, gas, and solids.
10	Final GNP	Data is displayed for the USA, Canada and Western Europe, OECD Pacific, USSR and Eastern Europe, China et al., Mideast, Africa, Latin America, and South and East Asia.
11	Global Population	Data is displayed for the USA, Canada and Europe, OECD Pacific, USSR and Eastern Europe, China et al., Mideast, Africa, Latin America, and South and East Asia.
Ø	Quit	

ewing Mode

After selecting the desired output category (1-11) the program prompts you to select the form of the output. The output format options are displayed in Figure 5.8.

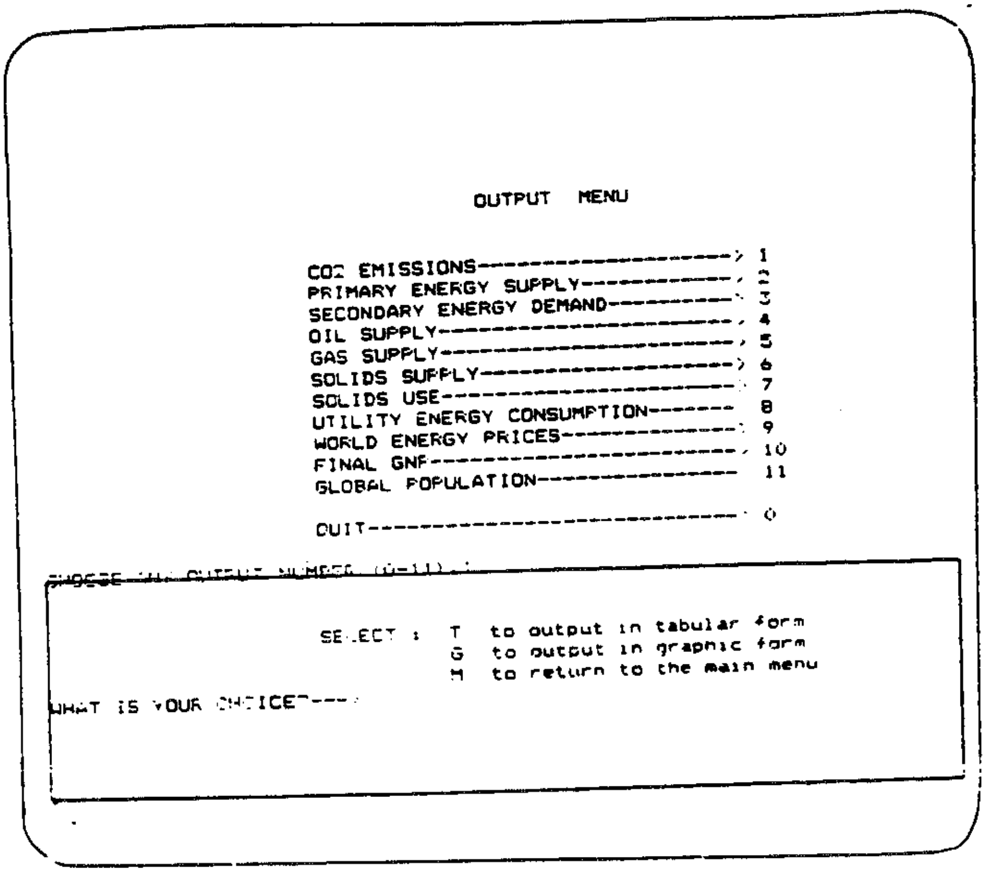


Figure 5.8. Output Format Selection

Three choices are available to the user.

To select a format for output examination

Type: T, G, or M
Press: Return key
Result: T → Output is displayed in tabular form
G → Output is displayed in graphical form
M → No output is displayed; program returns to main menu.

NOTE: The color graphic format can only be used with an IBM color monitor and a color graphics board.

End Screen

After examining output, simply

Press: Return key
Result: Screen disappears; program returns to viewing mode selection. User may change viewing modes at this point or return to main menu.

> NOTE: No prompt is given for the return key.

> NOTE: The Return Key. Pressing the return key returns the user to the previous decision step. If you are at viewing mode selection and press the return key without entering T, G, or M, the program automatically assumes that M was selected and returns to the main menu selection. Pressing the return key again leads the program to assume ∅ was selected and terminates the session.

When you are through with all examinations of output, return to the main assumptions menu and then

Type: ∅
Press: Return key
Result: Session ends
"STOP–PROGRAM TERMINATED" appears on the screen (Figure 5.9).

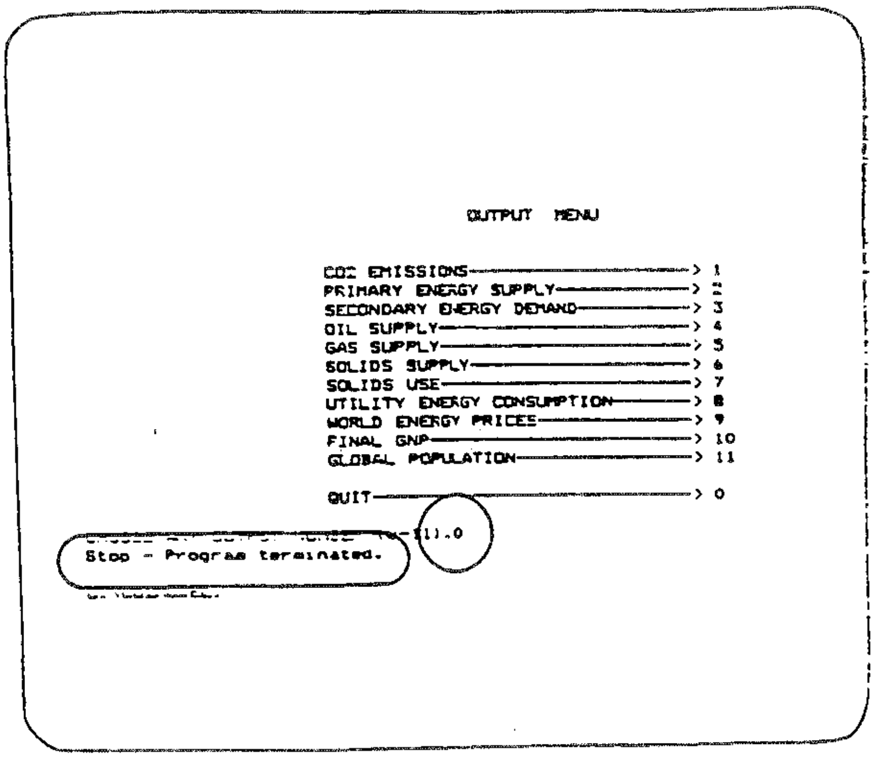


Figure 5.9. Examination Terminated

PRINTRUN: EXAMINING HARD COPY OUTPUT

> **Overview**
>
> To obtain a hard copy of the output:
> - Turn on printer
>   Type: PRINTRUN
>   Press: Return key

EXAMPLE

We will run an example of printing the output.

1. Enter printed output command

   Type: PRINTRUN
   Press: Return key
   Result: Printer prints output in tabular form (See Table 5.4)

> NOTE: Graphic form. The printer cannot print the output in graphic form.

> NOTE: Printer. Make sure that your printer is turned on, and that the power and line lights are on.

TABLE 5.4. PRINTRUN—PRINTED OUTPUT

CARBON DIOXIDE EMISSIONS
10**6 TONNES OF CARBON PER YEAR

PERIOD	CONV. OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
1975	2125.0	.0	.0	1792.1	.0	590.1	4507.2
2000	2693.7	.0	19.1	3145.3	.1	661.8	6520.0
2025	3167.4	8.6	327.9	4132.4	5.1	1412.7	9054.0
2050	3196.1	28.4	1294.5	5864.2	91.9	1977.8	12453.0
2075	2750.0	54.0	2781.0	7897.4	893.1	1431.7	15807.1

TABLE 5.4. PRINTRUN—PRINTED OUTPUT (Continued)

PRIMARY ENERGY SUPPLY
10**18 JOULES PER YEAR

PERIOD	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
1975	118.8	41.4	75.5	4.2	.0	18.5	258.4
2000	149.9	48.7	147.4	17.5	.1	57.2	420.7
2025	175.5	104.6	211.3	45.5	18.5	92.9	648.3
2050	181.2	146.5	344.1	73.5	38.1	120.0	903.3
2075	162.4	106.0	541.7	146.0	55.4	121.0	1132.6

SECONDARY ENERGY DEMAND
10**18 JOULES PER YEAR

PERIOD	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
1975	80.31	29.32	43.25	23.84	176.72
2000	124.05	38.56	74.06	53.51	290.12
2025	155.52	73.59	103.06	93.70	425.87
2050	169.76	100.75	101.71	147.70	520.12
2075	183.13	88.95	111.68	201.62	585.38

OIL SUPPLY
10**18 JOULES PER YEAR

PERIOD	CONV	SHALE	TOTAL PRIMARY	SYNOIL	TOTAL AVAILABLE
1975	118.8	.0	118.8	.0	118.8
2000	149.9	.0	149.9	.6	150.5
2025	175.2	.4	175.6	10.8	186.4
2050	180.3	.9	181.2	42.7	223.9
2075	160.6	1.8	162.4	90.3	252.6

TABLE 5.4. PRINTRUN—PRINTED OUTPUT (Continued)

GAS SUPPLY
10**18 JOULES PER YEAR

PERIOD	CONV	SYNGAS	TOTAL
1975	41.4	.0	41.4
2000	48.7	.0	48.7
2025	104.6	.2	104.8
2050	146.5	2.9	149.4
2075	106.0	27.8	133.8

PRIMARY ENERGY SOLIDS SUPPLY
10**18 JOULES PER YEAR

PERIOD	COAL	BIOMASS	TOTAL
1975	75.5	.0	75.5
2000	133.4	14.0	147.4
2025	188.9	22.4	211.3
2050	308.6	35.5	344.1
2075	494.4	47.3	541.7

SOLIDS USE
10**18 JOULES PER YEAR

PERIOD	SYNOIL	SYNGAS	UTILITY	END-USE	TOTAL
1975	.0	.0	31.3	43.3	74.6
2000	1.0	.0	72.4	74.1	147.4
2025	16.2	.2	92.0	103.1	211.6
2050	64.0	4.4	174.1	101.7	344.1
2075	135.4	41.7	253.0	111.7	541.8

UTILITY ENERGY CONSUMPTION
10**18 JOULES PER YEAR

PERIOD	LIQUIDS	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
1975	20.0	8.9	31.3	4.2	.0	18.5	82.9
2000	26.6	10.2	72.4	17.5	.1	57.2	183.9
2025	30.9	31.2	92.0	45.5	18.5	92.9	310.9
2050	54.1	48.4	174.1	73.5	38.1	120.0	508.2
2075	69.5	44.9	253.0	146.0	55.4	121.0	689.9

TABLE 5.4. PRINTRUN—PRINTED OUTPUT (Continued)

WORLD ENERGY PRICES
1975 U.S.$ PER GIGAJOULE

PERIOD	OIL	GAS	SOLIDS
1975	1.84	.63	.51
2000	2.58	.83	.61
2025	3.69	1.42	.69
2050	4.51	2.26	.80
2075	4.89	3.15	.81

FINAL GNP BY REGION AND YEAR
10**9 1975 U.S.$

REGION	1975	2000	2025	2050	2075
USA	1520.	3390.	6340.	11025.	17574.
CANADA & EUR	1818.	3911.	7273.	12689.	20844.
OECD PACIFIC	586.	1307.	2619.	4622.	7788.
USSR/E. EUR.	966.	2117.	3928.	6564.	10287.
CHINA/ET.AL.	324.	854.	1961.	3876.	6831.
MIDDLE EAST	138.	502.	1620.	3953.	8331.
AFRICA	155.	479.	1437.	3278.	6410.
LATIN AMER	315.	992.	2761.	5788.	10346.
S.&E. ASIA	234.	677.	1847.	3871.	6999.
ALL REGIONS	6056.	14229.	29786.	55666.	95411.

GLOBAL POPULATION
10**6 PERSONS

REGION	1975	2000	2025	2050	2075
USA	214.	254.	282.	288.	292.
CANADA & EUR	405.	476.	528.	553.	562.
OECD PACIFIC	128.	154.	164.	167.	169.
USSR/E. EUR.	395.	472.	516.	[illegible]	541.
CHINA/ET.AL.	911.	1248.	1499.	1612.	1647.
MIDDLE EAST	81.	147.	199.	[illegible]	241.
AFRICA	399.	697.	943.	1101.	1150.
LATIN AMER	313.	540.	718.	827.	845.
S.&E. ASIA	1130.	1904.	2515.	2888.	2995.
ALL REGIONS	3976.	5892.	7364.	8197.	8446.

When all of the model has been printed,

> "WRITING COMPLETE...
> STOP-PROGRAM TERMINATED"

will appear (Figure 5.10)

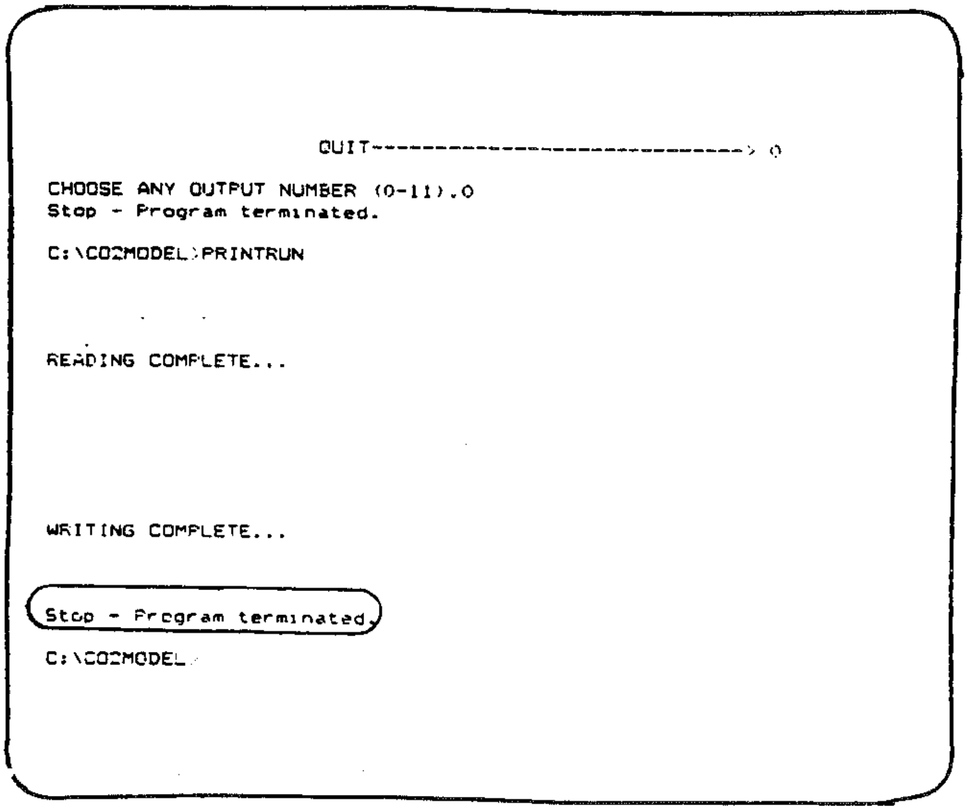


Figure 5.10. Writing Terminated

We have successfully printed a hard copy of the output and may examine the output when the printer is finished.

CHAPTER VI
ADVANCED INPUT MODIFICATION

While the model user has access to 39 input assumption categories via the input data editor incorporated directly in the model, this represents only a fraction of the total number of parameters that comprise the model's data base. The total data set contains 2,126 elements grouped under 50 parameter names. All of these elements are potentially available to the user for examination and/or modification. However, the user is responsible for obtaining and utlizing his own editing program to make desired changes to the full data set.

> NOTE: Database Editor. This advanced modification process requires the user to have his own database editor. This example uses "wordperfect."

Data Sets

The model has two data sets: IEA.DAT and NIEA.DAT

IEA.DAT: A base data set. This data set should never be modified. IEA.DAT serves as a reference data set.

NIEA.DAT: The data set that the model uses as its reference base (See The Model below). NIEA.DAT is a working data set in tablular form used to carry detailed input assumptions to the model.

> NOTE: NIEA.DAT can be restored to the same values as contained in IEA.DAT. You may return the NIEA.DAT operating data set to the same values as the reference set by:
> Type: Copy IEA.DAT NIEA.DAT
> Press: Return key
> Result: The operating data set has the same values as the reference set. (Figure 6.1)

> NOTE: Changing NIEA.DAT. If you change a value in NIEA.DAT, remember that that change will remain for all other runs of the model unless it is changed back again.

```
                         DISTRIBUTED BY
              CARBON DIOXIDE INFORMATION CENTER
                OAK RIDGE NATIONAL LABORATORY
                     OAK RIDGE, TN  37831

            UNDER CONTRACT NO:  DE-AC05-760R00033

                        COPYRIGHT 1985
                    THE PROGRAM IS RUNNING


WRITING COMPLETE...

Stop - Program terminated.

C:\CO2MODEL>ERASE NIEA.DAT

C:\CO2MODEL>COPY IEA.DAT NIEA.DAT
        1 File(s) copied

C:\CO2MODEL>
```

Figure 6.1. Changing NIEA.DAT to Values of Reference Data Set

The Model

The flowchart of the model is shown in Figure 6.2.

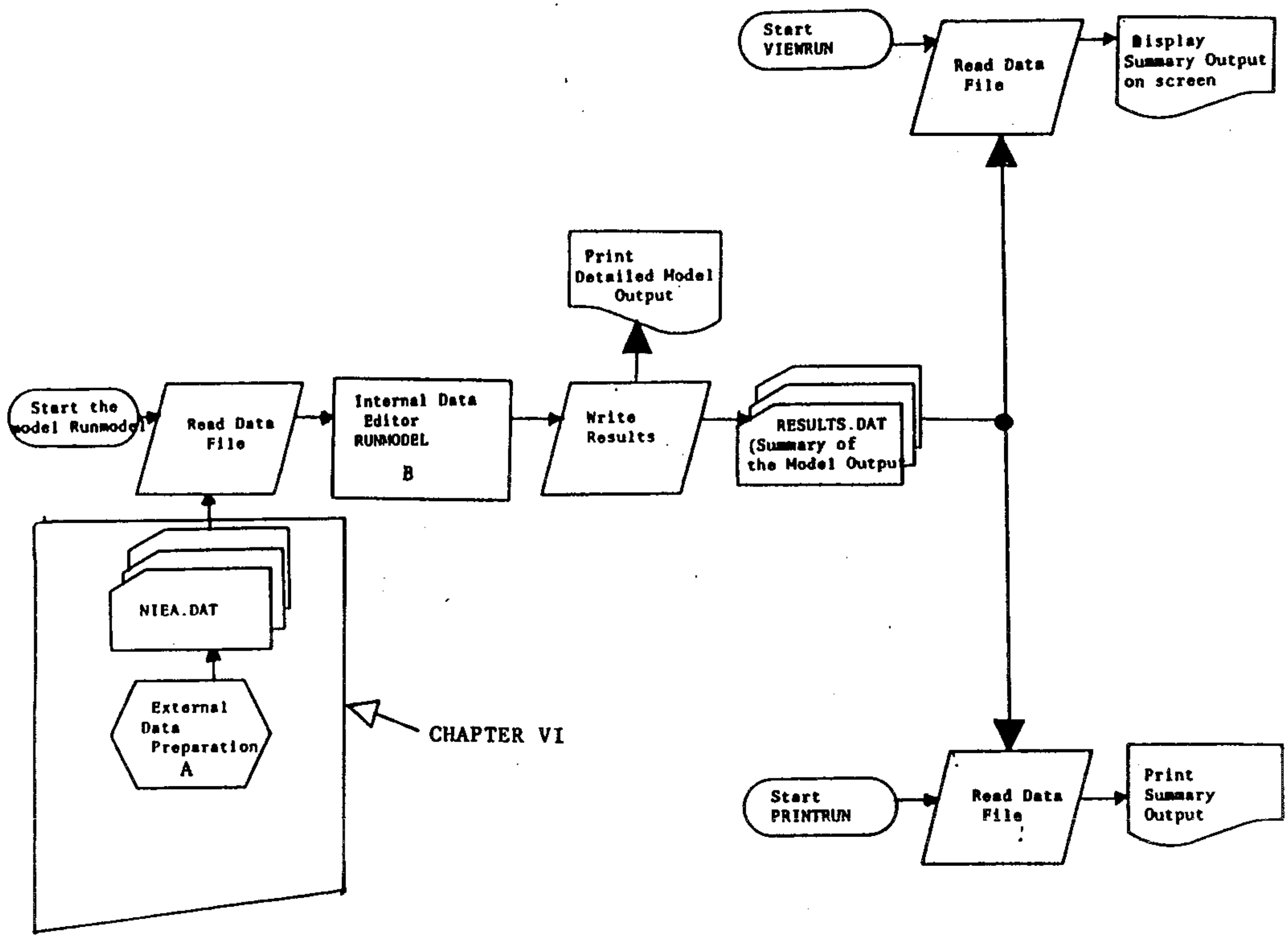


Figure 6.2. Flowchart of the Model

TABLE 6.1. THE IEA.DAT DATA SET

```
***********************************************************************
** MODEL=A84PC **      BASE CASE:  MEDIAN INPUTS ASSUMPTIONS       ****
** DATA=DATAA  **                  1 OCTOBER 1985                  ****
***********************************************************************

   *** DETAILED PRINTED OUTPUT OPTION CODES:  NOPT.NE.1==> PRINT ***

     1 =NOPT(1) =TABLE OF PROGRAM CONTROL PARAMETERS
     1 =NOPT(2) =TABLE OF INPUT VARIABLES (THIS DATA SET)
     1 =NOPT(3) =INTERMEDIATE OUTPUT FROM SUBROUTINES XXXX AND REVISE
     1 =NOPT(4) =INTERMEDIATE OUTPUT FROM SUBROUTINE ELAS
     1 =NOPT(5) =REGIONAL ENERGY BALANCE TABLES FOR PERIOD M
     1 =NOPT(6) =SUMMARY TABLES FOR PERIOD M
     1 =NOPT(7) =PRICE DATA TABLES FOR PERIOD M
     1 =NOPT(8) =CARBON DIOXIDE OUTPUT FOR PERIOD M
     1 =NOPT(9) =SUMMARY TABLES FOR ALL PERIODS

     5 =NUMBER OF FORECAST PERIODS

***********************************************************************
** MODEL=A84PC **      BASE CASE:  MEDIAN INPUTS ASSUMPTIONS       ****
** DATA=DATAA  **                  1 OCTOBER 1985                  ****
***********************************************************************
```

TRI--TRANSPORTATION COSTS FOR TRADED FUELS
PIM--INITIAL ESTIMATE OF PRICES FOR TRADED FUELS BY FUEL AND PERIOD
(UNITS=1975 DOLLARS PER GJ (GIGAJOULE))

OIL	GAS	COAL	
0.1397	2.8458	.3409	TRI
1.8398	0.6256	0.5121	PIM M=1
2.65	0.84	0.62	PIM M=2
3.77	1.37	0.70	PIM M=3
4.74	2.23	0.87	PIM M=4
5.90	3.41	1.06	PIM M=5
6.70	3.43	1.43	PIM M=6

TXILM — TRADE BARRIERS (SCALE FACTOR APPLIED TO FUEL PRICES)

OIL -- TXILM

1975	2000	2025	2050	2075	2100	REGION
0.98	1.00	1.00	1.00	1.00	1.00	USA
1.48	1.48	1.48	1.48	1.48	1.48	CANADA&EUR
1.10	1.10	1.10	1.10	1.10	1.10	JANZ
0.9294	1.00	1.00	1.00	1.00	1.00	EUSSR
1.00	1.00	1.00	1.00	1.00	1.00	ACENP
0.0929	0.40	0.70	1.00	1.00	1.00	MIDEAST
1.9983	1.50	1.00	1.00	1.00	1.00	AFR
0.9945	1.02	1.00	1.00	1.00	1.00	LA
0.85	1.00	1.00	1.00	1.00	1.00	S&E ASIA

GAS -- TXILM

1975	2000	2025	2050	2075	2100	REGION
0.1802	1.00	1.00	1.00	1.00	1.00	USA
1.80	1.80	1.40	1.20	1.20	1.20	CANADA&EUR
1.84	1.55	1.25	1.00	1.00	1.00	JANZ
0.1802	1.00	1.00	1.00	1.00	1.00	EUSSR
0.1802	1.00	1.00	1.00	1.00	1.00	ACENP
0.0901	0.70	0.85	1.00	1.00	1.00	MIDEAST
0.1802	1.00	1.00	1.00	1.00	1.00	AFR
0.1802	1.00	1.00	1.00	1.00	1.00	LA
0.1802	1.00	1.00	1.00	1.00	1.00	S&E ASIA

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

COAL -- TXILM

1975	2000	2025	2050	2075	2100	REGION
0.6004	1.00	1.00	1.00	1.00	1.00	USA
2.07	2.07	1.75	1.50	1.50	1.50	CANADA&EUR
1.00	1.00	1.00	1.00	1.00	1.00	JANZ
0.6124	1.00	1.00	1.00	1.00	1.00	EUSSR
0.6004	1.00	1.00	1.00	1.00	1.00	ACENF
1.00	1.00	1.00	1.00	1.00	1.00	MIDEAST
1.00	1.00	1.00	1.00	1.00	1.00	AFR
1.08	1.04	1.00	1.00	1.00	1.00	LA
1.08	1.04	1.00	1.00	1.00	1.00	S&E ASIA

TXJLM -- ENERGY TAXES ON FINAL CONSUMPTION BY FUEL, REGION AND PERIOD

OIL -- TXJLM

1975	2000	2025	2050	2075	2100	REGION
1.00	1.000	1.00	1.00	1.00	1.00	USA
1.00	1.00	1.00	1.00	1.00	1.00	CANADA&EUR
1.00	1.00	1.00	1.00	1.00	1.00	JANZ
1.00	1.00	1.00	1.00	1.00	1.00	EUSSR
1.00	1.00	1.00	1.00	1.00	1.00	ACENF
1.00	1.00	1.00	1.00	1.00	1.00	MIDEAST
1.00	1.00	1.00	1.00	1.00	1.00	AFR
1.00	1.00	1.00	1.00	1.00	1.00	LA
1.00	1.00	1.00	1.00	1.00	1.00	S&E ASIA

GAS -- TXJLM

1975	2000	2025	2050	2075	2100	REGION
1.00	1.000	1.00	1.00	1.00	1.00	USA
1.00	1.00	1.00	1.00	1.00	1.00	CANADA&EUR
1.00	1.00	1.00	1.00	1.00	1.00	JANZ
1.00	1.00	1.00	1.00	1.00	1.00	EUSSR
1.00	1.00	1.00	1.00	1.00	1.00	ACENF
1.00	1.00	1.00	1.00	1.00	1.00	MIDEAST
1.00	1.00	1.00	1.00	1.00	1.00	AFR
1.00	1.00	1.00	1.00	1.00	1.00	LA
1.00	1.00	1.00	1.00	1.00	1.00	S&E ASIA

COAL -- TXJLM

1975	2000	2025	2050	2075	2100	REGION
1.00	1.00	1.00	1.00	1.00	1.00	USA
1.00	1.00	1.00	1.00	1.00	1.00	CANADA&E
1.00	1.00	1.00	1.00	1.00	1.00	JANZ
1.00	1.00	1.00	1.00	1.00	1.00	EUSSR
1.00	1.00	1.00	1.00	1.00	1.00	ACENF
1.00	1.00	1.00	1.00	1.00	1.00	MIDEAST
1.00	1.00	1.00	1.00	1.00	1.00	AFR
1.00	1.00	1.00	1.00	1.00	1.00	LA
1.00	1.00	1.00	1.00	1.00	1.00	S&E ASIA

ELECTRICITY -- TXJLM

1975	2000	2025	2050	2075	2100	REGION
1.00	1.00	1.00	1.00	1.00	1.00	USA
1.00	1.00	1.00	1.00	1.00	1.00	CANADA&EUR
1.00	1.00	1.00	1.00	1.00	1.00	JANZ
1.00	1.00	1.00	1.00	1.00	1.00	EUSSR
1.00	1.00	1.00	1.00	1.00	1.00	ACENF
1.00	1.00	1.00	1.00	1.00	1.00	MIDEAST
1.00	1.00	1.00	1.00	1.00	1.00	AFR
1.00	1.00	1.00	1.00	1.00	1.00	LA
1.00	1.00	1.00	1.00	1.00	1.00	S&E ASIA

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

POPULATION (ZLM)
UNITS=THOUSANDS OF PERSONS

1950	1975	2000	2025	2050	2075	2100	
152271.	214000.	254000.	282000.	288000.	292000.	292000.	USA
300245.	405000.	476000.	529000.	553000.	562000.	562000.	CAN&WEU
96307.	128000.	154000.	164000.	167000.	169000.	169000.	JANZ
286136.	395000.	472000.	516000.	533000.	541000.	541000.	EUSSR
590509.	911000.	1248000.	1499000.	1612000.	1647000.	1647000.	ACENF
39048.	81000.	147000.	199000.	232000.	241000.	241000.	MIDEAST
222039.	399000.	697000.	943000.	1101000.	1150000.	1150000.	AFR
165764.	313000.	540000.	718000.	823000.	849000.	849000.	LA
652760.	1130000.	1904000.	2515000.	2888000.	2995000.	2995000.	SEASIA

LABOR PRODUCTIVITY GROWTH RATE (UNITS=ANNUAL RATE)
AND BASE GNP (UNITS=MILLIONS 1975 US DOLLARS)

LABOR PRODUCTIVITY	BASE GNP	
0.017	1519890.	USA
0.017	1817860.	WEUR&CAN
0.017	586400.	JANZ
0.017	966400.	EUSSR
0.029	323600.	ASENP
0.029	138410.	MIDEAST
0.029	154690.	AFR
0.029	315490.	LA
0.029	233620.	SEASIA

REFINERY COEFFICIENTS (GIJ AND HIJ)
"GIJ" IS A CONVERSION EFFICIENCY, THE RATIO OF JOULES OF PRIMARY ENERGY IN TO JOULES OF ENERGY PRODUCT OUT (EXCLUSIVE OF FUELS USED AS ENERGY BY THE REFINERY). IT IS APPROXIMATED AS 1.
"HIJ" IS A MARK-UP COST, ACCOUNTING FOR COST OF REFINING AND DISTRIBUTING ENERGY PRODUCTS.

OIL		GAS		COAL	
GIJ	HIJ	GIJ	HIJ	GIJ	HIJ
1.00	1.425	1.00	.3487	1.00	.2600

ELECTRICITY GENERATION COEFFICIENTS (GUI, HUIL, AND RUI)
"GUI" IS A GENERATION EFFICIENCY COEFFICIENT -- THE RATIO OF JOULES OF ENERGY IN TO JOULES OF ELECTRICITY OUT. BY DEFINITION, GUI=1 FOR NUCLEAR, HYDRO, AND SOLAR.
"HUIL" REFLECTS NONENERGY COSTS IN 1975 DOLLARS PER GJ.
"RUI" IS A LOGIT SUBSTITUTION PARAMETER GOVERNING THE RESPONSE OF UTILITIES TO PRICE INCREASES FOR A GIVEN TECHNOLOGY -- HYDRO ENTERS AS A FIXED AMOUNT.

FUEL						PARAMETER
OIL	GAS	COAL	NUCLEAR	SOLAR	HYDRO	
3.658	3.658	3.325	1.097	1.097	1.097	GUI
4.5330	4.5052	6.8660	1.7000	1.7000	1.7000	HUIL L=1
4.5330	4.5052	6.8660	1.7000	1.7000	1.7000	HUIL L=2
4.5330	4.5052	6.8660	1.7000	1.7000	1.7000	HUIL L=3
4.5330	4.5052	5.8630	1.7000	1.7000	1.7000	HUIL L=4
4.5330	4.5052	5.8630	1.7000	1.7000	1.7000	HUIL L=5
4.5330	4.5052	5.8630	1.7000	1.7000	1.7000	HUIL L=6
4.5330	4.5052	5.8630	1.7000	1.7000	1.7000	HUIL L=7
4.5330	4.5052	5.8630	1.7000	1.7000	1.7000	HUIL L=8
4.5330	4.5052	5.8630	1.7000	1.7000	1.7000	HUIL L=9
-3.00	-3.00	-3.00	-3.00	-3.00		RUI

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

PAUIL -- ELECTRICITY GENERATION COEFFICIENTS
(FAUIL IS A MULTIPLICATIVE FACTOR WHICH ADJUSTS THE REFINED FOSSILE FUEL PRICE TO ACCOUNT FOR DIFFERENT FUEL TYPE (E.G. RESIDUAL US GASOLINE) AND DISTRIBUTION COSTS.)

	FUEL		
LIQUID	GAS	SOLID	REGION
0.4850	0.7330	1.00	US
0.5747	0.6195	0.8293	WEUR+CAN
0.5243	0.9595	1.00	OECD PAC
0.4000	1.00	1.00	EUSSR
0.4000	1.00	1.00	ACENP
1.0595	1.00	1.00	MIDEAST
0.4185	1.00	1.00	AFRICA
0.4013	1.00	1.00	L AMER
0.6059	1.00	1.00	S&E ASIA

BSUILM: ELECTRIC UTILITY FUEL SHARE WEIGHTS, BY PERIOD, FUEL AND REGION

		1975			
OIL	GAS	COAL	NUCLEAR	SOLAR	REGION
0.0915	0.0274	0.2000	0.0346	0.0253	US
0.1680	0.0694	0.2000	0.0192	0.0172	WEUR+CAN
0.1937	0.2000	0.0458	0.0082	0.0056	OECD PAC
0.1157	0.0565	0.2000	0.0060	0.0060	EUSSR
0.0547	0.0074	0.2000	0.0000	0.0011	ACENP
0.2000	0.0408	0.0000	0.0001	0.0000	MIDEAST
0.1851	0.0128	0.2000	0.0000	0.0009	AFRICA
0.2000	0.0453	0.0319	0.0080	0.0061	L AMER
0.1158	0.0007	0.2000	0.0039	0.0036	S&E ASIA

BSUILM: YEAR 2000

OIL	GAS	COAL	NUCLEAR	SOLAR	REGION
0.0181	0.0288	0.2000	0.0702	0.0651	US
0.1403	0.0542	0.2000	0.0718	0.0458	WEUR+CAN
0.2000	0.0667	0.1178	0.0433	0.0347	OECD PAC
0.2000	0.1259	0.2000	0.0373	0.0370	EUSSR
0.1346	0.0082	0.2000	0.0161	0.0062	ACENP
0.2000	0.1102	0.0200	0.0045	0.0045	MIDEAST
0.2000	0.0276	0.2000	0.0148	0.0134	AFRICA
0.2000	0.1174	0.0951	0.0428	0.0376	L AMER
0.1600	0.0118	0.2000	0.0291	0.0280	S&E ASIA

BSUILM: YEAR 2025

OIL	GAS	COAL	NUCLEAR	SOLAR	REGION
0.0850	0.1274	0.2000	0.1754	0.2000	US
0.2000	0.2000	0.2000	0.2000	0.2000	WEUR+CAN
0.2000	0.2000	0.2000	0.2000	0.2000	OECD PAC
0.2000	0.2000	0.2000	0.2000	0.2000	EUSSR
0.2000	0.1000	0.2000	0.2000	0.0357	ACENP
0.2000	0.2000	0.1000	0.2000	0.2000	MIDEAST
0.2000	0.2000	0.2000	0.2000	0.2000	AFRICA
0.2000	0.2000	0.2000	0.2000	0.2000	L AMER
0.2000	0.2000	0.2000	0.2000	0.2000	S&E ASIA

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

BSUILM: YEAR 2050

OIL	GAS	COAL	NUCLEAR	SOLAR	REGION
0.1275	0.2000	0.2000	0.2000	0.2000	US
0.2000	0.2000	0.2000	0.2000	0.2000	WEUR+CAN
0.2000	0.2000	0.2000	0.2000	0.2000	OECD PAC
0.2000	0.2000	0.2000	0.2000	0.2000	EUSSR
0.2000	0.2000	0.2000	0.2000	0.2000	ACENP
0.2000	0.2000	0.1000	0.2000	0.2000	MIDEAST
0.2000	0.2000	0.2000	0.2000	0.2000	AFR
0.2000	0.2000	0.2000	0.2000	0.2000	L AMER
0.2000	0.2000	0.2000	0.2000	0.2000	S&E ASIA

BSUILM: YEAR 2075

OIL	GAS	COAL	NUCLEAR	SOLAR	REGION
0.1275	0.2000	0.2000	0.2000	0.2000	US
0.2000	0.2000	0.2000	0.2000	0.2000	WEUR+CAN
0.2000	0.2000	0.2000	0.2000	0.2000	OECD PAC
0.2000	0.2000	0.2000	0.2000	0.2000	EUSSR
0.2000	0.2000	0.2000	0.2000	0.2000	ACENP
0.2000	0.2000	0.1000	0.2000	0.2000	MIDEAST
0.2000	0.2000	0.2000	0.2000	0.2000	AFR
0.2000	0.2000	0.2000	0.2000	0.2000	L AMER
0.2000	0.2000	0.2000	0.2000	0.2000	S&E ASIA

BSUILM: YEAR 2100

OIL	GAS	COAL	NUCLEAR	SOLAR	REGION
0.1275	0.2000	0.2000	0.2000	0.2000	US
0.2000	0.2000	0.2000	0.2000	0.2000	WEUR+CAN
0.2000	0.2000	0.2000	0.2000	0.2000	OECD PAC
0.2000	0.2000	0.2000	0.2000	0.2000	EUSSR
0.2000	0.2000	0.2000	0.2000	0.2000	ACENP
0.2000	0.2000	0.1000	0.2000	0.2000	MIDEAST
0.2000	0.2000	0.2000	0.2000	0.2000	AFR
0.2000	0.2000	0.2000	0.2000	0.2000	L AMER
0.2000	0.2000	0.2000	0.2000	0.2000	S&E ASIA

TKL--RATE OF END-USE ENERGY EFFICIENCY IMPROVEMENT BY SECTOR
AND REGION
UNITS=NONE

OECD REGIONS

RES/COM	INDUSTRY	TRANSPORT	REGION
0.01	0.01	0.01	1=USA
0.01	0.01	0.01	2=WEUR+CAN
0.01	0.01	0.01	3=OECD PAC

NON-OECD REGIONS

ALL SECTORS	REGION
0.01	4=EUSSR
0.01	5=ACENP
0.01	6=MIDEAST
0.01	7=AFRICA
0.01	8=L AMER
0.01	9=S&E ASIA

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

[illegible]
(UNITS=EXAJOULES)

GRADE: IG=1

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
77.	670.	7964.	4691.	109.	1=USA
100.	434.	2459.	2142.	200.	2=WEUR+CAN
3.	70.	1891.	1564.	97.	3=OECD PAC
190.	1324.	13536.	4274.	267.	4=EUSSR
62.	178.	4054.	2147.	128.	5=ACENP
400.	1054.	2.	537.	2.	6=MIDEAST
180.	346.	607.	6411.	442.	7=AFRICA
159.	366.	121.	3205.	1010.	8=L AMER
29.	160.	365.	1610.	21.	9=S&E ASIA

GRADE: IG=2

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
221.	227.	9763.	9170.	584.	1=USA
290.	179.	3015.	4188.	1068.	2=WEUR+CAN
9.	29.	2318.	3057.	518.	3=OECD PAC
550.	547.	16592.	8397.	1426.	4=EUSSR
151.	73.	4970.	4197.	682.	5=ACENP
1000.	435.	2.	1049.	12.	6=MIDEAST
436.	142.	745.	12532.	2356.	7=AFRICA
384.	151.	148.	6266.	5388.	8=L AMER
70.	66.	447.	3148.	113.	9=S&E ASIA

GRADE: IG=3

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
441.	510.	13874.	88173.	100000.	1=USA
577.	330.	4284.	40266.	100000.	2=WEUR+CAN
17.	53.	3294.	29391.	100000.	3=OECD PAC
1095.	1007.	23578.	80708.	100000.	4=EUSSR
267.	135.	7062.	40354.	100000.	5=ACENP
880.	802.	3.	10088.	100000.	6=MIDEAST
771.	263.	1058.	120503.	100000.	7=AFRICA
679.	279.	211.	60252.	100000.	8=L AMER
123.	121.	635.	30266.	100000.	9=S&E ASIA

GRADE: IG=4

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
373.	582.	19012.	264516.	100000.	1=USA
488.	377.	5871.	120797.	100000.	2=WEUR+CAN
14.	61.	4515.	88173.	100000.	3=OECD PAC
925.	1150.	32311.	242123.	100000.	4=EUSSR
204.	155.	9678.	121062.	100000.	5=ACENP
3650.	916.	4.	30266.	100000.	6=MIDEAST
591.	301.	1450.	361510.	100000.	7=AFRICA
520.	318.	289.	180755.	100000.	8=L AMER
94.	139.	871.	90797.	100000.	9=S&E ASIA

GRADE: IG=5

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
292.	0.	19012.	0.	0.	1=USA
382.	0.	5871.	0.	0.	2=WEUR+CAN
11.	0.	4515.	0.	0.	3=OECD PAC
723.	0.	32311.	0.	0.	4=EUSSR
154.	0.	9678.	0.	0.	5=ACENP
1460.	0.	4.	0.	0.	6=MIDEAST
1444.	0.	1450.	0/	0.	7=AFRICA
391.	0.	287.	0.	0.	8=L AMER
371.	0.	871.	0.	0.	9=S&E ASIA

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

CIGIS--MINIMUM EXTRACTION COSTS BY GRADE AND FUEL
FINAL COST IS THE MAXIMUM EXTRACTION COST AT
RESOURCE EXHAUSTION
(UNITS=1975 DOLLARS/GIGAJOULE)

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	GRADE
0.16	0.50	0.30	3.80	6.83	IG=1
0.82	1.50	0.40	7.60	15.20	IG=2
3.80	2.50	0.80	12.80	21.80	IG=3
5.10	3.60	1.60	25.60	22.00	IG=4
7.10	15.00	2.70	51.00	23.00	IG=5
12.30	16.00	5.30	52.00	24.00	FINAL

VISL--ENVIRONMENTAL COST AMOUNTS BY REGION AND FUEL
(UNITS=1975 DOLLARS/GIGAJOULE)

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
0.0	0.0	1.60	1.30	10.00	1=USA
0.0	0.0	1.60	1.30	10.00	2=WEUR+CAN
0.0	0.0	1.60	1.30	10.00	3=OECD PAC
0.0	0.0	0.80	0.90	10.00	4=EUSSR
0.0	0.0	0.80	0.90	10.00	5=ACENP
0.0	0.0	0.80	0.90	10.00	6=MIDEAST
0.0	0.0	0.80	0.90	10.00	7=AFRICA
0.0	0.0	0.80	0.90	10.00	8=L AMER
0.0	0.0	0.80	0.90	10.00	9=S&E ASIA

RIL--PRICE ELASTICITY OF SUPPLY, EVALUATED PREVIOUS PRICE
(BY SUPPLY TYPE AND REGION)

CONV OIL	CONV GAS	COAL	UNCON OIL	REGION
1.0	1.0	1.0	1.0	1=USA
1.0	1.0	1.0	1.0	2=WEUR+CAN
1.0	1.0	1.0	1.0	3=OECD PAC
1.0	1.0	1.0	1.0	4=EUSSR
1.0	1.0	1.0	1.0	5=ACENP
1.0	1.0	1.0	1.0	6=MIDEAST
1.0	1.0	1.0	1.0	7=AFRICA
1.0	1.0	1.0	1.0	8=L AMER
1.0	1.0	1.0	1.0	9=S&E ASIA

STISL--RATE OF TECHNOLOGICAL CHANGE BY SUPPLY TYPE
AND REGION

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
0.005	0.005	0.005	0.005	0.005	1=USA
0.005	0.005	0.005	0.005	0.005	2=WEUR+CAN
0.005	0.005	0.005	0.005	0.005	3=OECD PAC
0.005	0.005	0.005	0.005	0.005	4=EUSSR
0.005	0.005	0.005	0.005	0.005	5=ACENP
0.005	0.005	0.005	0.005	0.005	6=MIDEAST
0.005	0.005	0.005	0.005	0.005	7=AFRICA
0.005	0.005	0.005	0.005	0.005	8=L AMER
0.005	0.005	0.005	0.005	0.005	9=S&E ASIA

RESIL--MINIMUM LEVEL OF SHORT-TERM SUPPLY BY TYPE
AND REGION

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
0.03	0.03	0.03	0.03	0.03	1=USA
0.03	0.03	0.03	0.03	0.03	2=WEUR+CAN
0.03	0.03	0.03	0.03	0.03	3=OECD PAC
0.03	0.03	0.03	0.03	0.03	4=EUSSR
0.03	0.03	0.03	0.03	0.03	5=ACENP
0.03	0.03	0.03	0.03	0.03	6=MIDEAST
0.03	0.03	0.03	0.03	0.03	7=AFRICA
0.03	0.03	0.03	0.03	0.03	8=L AMER
0.03	0.03	0.03	0.03	0.03	9=S&E ASIA

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

ESFIL--INITIAL ESTIMATE OF ENERGY SUPPLY
BY FUEL, REGION, AND PERIOD
(UNITS=EXAJOULES/YR)

YEAR=1975

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
20.41	20.73	17.18	0.0	0.62	1=USA
4.77	8.98	9.60	0.0	0.58	2=WEUR+CAN
0.96	0.31	2.67	0.0	0.09	3=OECD PAC
22.77	11.91	25.77	0.0	0.07	4=EUSSR
3.23	0.14	15.01	0.0	0.00	5=ACENP
42.35	1.21	0.03	0.0	0.00	6=MIDEAST
10.59	0.39	2.18	0.0	0.00	7=AFRICA
9.92	1.55	0.39	0.0	0.01	8=L AMER
3.79	0.75	2.68	0.0	0.01	9=S&E ASIA

GAS FLARING
"FLRL1" IS THE FLARING RATE IN 1975, "FLRL2" IS THE ULTIMATE FLARING RATE, AND "FLRL3" IS THE NUMBER OF YEARS TO REACH "FLRL2." THE MODEL EXPONENTIALLY INTERPOLATES BETWEEN THE RATES.

FLRL1	FLRL2	FLRL3	REGION
.055	.050	10.0	US
.070	.050	10.0	WEUR+CAN
.005	.010	10.0	JANZ
.049	.050	10.0	EUSSR
.107	.050	10.0	ACENP
.727	.050	50.0	MIDEAST
.736	.050	50.0	AFR
.523	.050	28.0	LA
.349	.050	15.0	SEASIA

RENEWABLE RESOURCE CONSTRAINED TECHNOLOGIES
PARAMETERS INCLUDE LOGISTICS FUNCTION PARAMETERS, COST, AND SHARE DATA. "HYDRO1L" ORIENTS THE PRODUCTION PATH IN TIME: "HYDRO2L" DETERMINES ITS SHAPE: "HYDRO3L" IS THE RESOURCE AMOUNT IN EJ; "HYDRO4L" IS PRODUCTION PRICE IN 1975 DOLLARS PER GJ: AND "HYDRO5L" IS THE ELECTRICITY SHARE OF HYDRO.

HYDRO1L	HYDRO2L	HYDRO3L	HYDRO4L	HYDRO5L	REGION
0.42040	0.06505	1.83	4.03	0.15297	US
0.38610	0.07198	3.51	4.03	0.34268	WEUR+CAN
0.24160	0.06884	0.77	4.03	0.20997	JANZ
-1.99788	0.09314	4.77	4.03	0.11591	EUSSR
-3.20686	0.09000	5.76	4.03	0.34665	ACENP
-3.64180	0.15488	0.61	4.03	0.09685	MIDEAST
-3.97006	0.09969	7.31	4.03	0.28723	AFR
-2.52283	0.09701	6.48	4.03	0.56237	LA
-2.77226	0.10060	4.17	4.03	0.26934	SEASIA

SOLAR COSTS: CSLT(L,1) = PRODUCTION COST IN 1975
CSLT(L,2) = FINAL PRODUCTION COSTS .
CSLT(L,3) = YEARS TO REACH FINAL PRODUCTION COSTS

CSLT1	CSLT2	CSLT3	REGION
200.60	14.85	50.00	US
402.40	14.85	50.00	WEUR+CAN
281.60	14.85	50.00	OECD PAC
402.40	14.85	50.00	EUSSR
321.40	14.85	50.00	ACENP .
128.60	14.85	50.00	MIDEAST
144.00	14.85	50.00	AFR
321.40	14.85	50.00	LA
200.60	14.85	50.00	SEASIA

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

SYNFUEL PARAMETERS
(PARAMETERS INCLUDE A CONVERSION EFFICIENCY (GCI), ADD ON COSTS (HCILT) AND AN ELASTICITY CONTROL PARAMETER (RCI). HCILT1 IS THE INITIAL VALUE, HCILT2 THE FINAL VALUE, AND HCILT3 THE NUMBER OF YEARS TO REACH THE FINAL VALUE. THE MODEL EXPONENTIALLY INTERPOLATES FOR INTERMEDIATE YEARS)

SYNCRUDE			SYNGAS			
HCILT1	HCILT2	HCILT3	HCILT1	HCILT2	HCILT3	REGION
100.00	4.55	25.	100.	3.30	25.	US
100.00	4.55	25.	100.	3.30	25.	WEUR+CAN
100.00	4.55	25.	100.	3.30	25.	OECD PAC
100.00	4.55	25.	100.	3.30	25.	EUSSR
100.00	4.55	50.	100.	3.30	50.	ACENP
100.00	4.55	100.	100.	3.30	100.	MIDEAST
12.54	4.55	25.	100.	3.30	25.	AFRICA
12.54	4.55	25.	100.	3.30	25.	L AMER
100.00	4.55	50.	100.	3.30	50.	S&E ASIA

SYNCRUDE GCI = 1.50 SYNGAS GCI = 1.50
SYNCRUDE RCI = -6.00 SYNGAS RCI = -6.00

ENERGY SERVICE INPUT-OUTPUT COEFFICIENTS

TABLE 1.
ENERGY TRANSFORMATION BY SECTOR
(GJK, GJ)

OIL	GAS	COAL	ELECTRIC	SECTOR	VARIABLE	
1.67	1.54	2.5	.86	RES/COM	GJK,J=1,NJ	K=1
1.92	1.90	2.0	1.05	INDUSTRY	GJK,J=1,NJ	K=2
3.0	3.0	3.33	1.05	TRANSPORT	GJK,J=1,NJ	K=3
2.0	1.7	2.05	0.95	AGGREGATE	GJ, J=1,NJ	

TABLE 2.
NON-ENERGY I-O COEFFICIENTS BY SECTOR
(HJK, HJ)

OIL	GAS	COAL	ELECTRIC	SECTOR	VARIABLE	
4.98	3.24	2.87	3.41	RES/COM	HJK,J=1,NJ	K=1
.41	.32	.80	1.16	INDUSTRY	HJK,J=1,NJ	K=2
98.88	200.00	200.00	153.17	TRANSPORT	HJK,J=1,NJ	K=3
2.10	2.03	1.18	1.15	AGGREGATE	HJ, J=1,NJ	

BASE ENERGY SERVICE CONSUMPTION WEIGHTS
BY FUEL BY SECTOR BY REGION
SJKLP (UNITS=UNDIMENTIONED) AND BSKL (UNITS=EXAJOULES)

OIL	GAS	COAL	ELECTRIC	BSKL	SECTOR	REGION
0.105	0.683	0.011	0.379	15.2777	RES/COM	USA
0.091	0.345	0.129	0.145	9.7081	INDUSTRY	USA
1.369	0.000	0.000	0.001	6.6411	TRANSPORT	USA
0.359	0.122	0.112	0.372	11.1476	RES/COM	WEUR+CAN
0.260	0.065	0.131	0.212	9.4047	INDUSTRY	WEUR+CAN
1.962	0.000	0.003	0.028	3.3974	TRANSPORT	WEUR+CAN
0.443	0.088	0.207	0.462	2.0876	RES/COM	OECD PAC
0.224	0.032	0.267	0.263	3.9791	INDUSTRY	OECD PAC
2.672	0.000	0.001	0.050	0.8941	TRANSPORT	OECD PAC
0.277	0.194	0.336	0.197	26.3832	AGGREGATE	USSR
0.156	0.005	0.764	0.074	9.1210	AGGREGATE	CHINA
0.687	0.212	0.009	0.097	1.8153	AGGREGATE	MIDEAST
0.437	0.009	0.340	0.214	2.2834	AGGREGATE	AFRICA
0.675	0.148	0.044	0.174	5.0414	AGGREGATE	L AMER
0.516	0.068	0.172	0.244	4.2498	AGGREGATE	S&E ASIA

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

BSJKLM -- LOGIT FUNCTION SCALE PARAMETERS
(UNITS BSJKLM=UNDIMENSIONED)
YEAR = 1975

OIL	GAS	COAL	ELECTRIC	SECTOR	REGION
0.3585	0.0548	0.0008	0.5858	RES/COM	USA
0.1871	0.0124	0.0047	0.7958	INDUSTRY	USA
0.7030	0.0000	0.0004	0.2966	TRANSPORT	USA
0.5492	0.0814	0.0118	0.3577	RES/COM	WEUR+CAN
0.3184	0.0831	0.0122	0.5863	INDUSTRY	WEUR+CAN
0.0736	0.0000	0.5008	0.4256	TRANSPORT	WEUR+CAN
0.4533	0.0622	0.0058	0.4787	RES/COM	OECD PAC
0.1948	0.0420	0.0091	0.7541	INDUSTRY	OECD PAC
0.0299	0.0000	0.5779	0.3922	TRANSPORT	OECD PAC
0.4795	0.0380	0.0339	0.4486	AGGREGATE	USSR
0.5764	0.0018	0.1465	0.2753	AGGREGATE	CHINA
0.6032	0.0451	0.0025	0.3492	AGGREGATE	MIDEAST
0.7670	0.0004	0.0213	0.2113	AGGREGATE	AFRICA
0.7910	0.0186	0.0054	0.1850	AGGREGATE	L AMER
0.5508	0.0089	0.0260	0.4143	AGGREGATE	S&E ASIA

BSJKLM -- LOGIT FUNCTION SCALE PARAMETERS
(UNITS BSJKLM=UNDIMENSIONED)
YEAR = 2000

OIL	GAS	COAL	ELECTRIC	SECTOR	REGION
0.2600	0.0548	0.0008	0.5858	RES/COM	USA
0.1871	0.0207	0.0047	0.7958	INDUSTRY	USA
0.7030	0.0000	0.0004	0.2966	TRANSPORT	USA
0.5492	0.0814	0.0118	0.3577	RES/COM	WEUR+CAN
0.3184	0.0831	0.0122	0.5863	INDUSTRY	WEUR+CAN
0.0736	0.0000	0.5008	0.4256	TRANSPORT	WEUR+CAN
0.4533	0.0622	0.0058	0.4787	RES/COM	OECD PAC
0.1948	0.0420	0.0091	0.7541	INDUSTRY	OECD PAC
0.0299	0.0000	0.5779	0.3922	TRANSPORT	OECD PAC
0.4795	0.0790	0.0339	0.4486	AGGREGATE	USSR
0.5200	0.0200	0.1939	0.2753	AGGREGATE	CHINA
0.6032	0.0451	0.0025	0.3492	AGGREGATE	MIDEAST
0.6700	0.0287	0.0213	0.2800	AGGREGATE	AFRICA
0.6001	0.0423	0.0054	0.2117	AGGREGATE	L AMER
0.6500	0.0187	0.0260	0.4400	AGGREGATE	S&E ASIA

BSJKLM -- LOGIT FUNCTION SCALE PARAMETERS
(UNITS BSJKLM=UNDIMENSIONED)
YEAR = 2025

OIL	GAS	COAL	ELECTRIC	SECTOR	REGION
0.2600	0.0548	0.0008	0.5858	RES/COM	USA
0.1871	0.0207	0.0047	0.7958	INDUSTRY	USA
0.7030	0.0000	0.0004	0.2966	TRANSPORT	USA
0.5492	0.0814	0.0118	0.3577	RES/COM	WEUR+CAN
0.3164	0.0831	0.0122	0.5863	INDUSTRY	WEUR+CAN
0.0736	0.0000	0.5008	0.4256	TRANSPORT	WEUR+CAN
0.4533	0.0622	0.0058	0.4787	RES/COM	OECD PAC
0.1948	0.0420	0.0091	0.7541	INDUSTRY	OECD PAC
0.0299	0.0000	0.5779	0.3922	TRANSPORT	OECD PAC
0.4795	0.1125	0.0198	0.4486	AGGREGATE	USSR
0.5764	0.0400	0.0706	0.2753	AGGREGATE	CHINA
0.6032	0.0451	0.0025	0.3492	AGGREGATE	MIDEAST
0.5800	0.0487	0.0213	0.3400	AGGREGATE	AFRICA
0.6001	0.0423	0.0054	0.2383	AGGREGATE	L AMER
0.4500	0.0273	0.0260	0.4500	AGGREGATE	S&E ASIA

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

BSJKLM -- LOGIT FUNCTION SCALE PARAMETERS
(UNITS BSJKLM=UNDIMENSIONED)
YEAR = 2050

OIL	GAS	COAL	ELECTRIC	SECTOR	REGION
0.2600	0.0548	0.0008	0.5858	RES/COM	USA
0.1871	0.0207	0.0047	0.7958	INDUSTRY	USA
0.7030	0.0000	0.0004	0.2966	TRANSPORT	USA
0.5492	0.0814	0.0118	0.3577	RES/COM	WEUR+CAN
0.3184	0.0831	0.0122	0.5863	INDUSTRY	WEUR+CAN
0.0736	0.0000	0.5008	0.4256	TRANSPORT	WEUR+CAN
0.4533	0.0622	0.0058	0.4787	RES/COM	OECD PAC
0.1948	0.0420	0.0091	0.7541	INDUSTRY	OECD PAC
0.0299	0.0000	0.5779	0.3922	TRANSPORT	OECD PAC
0.4795	0.1425	0.0128	0.4486	AGGREGATE	USSR
0.4323	0.0800	0.0347	0.2753	AGGREGATE	CHINA
0.6032	0.0451	0.0025	0.3492	AGGREGATE	MIDEAST
0.4800	0.0787	0.0213	0.4000	AGGREGATE	AFRICA
0.6001	0.0423	0.0054	0.2650	AGGREGATE	L AMER
0.3900	0.0374	0.0260	0.4600	AGGREGATE	S&E ASIA

BSJKLM -- LOGIT FUNCTION SCALE PARAMETERS
(UNITS BSJKLM=UNDIMENSIONED)
YEAR = 2075

OIL	GAS	COAL	ELECTRIC	SECTOR	REGION
0.2600	0.0548	0.0008	0.5858	RES/COM	USA
0.1871	0.0207	0.0047	0.7958	INDUSTRY	USA
0.7030	0.0000	0.0004	0.2966	TRANSPORT	USA
0.5492	0.0814	0.0118	0.3577	RES/COM	WEUR+CAN
0.3184	0.0831	0.0122	0.5863	INDUSTRY	WEUR+CAN
0.0736	0.0000	0.5008	0.4256	TRANSPORT	WEUR+CAN
0.4533	0.0622	0.0058	0.4787	RES/COM	OECD PAC
0.1948	0.0420	0.0091	0.7541	INDUSTRY	OECD PAC
0.0299	0.0000	0.5779	0.3922	TRANSPORT	OECD PAC
0.4795	0.1425	0.0128	0.4486	AGGREGATE	USSR
0.4323	0.0800	0.0347	0.2753	AGGREGATE	CHINA
0.6032	0.0451	0.0025	0.3492	AGGREGATE	MIDEAST
0.4800	0.0787	0.0213	0.4000	AGGREGATE	AFRICA
0.6001	0.0423	0.0054	0.2650	AGGREGATE	L AMER
0.3900	0.0374	0.0260	0.4600	AGGREGATE	S&E ASIA

BSJKLM -- LOGIT FUNCTION SCALE PARAMETERS
(UNITS BSJKLM=UNDIMENSIONED)
YEAR = 2100

OIL	GAS	COAL	ELECTRIC	SECTOR	REGION
0.2600	0.0548	0.0008	0.5858	RES/COM	USA
0.1871	0.0207	0.0047	0.7958	INDUSTRY	USA
0.7030	0.0000	0.0004	0.2966	TRANSPORT	USA
0.5492	0.0814	0.0118	0.3577	RES/COM	WEUR+CAN
0.3184	0.0831	0.0122	0.5863	INDUSTRY	WEUR+CAN
0.0736	0.0000	0.5008	0.4256	TRANSPORT	WEUR+CAN
0.4533	0.0622	0.0058	0.4787	RES/COM	OECD PAC
0.1948	0.0420	0.0091	0.7541	INDUSTRY	OECD PAC
0.0299	0.0000	0.5779	0.3922	TRANSPORT	OECD PAC
0.4795	0.1425	0.0128	0.4486	AGGREGATE	USSR
0.4323	0.0800	0.0347	0.2753	AGGREGATE	CHINA
0.6032	0.0451	0.0025	0.3492	AGGREGATE	MIDEAST
0.4800	0.0787	0.0213	0.4000	AGGREGATE	AFRICA
0.6001	0.0423	0.0054	0.2650	AGGREGATE	L AMER
0.3900	0.0374	0.0260	0.4600	AGGREGATE	S&E ASIA

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

PRICE ELASTICITY CONTROL PARAMETERS

AGG RPKK	OIL	GAS	COAL	ELECTRIC	SECTOR
		RPJK			
-0.7	-3.0	-3.0	-3.0	-3.0	RES/COM RPJK,JK,K=1
-0.7	-3.0	-3.0	-3.0	-3.0	INDUSTRY RPJK,JK,K=2
-0.7	-13.0	-13.0	-13.0	-13.0	TRANSPORT RPJK,JK,K=3
RPK		RPJ			
-0.7	-2.5	-2.5	-2.5	-2.5	AGGREGATE RPK,RPJ

INCOME ELASTICITY CONTROL PARAMETERS

AGG RYKK	OIL	GAS	COAL	ELECTRIC	SECTOR
		RYJK			
1.00	-0.10	0.30	-0.20	0.10	RES/COM RYJK,JK,K=1
1.000	0.00	0.10	-0.30	0.30	INDUSTRY RYJK,JK,K=2
1.00	0.00	0.00	0.00	0.00	TRANSPORT RYJK,JK,K=3
	RYJ				
-0.10	0.10	-0.20	0.10		RYJ,J=1,4

RYKLT--INCOME ELASTICITY FOR THE EUSSR (L=4) AND OTHER LDC'S (L>4)
INPUT IS THE INITIAL VALUE IN 1975. THE PROGRAM INTERPOLATES OVER A 75 YEAR PERIOD TO A FINAL VALUE 0.8 TIMES THE ORIGINAL FOR THE EUSSR AND 0.71 TIMES THE ORIGINAL FOR OTHER LDC'S

1.25	EUSSR(L=4)
1.40	LDC'S(L>4)

RYL--ENERGY-GNP FEEDBACK ELASTICITY, BY REGION

-0.15	1=USA
-0.15	2=WEUR+CAN
-0.15	3=OECD PAC
-0.15	4=EUSSR
-0.20	5=ACENP
0.05	6=MIDEAST
-0.20	7=AFRICA
-0.20	8=L AMER
-0.20	9=S&E ASIA

COI -- CARBON RELEASE BY SOURCE
(IN TERAGRAMS OF CARBON PER EXAJOULE)

OIL BURNUP	GAS BURNUP	COAL BURNUP	COAL LIQUIFACTION	COAL GASIFICATION	SHALE OIL PRODUCTION	BIOMASS
19.7	13.8	23.9	18.9	26.9	27.9	0.0

PROPORTION OF FLARED GAS BURNED (SBURNLT T=1 IS INITIAL (1975) SHARE, T=2 IS ULTIMATE SHARE, T=3 IS NUMBER OF YEARS TO SBURNL2. PROPORTION OF BACKSTOP FUEL FROM CARBONATE ROCK (SHALET, T=1,2,3) HAS IDENTICAL INTERPRETATION.

SBURNL1	SBURNL2	SBURNL3	SHALE1	SHALE2	SHALE3	REGION
0.13	0.13	1.0	0.01	0.99	70.0	US
0.47	0.15	25.0	0.01	0.45	70.0	WEUR+CAN
1.00	0.15	35.0	0.01	0.99	70.0	OECD PAC
1.00	0.15	35.0	0.01	0.90	70.0	EUSSR
1.00	0.15	35.0	0.01	0.25	70.0	ACENP
0.90	0.15	35.0	0.01	0.25	70.0	MIDEAST
0.90	0.15	35.0	0.01	0.25	70.0	AFRICA
0.35	0.15	25.0	0.01	0.25	70.0	L AMER
0.85	0.15	35.0	0.01	0.25	70.0	S&E ASIA

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

FEEDSTOCK USES OF FOSSIL FUELS (SFEDIL) -- SHARE OF EACH FOSSIL FUEL USED AS A FEEDSTOCK.

OIL	GAS	COAL	REGION
0.045	0.029	0.007	US
0.072	0.029	0.007	WEUR+CAN
0.092	0.029	0.007	OECD PAC
0.091	0.029	0.007	EUSSR
0.070	0.029	0.007	ACENF
0.141	0.029	0.007	MIDEAST
0.030	0.029	0.007	AFRICA
0.068	0.029	0.007	L AMER
0.082	0.029	0.007	S&E ASIA

BIOMASS COEFFICIENTS: THE SUPPLY FUNCTION FOR BIOMASS INCLUDES WASTE AND "ENERGY FARMS" AS SEPARATE TECHNOLOGIES. THE CODED FUNCTIONS ARE REPRESENTED BY LINEAR SEGMENTS. THE JPARAMETERS ARE CRITICAL POINTS FOR THE FUNCTION AND REGIONAL RESOURCES. BIOPSM ARE CRITICAL PRICE/SHARE COMBINATIONS. BIOLM ARE MAXIMUM RESOURCE AMOUNTS -- WASTE IS DEPENDENT ON ECONOMIC ACTIVITY. THE WASTE TOTAL IS BASED ON 1975 ECONOMIC ACTIVITY (PRICE--1975 $/GJ, QUANTITY--EJ)

WASTE (BIOPSM)		ENERGY FARMS (BIOPSM)	
PRICE	SHARE	PRICE	SHARE
0.1705	0.0	0.0	0.0
1.60	0.3	2.1	0.0
4.60	0.8	2.6	0.2
5.60	0.8	4.6	0.8

WASTE (BIOLM)	ENERGY FARMS (BIOLM)	REGION
5.48	82.29	US
7.95	00.00	WEUR+CAN
2.71	13.19	OECD PAC
8.73	98.43	EUSSR
7.04	0.00	ACENF
1.00	0.00	MIDEAST
5.71	173.44	AFRICA
7.81	225.45	L AMER
10.40	0.00	S&E ASIA

INCOME ELASTICITY OF BIOMASS SUPPLY

0.50 RYSHT

TABLE 6.1. THE IEA.DAT DATA SET (Continued)

NOTES:

General References for letters used in the variables:

I = Fuel (oil, gas, solids, nuclear, solar, hydro)
J = Secondary Fuel (oil, gas, solids, electricity)
K = Sector of Energy Consumption (1=residential/commercial, 2=industrial, 3=transport)
L = Region (See below)
M = Time Period (1=1975, 2=2000, 3=2025, 4=2050, 5=2075, 6=2100)

Regions:

1 = USA = United States
2 = CAN/WE = Canada, Western Europe, and Turkey
3 = JANZ = Japan, Australia, New Zealand
4 = EUSSR = Soviet Union and Centrally Planned Europe
5 = ACENP = Centrally Planned Asia
6 = MIDEAST = Middle East
7 = AFR = Africa
8 = LA = Latin America
9 = SEASIA = Noncommunist South, East, and Southeast Asia

TABLE 6.2. LIST OF INPUTS TO THE IEA/ORAU GLOBAL MODEL

Input	Applied to	Symbol	Comments
Transportation Costs	Oil, gas, coal	TRI	Cost of transporting each fossil fuel per gigajoule. Assumed paid by importers of the fuel.
Initial Price Estimates	Oil, gas, coal. Each period.	PIM	Initial estimates of world prices. These prices are used to start the search process for market clearing prices.
Trade Barriers	Oil, gas, coal. Each period. Each region.	TXILM	Scale factor applied to fuel prices to represent import or export tariffs (value of 1.0 leaves prices unchanged).
Energy Taxes	Oil, gas, coal, electricity. Each period. Each region.	TXJLM	Energy taxes on final consumption (value of 1.0 leaves prices unchanged).
Population	Each period. Each region.	ZL, ZLM	Populations (thousands of persons). ZL=1950. ZLM (forecast periods 1975, 2000, 2025, 2050,2075, 2100)
Labor Productivity	Each region.	PROL	Annual labor productivity growth rate.
Base GNP	Each region, base year.	GNPL	GNP in millions of US 1975$.
Refinery Coefficients - Conversion Efficiency	Oil, gas, coal.	GIJ	Ratio of joules of primary energy in to joules of energy product out (exclusive of fuels used as energy by the refinery).
- Non-energy Mark-up Cost	Oil, gas, coal.	HIJ	Accounts for cost of refining and distributing energy products. (1975 US $/gj).
Electricity Parameters - Generation Efficiency	Oil, gas, coal, nuclear, solar, hydro.	GUI	Ratio of joules of energy in to joules of electricity out.
- Non-Energy Costs	Oil, gas, coal, nuclear, solar, hydro. Each region.	HUIL	Reflects non-energy costs (fixed on capital costs).

TABLE 6.2. LIST OF INPUTS TO THE IEA/ORAU GLOBAL MODEL (Continued)

Input	Applied to	Symbol	Comments
Electricity Parameters (cont'd)			
- Logit Substitution Coefficient	Oil, gas, coal, nuclear, solar.	RUI	Governs the response to utilities to price changes for a given technology (hydro is fixed). (Value ranges between 0.0 and - infinity.)
- Multiplicative Factor	Liquids, gases, solids. Each region.	PAUIL	Adjusts the refined fossil fuel price to account for different fuel type & distribution
- Utility Fuel Share Weights	Oil, gas, coal, nuclear, solar. Each period. Each region.	BSUILM	These weights are used to calibrate the model to 1975 actual shares then are gradually revised to remove fixed capital bias.
End-Use Energy Productivity Improvements	Each sector. Each region.	TKL	Annual rate of end-use energy efficiency improvement.
Resources	Conv. oil, gas, coal, uncon. oil, nuclear. Each grade. Each region.	RIGISL	Resource base for 5 resource grades (exajoules).
Minimum Extraction Costs	Conv. oil, gas, coal, uncon. oil, nuclear. Each grade.	CIGIS	Minimum extraction cost (1975 US $/gj) for grades 1-5. Final cost is the maximum extraction cost at resource exhaustion.
Environmental Cost	Conv. oil, gas, coal, uncon. oil, nuclear. Each region.	VISL	Additional cost to protect the environment over and above those existing in 1975. (1975 US $/gj). Applied as an add-on cost to all grades.
Price Elasticity of Supply	Conv. oil, gas, coal, uncon. oil. Each region.	RIL	Percentage change in the short-term (25 yrs.) supply of fuel for each percent change in cost. Used to set a maximum rate of market penetration. Evaluated at the previous price.
Rate of Technological Change	Conv. oil, gas, coal, uncon. oil, nuclear. Each region.	STISL	Annual rate of reduction of cost of supply.

TABLE 6.2. LIST OF INPUTS TO THE IEA/ORAU GLOBAL MODEL (Continued)

Input	Applied to	Symbol	Comments
Short-Term Supply Minimum	Conv. oil, gas, coal, uncon. oil, nuclear. Each region.	BESIL	Minimum level of short-term supply forthcoming if the fuel price is high enough to allow some production. Basis of short-term market penetration constraint.
Initial Supply Estimate	Conv. oil, conv. gas, coal, uncon. oil, nuclear. Each region.	ESFIL	Initial estimate of rate of energy supply (gj) used to benchmark the model to 1975 base.
Gas Flaring Parameters			
- Flaring Rate, Base Year	Gas. Each region.	FLRL1	Flaring = Burning & reinjection.
- Ultimate Flaring Rate	Gas. Each region.	FLRL2	Ultimate fraction of gas that will be flared in each region.
- Years to FLRL2	Gas. Each region.	FLRL3	Number of years to reach the ultimate flaring fraction.
Renewable Resources			
Hydro			
- Orientation Parameter	Hydro. Each region.	HYDRO1L	Orients production path in time of logistic function.
- Shape	Hydro. Each region.	HYDRO2L	Determines the shape of the logistic function.
- Resource	Hydro. Each region.	HYDRO3L	Resource amount available in each region.
- Price	Hydro. Each region.	HYDRO4L	Production price in 1975 US$/gj.
- Electricity Share	Hydro. Each region.	HYDRO5L	Hydroelectricity cost in each region.
Solar Costs			
- Production Costs Base Year	Solar. Base year. Each region.	CSLT(L,1)	Production costs in 1975 (1975 US$/gj).

TABLE 6.2. LIST OF INPUTS TO THE IEA/ORAU GLOBAL MODEL (Continued)

Input	Applied to	Symbol	Comments
- Final Production Costs	Solar. Each region.	CSLT(L,2)	(1975 US$/gj)
- Years to CSLT(L,2)	Solar. Each region.	CSLT(L,3)	Number of years to reach final production costs.
Synfuel Parameters			
- Initial Non-Fuel Costs	Syncrude, syngas. Each region.	HCILT1	Initial (1975) non-fuel costs (1975 US $/gj).
- Final Non-Fuel Costs	Syncrude, syngas. Each region.	HCILT2	Ultimate (year=1975 + HCILT3) non-fuel cost (1975 US $/gj).
- Years to HCILT2	Syncrude, syngas. Each region.	HCILT3	Number of years to reach final value of add-on cost. Values for non-fuel costs for years other than 1975 and 1975 + HCILT3 are obtained through exponential interpolation.
- Conversion Efficiency	Syncrude, syngas.	GCI	Ratio of input of solid feedstock (gj) to output of synfuel (gj).
- Elasticity	Syncrude, syngas.	RCI	Elasticity parameter. Controls substitution between solids conversion to liquids, gases, or solids. (Value between 0 and - infinity).
Energy Service Input-Output Coefficients			
- Energy Transformation	Oil, gas, coal, electric.		
	Each sector.	GJK	Ratio of input of final energy (gj) to energy service (gj) produced. Energy service price = (GJK) x (secondary energy price) + HJK.
	Aggregate.	GJ	
- Non-Energy Transformation	Oil, gas, coal, electric.		
	Each sector.	HJK	Non-energy cost to produce energy services by fuel (1975 US $/gj).
	Aggregate.	HJ	

TABLE 6.2. LIST OF INPUTS TO THE IEA/ORAU GLOBAL MODEL (Continued)

Input	Applied to	Symbol	Comments
Base Energy Service Aggregate Price Weights	Oil, gas, coal, electric. Each sector. Each region. Each sector. Each region.	SJKLP BSKL	Weights used to calculate the end-use sectoral aggregate cost of energy services. 1975 total energy service by sector.
Scale Parameters	Oil, gas, coal, electric Each Sector. Each region. Each period.	BSJKLM	Undimensional parameter used to calculate fuel shares. Benchmarked to 1975 actual values. Minor modifications for other years (no units).
Price Elasticity	Oil, gas, coal, electric Each sector.	RPKK RPK	Price elasticity of energy demand. (Values between 0 and - infinity). Percentage change in final consumption for each percentage change in the price of final energy (aggregate of oil, gas, coal, and electricity).
End-Use Feel Substitution	Oil, gas, coal, electric Each sector. Each fuel.*	RPJK RPK	Dimensionless measure of end-use interfuel substitutability (values between 0 and - infinity). *Values for each fuel must be equal.
Income Elasticity	Oil, gas, coal, electric. Each sector.	RYKK	Dimensionless measure of the percentage change in aggregate end-use fuel demand (oil + gas + coal + electricity) for each percentage change in the aggregate price. OECD regions only.
Income/Fuel Preference	Oil, gas, coal, electric. Each sector.	RYJK RYJ	Controls the relative use of each fuel as income changes. Higher values imply that as income rises greater use is made of that fuel, other things equal (no units)

TABLE 6.2. LIST OF INPUTS TO THE IEA/ORAU GLOBAL MODEL (Continued)

Input	Applied to	Symbol	Comments
Income Elasticity	Regions (EUSSR, LDCs).	RYKLT	Percentage change in the aggregate end-use fuel demand (oil + gas + coal + electricity) for each percentage change in the aggregate price.
Energy-GNP Feedback	Each region.	RYL	Percentage change in GNP for each percentage change in the price of energy services. (Positive number implies that the price increases raise GNP).
CO_2 Release Coefficients	By energy activity.	COI	Rate of release of CO_2 (teragrams of carbon per ej). Note: coal liquefaction and gasification now are calculated internally.
Proportion of Flared Gas Actually Burned			
- Initial Share	Each region.	SBURNL1	Initial share (calculated for 1975) of flared gas burned. (1-SBURNL1 is the share vented and reinjected.)
- Ultimate Share	Each region.	SBURNL2	Share of flared gas burned after SBURNL3 years. Share is constant hereafter. Values for SBURNL between 1975 and SBURNL3 years later is exponentially interpolated.
- Years to SBURNL2	Each region.	SBURNL3	Number of years to reach the ultimate share of flared gas.

TABLE 6.2. LIST OF INPUTS TO THE IEA/ORAU GLOBAL MODEL (Continued)

Input	Applied to	Symbol	Comments
Proportion of Shale Oil Produced from Carbonate Rock - Initial Share	Each region.	SHALE1	Initial share of shale oil production from carbonate rock calculated for 1975.
- Ultimate Share	Each region.	SHALE2	Share of shale oil production from carbonate rock reached after (1975+SHALE3 years. Share for years between 1975 and (1975+SHALE3) is exponentially interpolated.
- Years to SHALE2	Each region.	SHALE3	Number of years to reach ultimate share of shale oil production from carbonate rock.
Feedstock Uses of Fossil Fuels	Oil, gas, coal. Each region.	SFEDIL	Share of each fossil fuel used as a feedstock.
Biomass Coefficients - Price/Share Combinations - Renewable Resource Base	Waste, energy farms. Waste, energy farms. Each region.	BIOPSM BIOLM	There are two supply functions for biomass. The first is the supply function for biomass waste. The second is for biomass from farms. Each is made up of a basic linearly segmented supply schedule which is shifted outward (quantity supplied multiplied) by the renewable resource base. Critical price quantity combinations for the basic supply schedules are given by the BIOPSM arrays. The basic renewable resource base for each type of biomass is given by BIOLM. For biomass supplied by waste, the resource base is scaled by an index of GNP (1975-1.0) taken to the power RYSHT.
Income Elasticity of Biomass Supply	GNP by region.	RYSHT	

TABLE 6.3. GLOSSARY OF VARIABLE DEFINITIONS

BESIL:	Minimum level of short-term supply forthcoming if the full price is high enough to allow some production. Basis of short-term market penetration constraint.
BIOPSM:	Each supply function for biomass is made up of a basic linearly segmented supply schedule which is shifted outward (quantity supply multiplied) by the renewable resource base. Critical price quantity combinations for the basic supply schedules are given by the BIOPSM arrays.
BIOLM:	Basic renewable resource base for each type of biomass (from waste and from farms),
BSKL:	1975 total energy service by sector.
BSJKLM:	Undimensioned parameter used to calculate fuel shares. Benchmarked to 1975 actual values. Minor modifications for other years (no units).
BSUILM:	Utility fuel share weights used to calibrate the model to 1975 actual shares then gradually revised to remove fixed capital bias.
CIGIS:	Minimum extraction cost (1975 US $/gj) for fuel grades 1-5. Final cost is the maximum extraction cost at resource exhaustion.
COI:	Rate of release of CO_2 (teragrams of carbon per ej). Note coal liquefaction and gasification now are calculated internally.
CSLT(L,1):	Solar production costs in 1975 US $/gj.
CSLT(L,2):	Final solar production costs in 1975 US $/gj.
CSLT(L,3):	Number of years to reach final solar production costs.
ESFIL:	Initial estimate of rate of energy supply (gj) used to benchmark the model to 1975 base.
FLRL1:	Gas flaring rate in 1975. Flaring = Burning and reinjection.
FLRL2:	Ultimate fraction of gas that will be flared in each region.
FLRL3:	Number of years to reach the ultimate flaring fraction.
GCI:	Synfuel parameter. Ratio of solid feedstock (gj) to output of synfuel (gj).

TABLE 6.3. GLOSSARY OF VARIABLE DEFINITIONS (Continued)

GIJ:	A refinery coefficient. A conversion efficiency, the ratio of joules of primary energy in to joules of energy product out (exclusive of fuels used as energy by the refinery).
GJ,GJK:	Ratio of final energy (gj) to energy service (gj) produced. Energy service price = (GJK) x (secondary energy price) + KJK.
GNPBL:	Base year GNP in millions of 1975 US dollars.
GUI:	Ratio of joules of energy in to joules of electricity out.
HCILT1:	Initial (1975) non-fuel costs of synfuel (1975 US $/gj).
HCILT2:	Ultimate (year = 1975 + HCILT3) nonfuel costs (1975 US $/gj)
HCILT3:	Number of years to reach final non-fuel synfuel costs.
HIJ:	Non-energy mark-up cost. Accounts for cost of refining and distributing energy products (1975 US $/gj).
HUIL:	Electricity parameter reflects non-energy costs (fixed on capital costs).
HYDRO1L:	Hydro orientation parameter orients production path in time of logistic function.
HYDRO2L:	Determines the shape of the hydro logistic function.
HYDRO3L:	Hydro resource amount available in each region.
HYDRO4L:	Renewable resource constrained technologies parameter reflecting production price (1975 US $/gj).
HYDRO5L:	Hydro electricity cost share in each region.
IG:	Grade of fuel.
PAUIL:	Electricity parameter. Multiplicative factor adjusting the refined fossil fuel price to account for different fuel type and distribution.
PIM:	Initial estimates of world prices for oil, gas, coal. These prices are used to start the search process for market clearing prices.
PROL:	Annual labor productivity growth rate.

TABLE 6.3. GLOSSARY OF VARIABLE DEFINITIONS (Continued)

RCI: Synfuel elasticity parameter. Controls substitution between solids conversion to liquids, gases, or solids (value between zero and negative infinity).

RIGISL: Resource base for five resource grades (exajoules).

RIL: Price elasticity of supply. Percentage change in the short-run (25 years) supply of fuel for each percent change in cost. Used to set maximum rate of market penetration. Evaluated at the previous price.

RPJ,RPJK: Dimensionless measure of end-use inter-fuel substitutability (values between zero and negative infinity).

RPK,RPKK: Price elasticity of energy demand (values between zero and negative infinity). Percentage change in final consumption for each percentage change in the price of final energy (aggregate of oil, gas, solids, and electricity).

RUI: Logit substitution coefficient governing the response to utilities to price changes for a given technology. Hydro is fixed (value ranges between zero and negative infinity).

RYJ,RYJK: Controls the relative use of each fuel as income changes. Higher values imply that as income rises greater use is made of that fuel, other things equal.

RYKK: Dimensionless measure of the percentage changes in aggregate end-use fuel demand (oil + gas + solids + electricity) for each percentage change in the aggregate price (OECD regions only).

RYKLT: Dimensionless measure of the percentage change in aggregate end-use fuel demand (oil + gas + solids + electricity) for each percentage change in the aggregate price.

RYL: Percentage change in GNP for each percentage change in the price of energy services (positive number implies that the price increases raise GNP).

RYSHT: A biomass supply variable. For biomass supplied by waste, the resource base is scaled by an index of GNP (1975 = 1.0) taken to the power RYSHT.

SBURNL1: Initial share (calculated for 1975) of flared gas actually burned (1 - SBURNL1 is the share vented and reinjected.)

TABLE 6.3. GLOSSARY OF VARIABLE DEFINITIONS (Continued)

SBURNL2:	Share of flared gas burned after SBURNL3 years. Share is constant thereafter. Values for SBURNL between 1975 and SBURNL3 years later is exponentially interpolated.
SBURNL3:	Number of years to reach the ultimate share of flared gas actually burned.
SFEDIL:	Share of each fossil fuel used as feedstock.
SHALE1:	Initial share of shale oil production from carbonate rock calculated for 1975.
SHALE2:	Share of shale oil production from carbonate rock reached after SHALE3 years. Share for years between 1975 and (1975 + SHALE3) are exponentially interpolated.
SHALE3:	Number of years to reach ultimate share of shale oil production from carbonate rock.
SJKLP:	Weights used to calculate the end-use sectoral aggregate cost of energy services.
STISL:	Rate of technological change. Annual rate of reduction of cost of supply.
TKL:	Annual rate of end-use energy efficiency improvement.
TRI:	Cost of transporting each fossil fuel per gigajoule. Assumed paid by importers of the fuel.
TXILM:	Scale factor applied to fuel prices to represent import or export tariffs (value of 1.0 leaves prices unchanged).
TXJLM:	Energy taxes on final consumption (value of 1.0 leaves prices unchanged).
VISL	Additional cost to protect the environment over and above those existing in 1975 (1975 US $/gj) applied as an add-on cost to all grades.
ZL:	Population (thousands of persons) in 1950.
ZLM:	Population (thousands of persons) in forecast periods 1975, 2000, 2025, 2050, 2075, 2100.

CHAPTER VII
DETAILED PRINTED OUTPUT

The model can also produce detailed printed output. A set of parameters at the beginning of the NIEA.DAT data set control access to detailed printed output. Unless these variables are changed from their initial values, no detailed printed output will be generatd. In this chapter we will look at how to obtain detailed printed output. The portion of the model this chapter deals with is shown in Figure 7.1.

<u>Overview</u>

- Retrieve NIEA.DAT
- Set values for NOPT
- Save changed NIEA.DAT
  Type: RUNMODEL
  Press: Return key

EXAMPLES

We will run two examples of detailed printed output:

Example 1: Printing Input Variables (NIEA.DAT).
Example 2: Printing Carbon Dioxide Emissions Output.

Example 1: Printing a Table of Input Variables

NOPT(2) controls the shadowprinting of NIEA.DAT as the model reads this data set. To shadowprint the data set we must go through a six step procedure.

1. First we must retrieve the NIEA.DAT data set, the beginning of which appears in Figure 7.2.

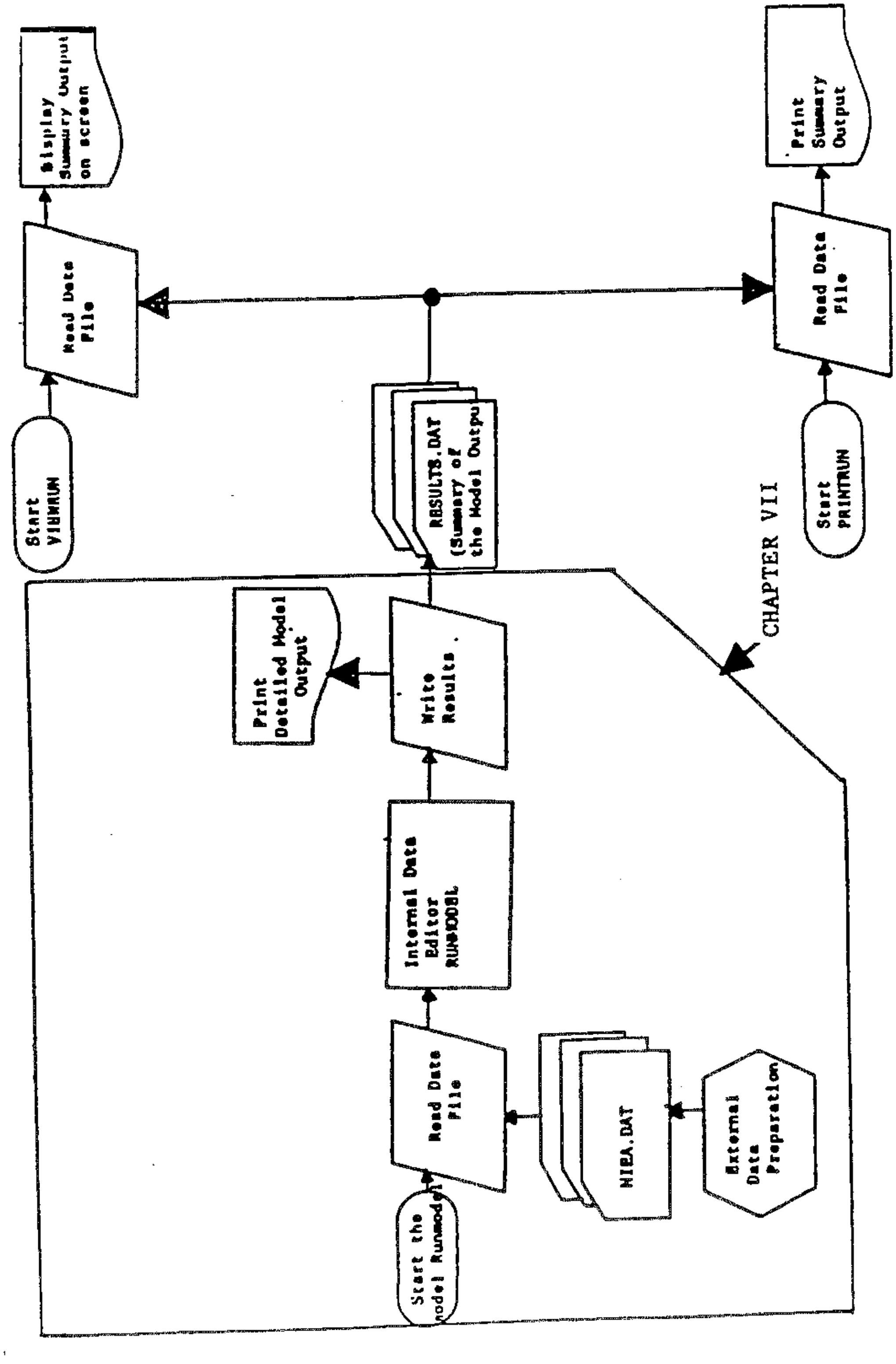


Figure 7.1. Flowchart of the Model

```
************************************************************************
** MODEL=A84PC **       BASE CASE:  MEDIAN INPUTS ASSUMPTIONS      ****
** DATA=DATAA  **                   1 OCTOBER 1985                 ****
************************************************************************

   *** DETAILED PRINTED OUTPUT OPTION CODES:  NOPT.NE.1==> PRINT ***

     1 =NOPT(1) =TABLE OF PROGRAM CONTROL PARAMETERS
     1 =NOPT(2) =TABLE OF INPUT VARIABLES (THIS DATA SET)
     1 =NOPT(3) =INTERMEDIATE OUTPUT FROM SUBROUTINES XXXX AND REVISE
     1 =NOPT(4) =INTERMEDIATE OUTPUT FROM SUBROUTINE ELAS
     1 =NOPT(5) =REGIONAL ENERGY BALANCE TABLES FOR PERIOD M
     1 =NOPT(6) =SUMMARY TABLES FOR PERIOD M
     1 =NOPT(7) =PRICE DATA TABLES FOR PERIOD M
     1 =NOPT(8) =CARBON DIOXIDE OUTPUT FOR PERIOD M
     1 =NOPT(9) =SUMMARY TABLES FOR ALL PERIODS

     5 =NUMBER OF FORECAST PERIODS

************************************************************************
** MODEL=A84PC **       BASE CASE:  MEDIAN INPUTS ASSUMPTIONS      ****
** DATA=DATAA  **                   1 OCTOBER 1985                 ****
************************************************************************
                                          Doc 1  Pg 1  Ln 1  Pos    1
```

Figure 7.2. Detailed Printed Output Options

> NOTE: Retrieving NIEA.DAT. You may wish to refer to Chapter VI for reference figures.

2. Change NOPT(2) to print mode. This is accomplished by changing "1=NOPT(2)" to read "2-NOPT(2). See Figure 7.3.

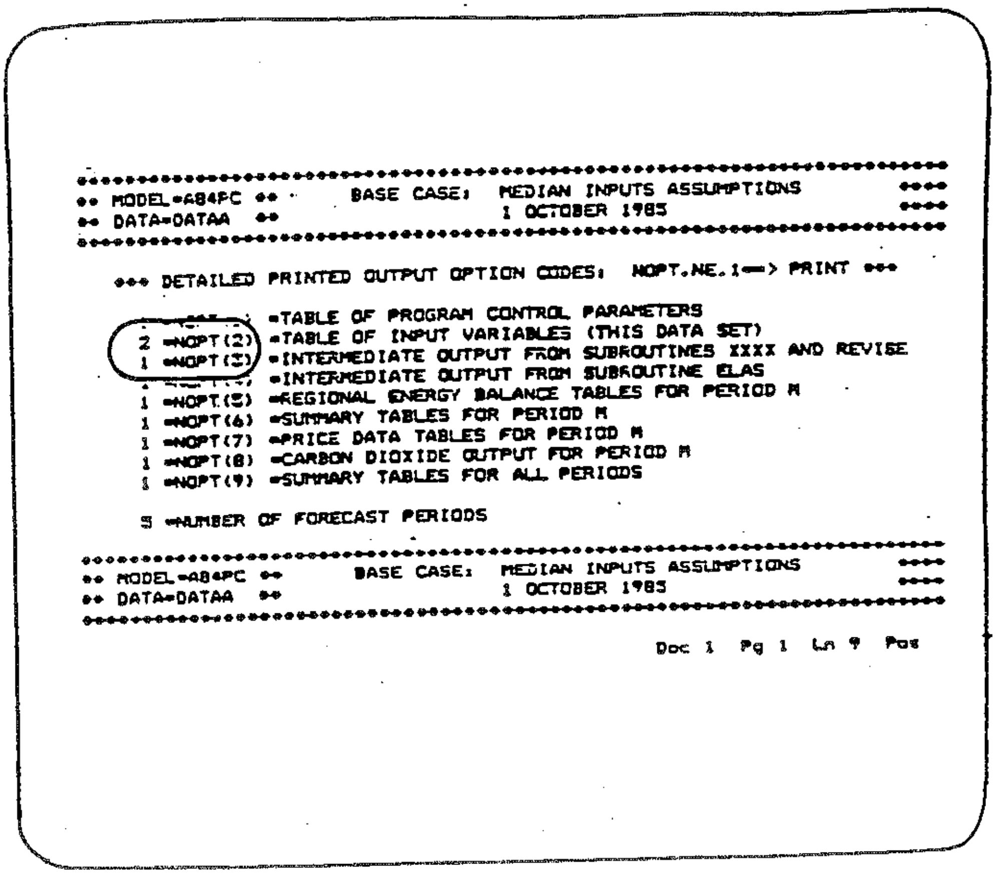


Figure 7.3. Changing "1=NOPT(1) to 2=NOPT(2)

3. Title the output. Brief comments may be included with the starred box below the NOPT tables, like "Example: Printout of Table of Input Variables" (see Figure 7.4).

```
****************************************************************************
** MODEL=A84PC **        BASE CASE:  MEDIAN INPUTS ASSUMPTIONS          ****
** DATA=DATAA  **                    1 OCTOBER 1985                     ****
****************************************************************************

  *** DETAILED PRINTED OUTPUT OPTION CODES:  NOPT.NE.1==> PRINT ***

    1 =NOPT(1)  =TABLE OF PROGRAM CONTROL PARAMETERS
    2 =NOPT(2)  =TABLE OF INPUT VARIABLES (THIS DATA SET)
    1 =NOPT(3)  =INTERMEDIATE OUTPUT FROM SUBROUTINES XXXX AND REVISE
    1 =NOPT(4)  =INTERMEDIATE OUTPUT FROM SUBROUTINE ELAS
    1 =NOPT(5)  =REGIONAL ENERGY BALANCE TABLES FOR PERIOD M
    1 =NOPT(6)  =SUMMARY TABLES FOR PERIOD M
    1 =NOPT(7)  =PRICE DATA TABLES FOR PERIOD M
    1 =NOPT(8)  =CARBON DIOXIDE OUTPUT FOR PERIOD M
    1 =NOPT(9)  =SUMMARY TABLES FOR ALL PERIODS

    5 =NUMBER OF FORECAST PERIODS

****************************************************************************
** MODEL=A84PC **   BASE CASE:  MEDIAN INPUTS ASSUMPTIONS               ****
** DATA=DATAA  **   EXAMPLE :  PRINTOUT OF TABLE OF INPUT VARIABLES     ****
****************************************************************************
```

Figure 7.4. Writing Title in Box

The printed note will appear as in Figure 7.5

```
    5 =NUMBER OF FORECAST PERIODS

****************************************************************************
** MODEL=A84PC **        BASE CASE:  MEDIAN INPUTS ASSUMPTIONS          ****
** DATA=DATAA  **   EXAMPLE :  PRINTOUT OF TABLE OF INPUT VARIABLES     ****
****************************************************************************

         PIM--INITIAL ESTIMATE OF PRICES FOR TRADED FUELS BY FUEL
              AND PERIOD
              (UNITS=1975 DOLLARS PER GJ (GIGAJOULE))

     OIL        GAS       COAL
    .1397     2.8458     .3409     TRI
   1.8398      .6256     .5121     PIM M=1
   2.6500      .8400     .6200     PIM M=2
   3.7700     1.3700     .7000     PIM M=3
   4.7400     2.2300     .8700     PIM M=4
   5.9000     3.4100    1.0600     PIM M=5
   6.7000     3.4300    1.4300     PIM M=6

  TXILM -- TRADE BARRIERS  (SCALE FACTOR APPLIED TO FUEL PRICES)

   OIL --  TXILM
   1975      2000       2025       2050       2075       2100      REGION
    .9800    1.0000     1.0000     1.0000     1.0000     1.0000    USA
   1.4800    1.4800     1.4800     1.4800     1.4800     1.4800    CANADALEUR
   1.1000    1.1000     1.1000     1.1000     1.1000     1.1000    JANZ
    .9294    1.0000     1.0000     1.0000     1.0000     1.0000    EUSSR
   1.0000    1.0000     1.0000     1.0000     1.0000     1.0000    ACENP
    .0929     .4000      .7000     1.0000     1.0000     1.0000    MIDEAST
   1.9985    1.5000     1.0000     1.0000     1.0000     1.0000    AFR
    .9945    1.0200     1.0000     1.0000     1.0000     1.0000    LA
    .8500    1.0000     1.0000     1.0000     1.0000     1.0000    S&E ASIA
```

Figure 7.5. How Title Will Appear on Printout

4. Save the changed NIEA.DAT data set.

NOTE: Saving NIEA.DAT. You may wish to refer to Chapter VI for reference figures.

5. Exit text editor.

6. Run the model.

   Type: RUNMODEL
   Press: Return key
   Result: Credits screen (Figure 7.6) appears
   Printer prints data as it is read

   Main Inputs Assumption Menu (described in Chapter IV and displayed in Figure 7.7) appears.

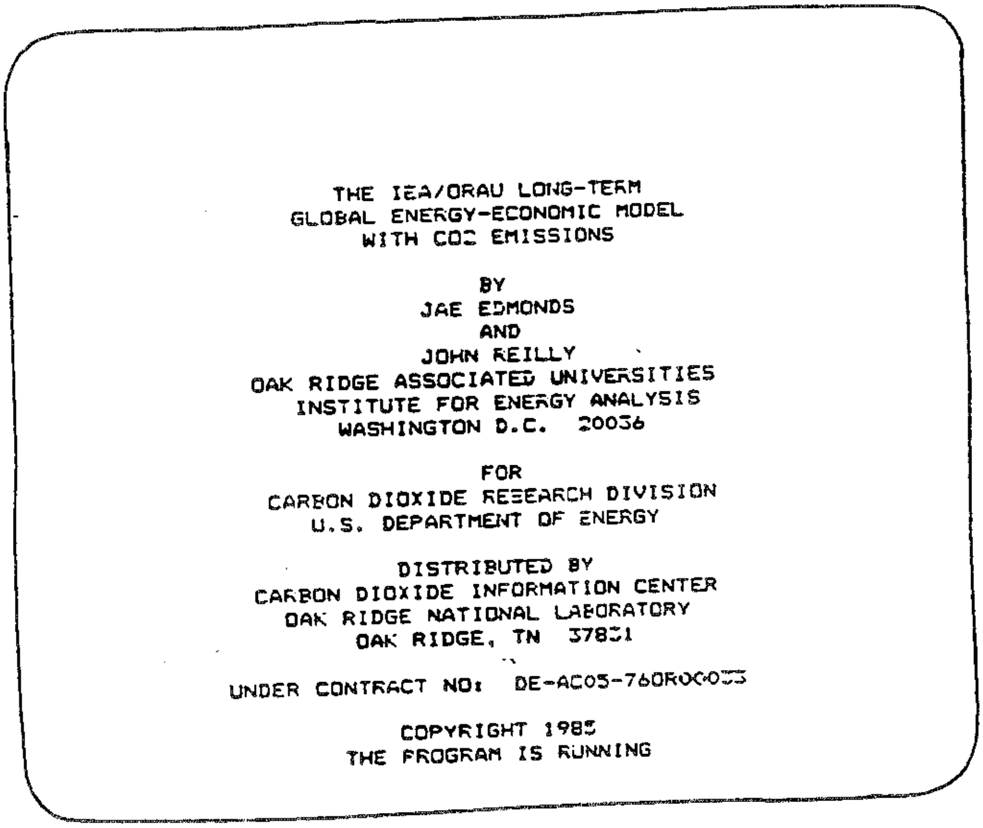


Figure 7.6. Credits Screen

```
*****************************
***                       ***
***   INPUT ASSUMPTIONS   ***
***                       ***
*****************************

THERE ARE TWELVE INPUT ASSUMPTION CATEGORIES OPEN
TO USER INSPECTION AND/OR MODIFICATION.  SELECT ONE
OF THE FOLLOWING:
           1  POPULATION
           2  LABOR PRODUCTIVITY
           3  END-USE ENERGY EFFICIENCY
           4  INCOME EFFECTS
           5  PRICE EFFECTS
           6  RESOURCE BASE
           7  TECHNOLOGICAL CHANGE IN ENERGY PRODUCTION
           8  ENVIRONMENTAL COSTS OF ENERGY PRODUCTION
           9  MARKET PENETRATION SUPPLY TECHNOLOGY
          10  SOLAR AND BIOMASS ENERGY COSTS
          11  SYNFUEL COSTS
          12  NUMBER OF FORECAST PERIODS

           0  NONE OF THE ABOVE.  RUN THE MODEL.

ENTER YOUR CHOICE, THEN PRESS RETURN =====>
```

Figure 7.7. Main Inputs Assumption Menu

Press: Return key
Result: Credits screen reappears
"Writing complete . . . stop, program terminated"
(Figure 7.8) appears

```
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               CARBON DIOXIDE RESEARCH DIVISION
                 U.S. DEPARTMENT OF ENERGY

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                OAK RIDGE NATIONAL LABORATORY
                     OAK RIDGE, TN  37831

            UNDER CONTRACT NO:  DE-AC05-760R00033

                        COPYRIGHT 1985
                    THE PROGRAM IS RUNNING


WRITING COMPLETE...


Stop - Program terminated.

C:\CO2MODEL>
```

Figure 7.8. Program Terminated

You have successfully printed the input data set for your model run.

Example 2: Printing Carbon Dioxide Output

1. Retrieve the NIEA.DAT data set

> NOTE: Retrieving NIEA.DAT. You may wish to refer to Chapter VI for reference figures.

See Figure 7.9.

```
*******************************************************************************
** MODEL=A84PC **        BASE CASE:  MEDIAN INPUTS ASSUMPTIONS              ****
** DATA=DATAA   **                   1 OCTOBER 1985                         ****
*******************************************************************************

 *** DETAILED PRINTED OUTPUT OPTION CODES:  NOPT.NE.1==> PRINT ***

   1 =NOPT(1) =TABLE OF PROGRAM CONTROL PARAMETERS
   1 =NOPT(2) =TABLE OF INPUT VARIABLES (THIS DATA SET)
   1 =NOPT(3) =INTERMEDIATE OUTPUT FROM SUBROUTINES XXXX AND REVISE
   1 =NOPT(4) =INTERMEDIATE OUTPUT FROM SUBROUTINE ELAS
   1 =NOPT(5) =REGIONAL ENERGY BALANCE TABLES FOR PERIOD M
   1 =NOPT(6) =SUMMARY TABLES FOR PERIOD M
   1 =NOPT(7) =PRICE DATA TABLES FOR PERIOD M
   1 =NOPT(8) =CARBON DIOXIDE OUTPUT FOR PERIOD M
   1 =NOPT(9) =SUMMARY TABLES FOR ALL PERIODS

   5 =NUMBER OF FORECAST PERIODS

*******************************************************************************
** MODEL=A84PC **        BASE CASE:  MEDIAN INPUTS ASSUMPTIONS              ****
** DATA=DATAA   **                   1 OCTOBER 1985                         ****
*******************************************************************************
                                              Doc 1  Pg 1  Ln 1  Pos    1
```

Figure 7.9. Printed Output Control Options

2. Change desired output option to print mode

For CO2 emissions change "1 =NOPT(8)" to "2 =NOPT(8)"

The data set should appear as in Figure 7.10.

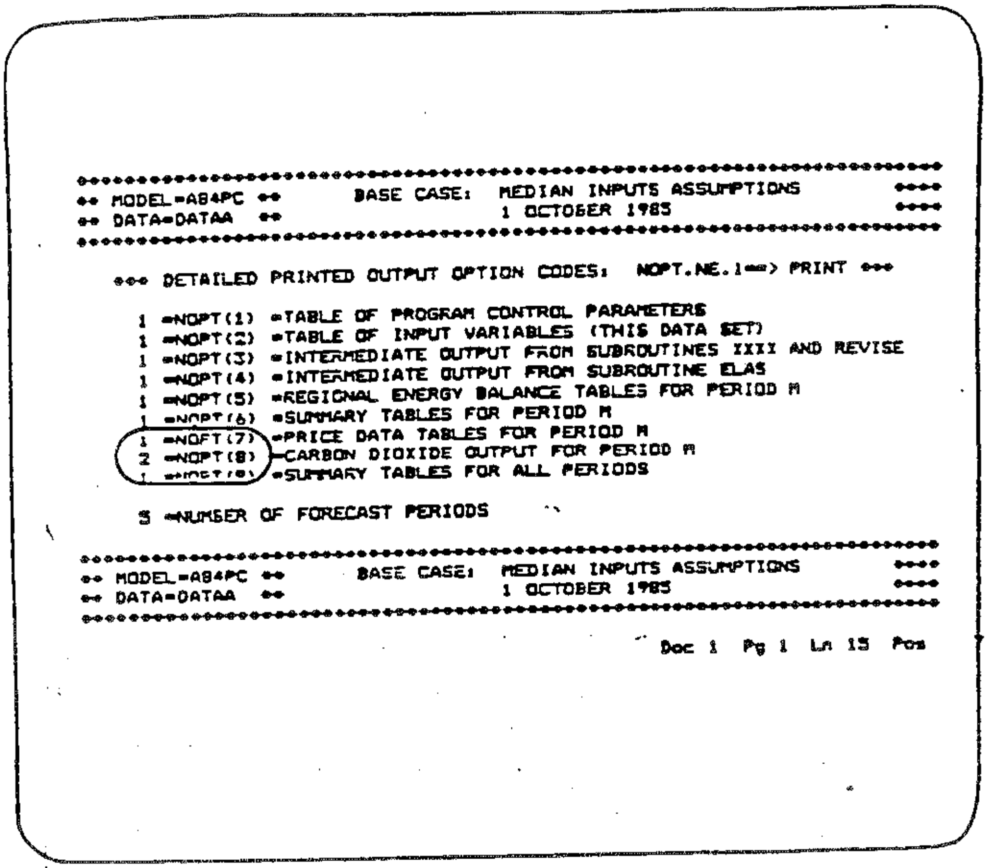


Figure 7.10. Changing "1 =NOPT(8) to "2 =NOPT(8)" for Printed Output Mode

3. We want to save the changed NIEA.DAT data set

NOTE: <u>Saving NIEA.DAT</u>. You may wish to refer to Chapter VI for reference figures.

4. Exit your text editor.

5. Run the model

Type: RUNNODEL
Press: Return key
Result: Credits Screen (Figure 7.11) appears
Main Inputs Assumption Menu (described in Chapter IV and displayed in Figure 7.12) appears.

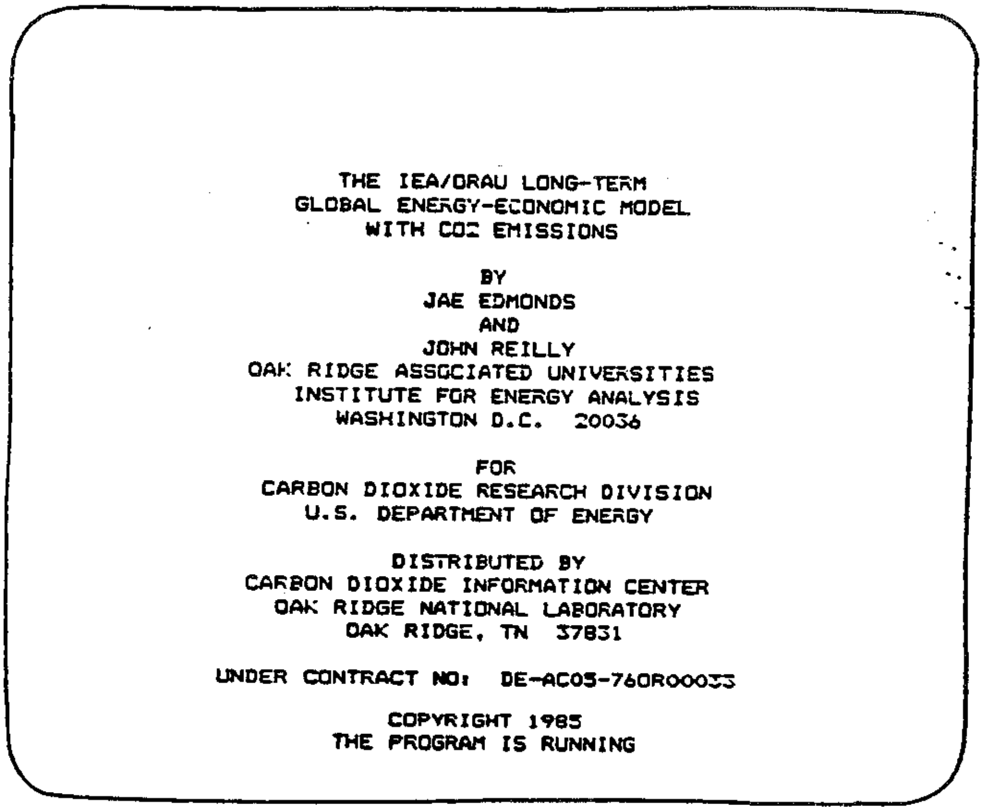


Figure 7.11. Credits Screen

```
          ******************************
          ***                        ***
          ***    INPUT ASSUMPTIONS   ***
          ***                        ***
          ******************************

 THERE ARE TWELVE INPUT ASSUMPTION CATEGORIES OPEN
 TO USER INSPECTION AND/OR MODIFICATION.  SELECT ONE
 OF THE FOLLOWING:
           1  POPULATION
           2  LABOR PRODUCTIVITY
           3  END-USE ENERGY EFFICIENCY
           4  INCOME EFFECTS
           5  PRICE EFFECTS
           6  RESOURCE BASE
           7  TECHNOLOGICAL CHANGE IN ENERGY PRODUCTION
           8  ENVIRONMENTAL COSTS OF ENERGY PRODUCTION
           9  MARKET PENETRATION SUPPLY TECHNOLOGY
          10  SOLAR AND BIOMASS ENERGY COSTS
          11  SYNFUEL COSTS
          12  NUMBER OF FORECAST PERIODS

           0  NONE OF THE ABOVE.  RUN THE MODEL.

 ENTER YOUR CHOICE, THEN PRESS RETURN =====>
```

Figure 7.12. Main Inputs Assumption Menu

Press: Return key
Result: Credits screen reappears. Output is printed. A screen message "WRITING COMPLETE ... STOP, PROGRAM TERMINATED" (Figure 7.13) appears.

```
                         FOR
          CARBON DIOXIDE RESEARCH DIVISION
             U.S. DEPARTMENT OF ENERGY

                   DISTRIBUTED BY
         CARBON DIOXIDE INFORMATION CENTER
           OAK RIDGE NATIONAL LABORATORY
                OAK RIDGE, TN  37831

      UNDER CONTRACT NO:  DE-AC05-76OR00033

                   COPYRIGHT 1985
               THE PROGRAM IS RUNNING


WRITING COMPLETE...


Stop - Program terminated.

C:\CO2MODEL>
```

Figure 7.13. Program Terminated

> NOTE: Notice that the printer begins to print after the credits screen has appeared the second time as opposed printing to after the first time the credits screen appears as in Example 1. For options NOPT(3) - NOPT(9), printing begins during the second credit screen appearance.

We have successfully printed the detailed output for Carbon Dioxide Emissions and may examine the output when the printer has stopped. The output should look like Table 7.1.

TABLE 7.1. PRINTED OUTPUT FOR CO_2 EMISSIONS

1975 CO2 EMISSIONS REPORT
****

CO2 EMISSIONS BY REGION AND PRIMARY ENERGY SOURCE
UNITS: 10**6 TONNES OF CARBON

REGION	CONV OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
USA	384.	0.	0.	408.	0.	265.	1056.
W EUR + CAN	87.	0.	0.	228.	0.	116.	431.
OECD PACIFIC	17.	0.	0.	63.	0.	4.	85.
USSR/E. EUR.	408.	0.	0.	612.	0.	160.	1179.
CHINA/ET.AL.	59.	0.	0.	356.	0.	2.	417.
MIDDLE EAST	717.	0.	0.	1.	0.	15.	733.
AFRICA	202.	0.	0.	52.	0.	5.	259.
LATIN AMER	182.	0.	0.	9.	0.	14.	205.
S.&E. ASIA	69.	0.	0.	64.	0.	10.	142.
ALL REGIONS	2125.	0.	0.	1792.	0.	590.	4507.

2000 CO2 EMISSIONS REPORT
****

CO2 EMISSIONS BY REGION AND PRIMARY ENERGY SOURCE
UNITS: 10**6 TONNES OF CARBON

REGION	CONV OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
USA	0.	0.	0.	0.	0.	51.	51.
W EUR + CAN	255.	0.	0.	0.	0.	89.	344.
OECD PACIFIC	0.	0.	0.	0.	0.	11.	11.
USSR/E. EUR.	434.	0.	17.	1461.	0.	394.	2307.
CHINA/ET.AL.	192.	0.	0.	1294.	0.	7.	1492.
MIDDLE EAST	804.	0.	0.	3.	0.	22.	829.
AFRICA	555.	0.	3.	223.	0.	6.	786.
LATIN AMER	459.	0.	0.	40.	0.	46.	547.
S.&E. ASIA	47.	0.	0.	260.	0.	29.	335.
ALL REGIONS	2745.	0.	20.	3281.	0.	654.	6701.

2025 CO2 EMISSIONS REPORT
****

CO2 EMISSIONS BY REGION AND PRIMARY ENERGY SOURCE
UNITS: 10**6 TONNES OF CARBON

REGION	CONV OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
USA	1.	1.	0.	0.	0.	143.	145.
W EUR + CAN	636.	1.	0.	0.	0.	212.	849.
OECD PACIFIC	1.	1.	0.	0.	0.	33.	34.
USSR/E. EUR.	1013.	1.	231.	2681.	3.	594.	4523.
CHINA/ET.AL.	177.	1.	162.	1857.	2.	27.	2226.
MIDDLE EAST	506.	1.	0.	0.	0.	124.	631.
AFRICA	555.	1.	20.	221.	0.	30.	828.
LATIN AMER	480.	1.	5.	52.	0.	239.	776.
S.&E. ASIA	121.	1.	0.	0.	0.	120.	242.
ALL REGIONS	3491.	9.	418.	4811.	5.	1521.	10255.

TABLE 7.1. PRINTED OUTPUT FOR CO_2 EMISSIONS (Cont'd)

2050 CO2 EMISSIONS REPORT
****

CO2 EMISSIONS BY REGION AND PRIMARY ENERGY SOURCE
UNITS: 10**6 TONNES OF CARBON

REGION	CONV OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
USA	2.	4.	0.	0.	0.	375.	381.
W EUR + CAN	169.	3.	0.	0.	0.	188.	360.
OECD PACIFIC	2.	4.	0.	0.	0.	57.	62.
USSR/E. EUR.	479.	3.	1121.	4500.	64.	627.	6795.
CHINA/ET.AL.	168.	3.	564.	2233.	32.	97.	3098.
MIDDLE EAST	1839.	4.	0.	1.	0.	569.	2412.
AFRICA	487.	4.	100.	383.	5.	130.	1109.
LATIN AMER	401.	3.	18.	69.	1.	180.	672.
S.&E. ASIA	36.	3.	0.	1.	0.	30.	70.
ALL REGIONS	3583.	31.	1803.	7187.	103.	2253.	14958.

2075 CO2 EMISSIONS REPORT
****

CO2 EMISSIONS BY REGION AND PRIMARY ENERGY SOURCE
UNITS: 10**6 TONNES OF CARBON

REGION	CONV OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
USA	3.	7.	0.	0.	0.	169.	179.
W EUR + CAN	117.	5.	0.	0.	0.	0.	122.
OECD PACIFIC	3.	6.	0.	0.	0.	0.	9.
USSR/E. EUR.	52.	6.	2833.	5789.	504.	0.	9184.
CHINA/ET.AL.	0.	7.	1563.	3146.	274.	163.	5152.
MIDDLE EAST	1703.	10.	1.	1.	0.	1091.	2806.
AFRICA	397.	10.	221.	433.	38.	395.	1494.
LATIN AMER	0.	8.	46.	92.	8.	0.	153.
S.&E. ASIA	87.	8.	1.	1.	0.	24.	121.
ALL REGIONS	2362.	67.	4663.	9462.	824.	1843.	19221.

DETAILED DISCUSSION OF PRINTED OUTPUT

Having worked through two examples in which detailed output was printed, we examine the detailed printed output options more closely.

Detailed Printed Output Option Codes

The detailed printed output option codes are displayed in Figure 7.14. Nine choices are available to the user.

To print an option set the appropriate NOPT to equal "2."

> NOTE: Changing NIEA.DAT. Remember that when you change a value in the NIEA.DAT data set, that change will remain for all future runs of the model. Thus, if you change an NOPT() code to the printing mode, detailed printed output will be printed every time you run the model unless you change it back again.

The detailed printed output options are summarized in Table 7.2 and displayed in Tables 7.3 - 7.11.

```
************************************************************************
** MODEL=AB4PC **       BASE CASE:  MEDIAN INPUTS ASSUMPTIONS      ****
** DATA=DATAA   **                  1 OCTOBER 1985                 ****
************************************************************************

   *** DETAILED PRINTED OUTPUT OPTION CODES:  NOPT.NE.1==> PRINT ***

      1 =NOPT(1)  =TABLE OF PROGRAM CONTROL PARAMETERS
      1 =NOPT(2)  =TABLE OF INPUT VARIABLES (THIS DATA SET)
      1 =NOPT(3)  =INTERMEDIATE OUTPUT FROM SUBROUTINES XXXX AND REVISE
      1 =NOPT(4)  =INTERMEDIATE OUTPUT FROM SUBROUTINE ELAS
      1 =NOPT(5)  =REGIONAL ENERGY BALANCE TABLES FOR PERIOD M
      1 =NOPT(6)  =SUMMARY TABLES FOR PERIOD M
      1 =NOPT(7)  =PRICE DATA TABLES FOR PERIOD M
      1 =NOPT(8)  =CARBON DIOXIDE OUTPUT FOR PERIOD M
      1 =NOPT(9)  =SUMMARY TABLES FOR ALL PERIODS

      5 =NUMBER OF FORECAST PERIODS

************************************************************************
** MODEL=AB4PC **       BASE CASE:  MEDIAN INPUTS ASSUMPTIONS      ****
** DATA=DATAA   **                  1 OCTOBER 1985                 ****
************************************************************************
                                       Doc 1  Pg 1  Ln 1  Pos       1
```

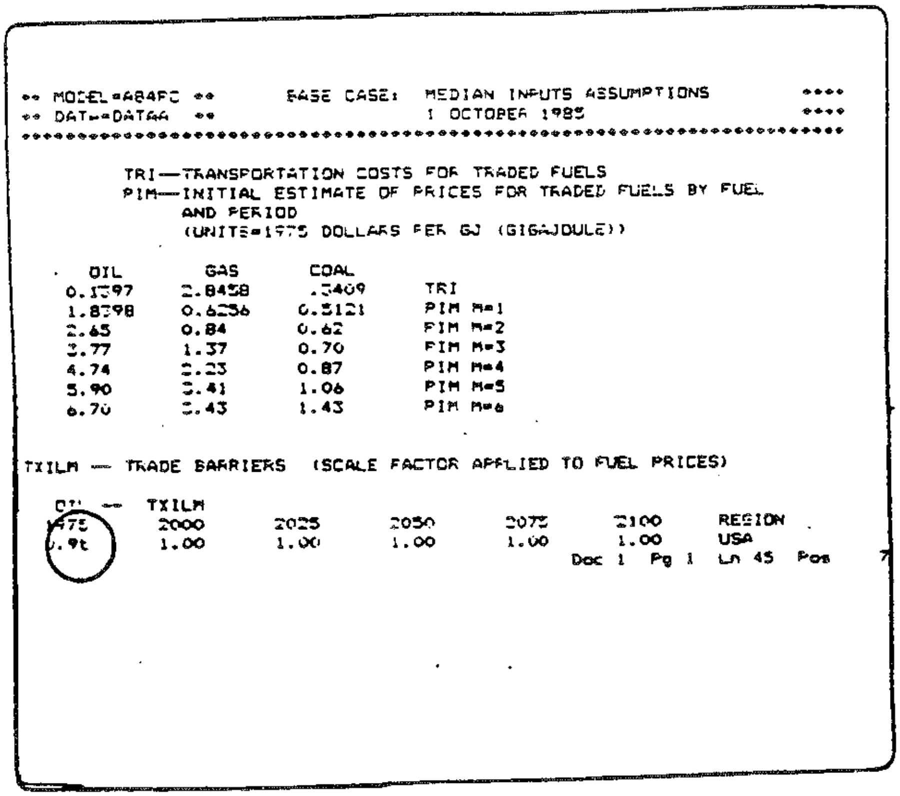
Figure 7.14. Detailed Printed Output Option Codes

TABLE 7.2. SUMMARY OF DETAILED PRINTED OUTPUT OPTIONS

Output Option Code	Title	Description
NOPT(1)	Table of Program Control Parameters (See Table 7.3)	Prints variables within the detailed structure of the model and the values they take on. These values cannot be changed by the user.
NOPT(2)	Table of Input Variables (this data set) (See Table 7.4)	Shadow prints the input file as it is read. We may wish to use this option: 1. For a complete record 2. If an error arises in running the program and we had changed a data element, NOPT(2) can be used to find an error that results from problems of reading the data.

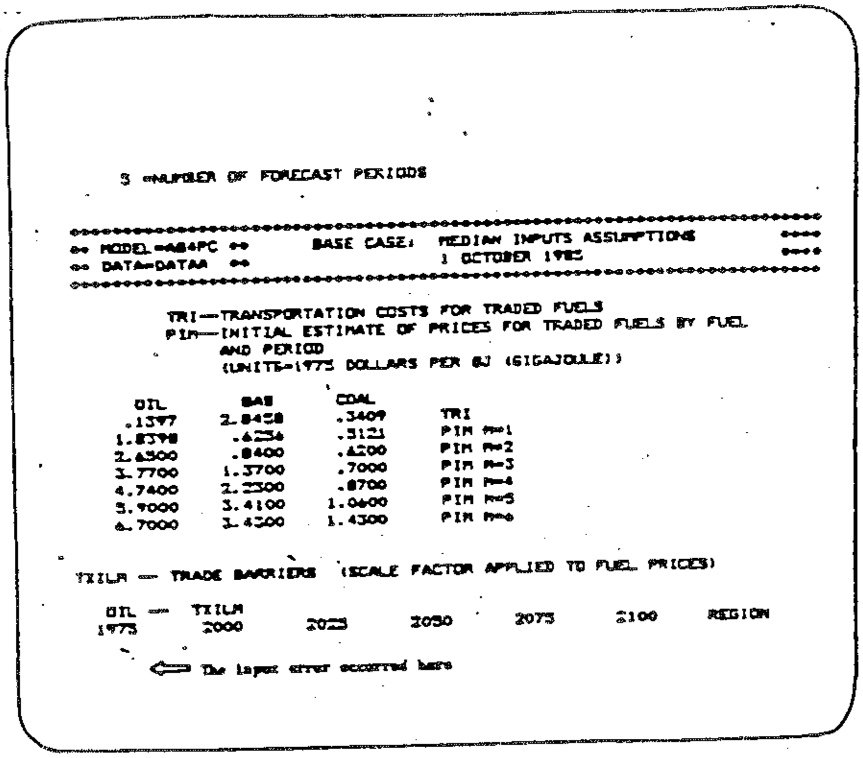
NOTE: The starred box. Below the Detailed Printed Outputs Options Codes is a box formed by asterisks. This box will be the heading of the Table of Input Variables. We may make changes within this box.

NOTE: NOPT(2): Examples of Use. Example 1 at the beginning of the chapter demonstrates how NOPT(2) can be used for a complete record. NOPT(2) can also be used to catch errors.
Case 1: We have accidentally typed "T" instead of "6" for a TXILM input variable. In other words, we have entered an alpha numeric character in a space specified for numeric characters. (Figure 7.15a) This will cause an error when the program tries to read the inputs. By using NOPT(2), we can shadow print the inputs as the model reads them so the printing will stop where the error occurs. By examining the printed output (Figure 7.15b), we can determine where to look to find and correct the error.
Case 2: We have pressed the return key and thus inserted an extra line between "5=number of forecast periods" and the starred box that will be the heading of the output. This pushes the other inputs down a line, forcing alphanumeric characters into spaces designated for numeric characters. By examining the printed output (Figure 7.16) we can see that the error was in the alphanumeric inputs.



```
** MODEL=AB4PC **        BASE CASE:   MEDIAN INPUTS ASSUMPTIONS          ****
** DATA=DATAA  **                     1 OCTOBER 1985                     ****
****************************************************************************

        TRI—TRANSPORTATION COSTS FOR TRADED FUELS
        PIM—INITIAL ESTIMATE OF PRICES FOR TRADED FUELS BY FUEL
             AND PERIOD
             (UNITS=1975 DOLLARS PER GJ (GIGAJOULE))

     OIL        GAS        COAL
   0.1397     2.8458      .3409       TRI
   1.8398     0.6256     0.5121       PIM M=1
   2.65       0.84       0.62         PIM M=2
   3.77       1.37       0.70         PIM M=3
   4.74       2.23       0.87         PIM M=4
   5.90       3.41       1.06         PIM M=5
   6.70       3.43       1.43         PIM M=6

TXILM — TRADE BARRIERS  (SCALE FACTOR APPLIED TO FUEL PRICES)

   OIL —  TXILM
   1975    2000      2025      2050      2075      2100      REGION
   .9t     1.00      1.00      1.00      1.00      1.00      USA
                                         Doc 1  Pg 1  Ln 45  Pos 7
```

Figure 7.15a. Typing a "T" Instead of a "6"



```
     5 =NUMBER OF FORECAST PERIODS

****************************************************************************
** MODEL=AB4PC **        BASE CASE:   MEDIAN INPUTS ASSUMPTIONS          ****
** DATA=DATAA  **                     1 OCTOBER 1985                     ****
****************************************************************************

        TRI—TRANSPORTATION COSTS FOR TRADED FUELS
        PIM—INITIAL ESTIMATE OF PRICES FOR TRADED FUELS BY FUEL
             AND PERIOD
             (UNITS=1975 DOLLARS PER GJ (GIGAJOULE))

     OIL        GAS        COAL
    .1397     2.8458      .3409       TRI
   1.8398      .6256      .5121       PIM M=1
   2.6500      .8400      .6200       PIM M=2
   3.7700     1.3700      .7000       PIM M=3
   4.7400     2.2300      .8700       PIM M=4
   5.9000     3.4100     1.0600       PIM M=5
   6.7000     3.4300     1.4300       PIM M=6

TXILM — TRADE BARRIERS  (SCALE FACTOR APPLIED TO FUEL PRICES)

   OIL —  TXILM
   1975    2000      2025      2050      2075      2100      REGION

       <== The input error occurred here
```

Figure 7.15b. Using NOPT(2) Shadow Printing to Catch the Error

```
    5 =NUMBER OF FORECAST PERIODS
                                         <== Extra line inserted here

*******************************************************************************
** MODEL=A84PC **      BASE CASE:  MEDIAN INPUTS ASSUMPTIONS               ****
** DATA=DATAA  **                  1 OCTOBER 1985                          ****
*******************************************************************************

          TRI--TRANSPORTATION COSTS FOR TRADED FUELS
          PIM--INITIAL ESTIMATE OF PRICES FOR TRADED FUELS BY FUEL
               AND PERIOD
               (UNITS=1975 DOLLARS PER GJ (GIGAJOULE))
```

Figure 7.16. Printed Output for Case 2

TABLE 7.2. SUMMARY OF DETAILED PRINTED OUTPUT OPTIONS (Continued)

Output Option Code	Title	Description
NOPT(3)	Intermediate Output from Subroutines XXXX and Revise (See Table 7.5)	Prints intermediate output concerning the number of iterations of the equilibrium price search process, prices and supply and demand. This option is a debugging tool and most likely will not be printed by the user.
NOPT(4)	Intermediate Output from Subroutine ELAS (See Table 7.6)	Prints intermediate values for the global price elasticties of demand for oil, gas, and coal. This option is a debugging tool and most likely will not be printed by the user.
NOPT(5)	Regional Energy Balance Tables for Period M (See Table 7.7)	Prints tables for each period and each region for energy supply, primary energy demand, and secondary energy demand.
NOPT(6)	Summary Tables for Period M (See Table 7.8)	Prints tables for each period and each region for primary energy demand, primary energy supply, secondary energy demand, refinable energy demand, refinable energy supply, imports, electricity demand, electricity supply, and synfuel production, all by region and type of energy source. Includes table on energy use per dollar GNP and per capita.
NOPT(7)	Price Data Tables for Period M (See Table 7.9)	Prints, for each period, the Energy Price Report composed of tables for primary energy prices, electric power generation costs, and secondary energy prices.
NOPT(8)	Carbon Dioxide Output for Period M (See Table 7.10)	Prints, for each period, the CO_2 Emissions Report, a table detailing CO_2 emissions by region & source.

TABLE 7.2. SUMMARY OF DETAILED PRINTED OUTPUT OPTIONS (Continued)

Output Option Code	Title	Description
NOPT(9)	Summary Tables for All Period (See Table 7.11)	Prints tables of primary energy demand, primary energy supply, secondary energy demand, conservation and non-electric solar, refinable energy demand, refinable energy supply, synfuel production, imports, electricity demand, electricity supply, energy use per capita and per dollar GNP, and carbon emissions, all by region and period.

TABLE 7.3. PROGRAM CONTROL PARAMETERS (2=NOPT(1)

PROGRAM CONTROL PARAMETERS

---INITIALIZED IN SUBROUTINE NSET---

NFF	= 2	NUMBER OF SYNFUELS
NF	= 3	NUMBER OF FOSSIL FUELS
NI	= 6	NUMBER OF PRIMARY ENERGY TYPES
NIG	= 5	NUMBER OF RESOURCE GRADES FOR FOSSIL FUELS AND URANIUM
NIM	= 2	NUMBER OF BIOMASS TYPES
NIP	= 4	NUMBER OF BIOMASS SUPPLY SCHEDULE SEGMENTS
NIS	= 4	NUMBER OF RESOURCE CONSTRAINED FUELS
NNIS	= 5	NIS PLUS ONE FOR NUCLEAR POWER
NJ	= 4	NUMBER OF SECONDARY ENERGY TYPES
NJUMP	= 25	NUMBER OF YEARS BETWEEN PERIODS
NKMAX	= 3	MAXIMUM NUMBER OF END-USE SECTORS
NKKMAX	= 4	MAXIMUM NUMBER OF END-USE SECTORS PLUS UTILITIES
NL	= 9	NUMBER OF REGIONS
NM	= 5	NUMBER OF FORECAST PERIODS
NMREAD	= 6	NUMBER OF PERIODS READ IN INPUT
NMKT	= 3	NUMBER OF INTERNATIONAL MARKETS
NU	= 5	NUMBER OF COMPETING FUELS IN ELECTRIC GENERATION
NCO2	= 8	NUMBER OF CO2 EMISSION CATEGORIES
MAXAGN	= 75	MAXIMUM NUMBER OF ITERATIONS PER PERIOD
TEST	= .0047	CONVERGENCE TEST VALUE

END USE SECTORS

REGION	FINAL DEMAND SECTORS	PLUS UTILITIES
USA	3	4
CANADA & EUR	3	4
OECD PACIFIC	3	4
USSRE/. EUR.	1	2
CHINA/ET.AL.	1	2
MIDDLE EAST	1	2
AFRICA	1	2
LATIN AMER	1	2
S.&E. ASIA	1	2

TABLE 7.4. INPUT VARIABLES
(2=NOPT(2)

5 =NUMBER OF FORECAST PERIODS

```
************************************************************************
** MODEL=AB4PC **       BASE CASE:  MEDIAN INPUTS ASSUMPTIONS        ****
** DATA=DATAA  **                   1 OCTOBER 1985                   ****
************************************************************************
```

TRI--TRANSPORTATION COSTS FOR TRADED FUELS
PIM--INITIAL ESTIMATE OF PRICES FOR TRADED FUELS BY FUEL AND PERIOD
(UNITS=1975 DOLLARS PER GJ (GIGAJOULE))

OIL	GAS	COAL	
.1397	2.8458	.3409	TRI
1.8398	.6256	.5121	PIM M=1
2.6500	.8400	.6200	PIM M=2
3.7700	1.3700	.7000	PIM M=3
4.7400	2.2300	.8700	PIM M=4
5.9000	3.4100	1.0600	PIM M=5
6.7000	3.4300	1.4300	PIM M=6

TXILM -- TRADE BARRIERS (SCALE FACTOR APPLIED TO FUEL PRICES)

OIL -- TXILM

1975	2000	2025	2050	2075	2100	REGION
.9800	1.0000	1.0000	1.0000	1.0000	1.0000	USA
1.4800	1.4800	1.4800	1.4800	1.4800	1.4800	CANADA&EUR
1.1000	1.1000	1.1000	1.1000	1.1000	1.1000	JANZ
.9294	1.0000	1.0000	1.0000	1.0000	1.0000	EUSSR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	ACENP
.0929	.4000	.7000	1.0000	1.0000	1.0000	MIDEAST
1.9983	1.5000	1.0000	1.0000	1.0000	1.0000	AFR
.9945	1.0200	1.0000	1.0000	1.0000	1.0000	LA
.8500	1.0000	1.0000	1.0000	1.0000	1.0000	S&E ASIA

GAS -- TXILM

1975	2000	2025	2050	2075	2100	REGION
.1802	1.0000	1.0000	1.0000	1.0000	1.0000	USA
1.8000	1.8000	1.4000	1.2000	1.2000	1.2000	CANADA&EUR
1.8400	1.5500	1.2500	1.0000	1.0000	1.0000	JANZ
.1802	1.0000	1.0000	1.0000	1.0000	1.0000	EUSSR
.1802	1.0000	1.0000	1.0000	1.0000	1.0000	ACENP
.0901	.7000	.8500	1.0000	1.0000	1.0000	MIDEAST
.1802	1.0000	1.0000	1.0000	1.0000	1.0000	AFR
.1802	1.0000	1.0000	1.0000	1.0000	1.0000	LA
.1802	1.0000	1.0000	1.0000	1.0000	1.0000	S&E ASIA

COAL -- TXILM

1975	2000	2025	2050	2075	2100	REGION
.6004	1.0000	1.0000	1.0000	1.0000	1.0000	USA
2.0700	2.0700	1.7500	1.5000	1.5000	1.5000	CANADA&EUR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	JANZ
.6124	1.0000	1.0000	1.0000	1.0000	1.0000	EUSSR
.6004	1.0000	1.0000	1.0000	1.0000	1.0000	ACENP
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	MIDEAST
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	AFR
1.0800	1.0400	1.0000	1.0000	1.0000	1.0000	LA
1.0800	1.0400	1.0000	1.0000	1.0000	1.0000	S&E ASIA

TABLE 7.4. INPUT VARIABLES (Continued)
(2=NOPT(2)

TXJLM -- ENERGY TAXES ON FINAL CONSUMPTION BY FUEL, REGION AND PERIOD

OIL -- TXJLM

1975	2000	2025	2050	2075	2100	REGION
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	USA
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	CANADA&EUR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	JANZ
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	EUSSR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	ACENP
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	MIDEAST
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	AFR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	LA
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	S&E ASIA

GAS -- TXJLM

1975	2000	2025	2050	2075	2100	REGION
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	USA
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	CANADA&EUR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	JANZ
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	EUSSR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	ACENP
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	MIDEAST
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	AFR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	LA
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	S&E ASIA

COAL -- TXJLM

1975	2000	2025	2050	2075	2100	REGION
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	USA
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	CANADA&E
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	JANZ
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	EUSSR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	ACENP
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	MIDEAST
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	AFR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	LA
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	S&E ASIA

ELECTRICITY -- TXJLM

1975	2000	2025	2050	2075	2100	REGION
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	USA
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	CANADA&EUR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	JANZ
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	EUSSR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	ACENP
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	MIDEAST
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	AFR
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	LA
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	S&E ASIA

POPULATION (ZLM)
UNITS=THOUSANDS OF PERSONS

1950	1975	2000	2025	2050	2075	2100	
152271.	214000.	254000.	282000.	288000.	292000.	292000.	USA
300245.	405000.	476000.	528000.	553000.	562000.	562000.	CAN&WE
96307.	128000.	154000.	164000.	167000.	169000.	169000.	JANZ
286136.	395000.	472000.	516000.	533000.	541000.	541000.	EUSSR
590509.	911000.	1248000.	1499000.	1612000.	1647000.	1647000.	ACENP
39048.	81000.	147000.	199000.	232000.	241000.	241000.	MIDEAS
222039.	399000.	697000.	943000.	1101000.	1150000.	1150000.	AFR
165764.	313000.	540000.	718000.	823000.	849000.	849000.	LA
652760.	1130000.	1904000.	2515000.	2888000.	2995000.	2995000.	SE-SIA

TABLE 7.4. INPUT VARIABLES (Continued) (2=NOPT(2)

LABOR PRODUCTIVITY GROWTH RATE (UNITS=ANNUAL RATE)
AND BASE GNP (UNITS=MILLIONS 1975 US DOLLARS)

LABOR PRODUCTIVITY	BASE GNP	
.017	1519890.	USA
.017	1817860.	WEUR&CAN
.017	586400.	JANZ
.017	966400.	EUSSR
.029	323600.	ASENP
.029	138410.	MIDEAST
.029	154690.	AFR
.029	315490.	LA
.029	233620.	SEASIA

REFINERY COEFFICIENTS (GIJ AND HIJ)
"GIJ" IS A CONVERSION EFFICIENCY, THE RATIO OF JOULES OF PRIMARY ENERGY IN TO JOULES OF ENERGY PRODUCT OUT (EXCLUSIVE OF FUELS USED AS ENERGY BY THE REFINERY). IT IS APPROXIMATED AS 1.
"HIJ" IS A MARK-UP COST, ACCOUNTING FOR COST OF REFINING AND DISTRIBUTING ENERGY PRODUCTS.

OIL		GAS		COAL	
GIJ	HIJ	GIJ	HIJ	GIJ	HIJ
1.0000	1.4250	1.0000	.3487	1.0000	.2600

ELECTRICITY GENERATION COEFFICIENTS (GUI, HUIL, AND RUI)
"GUI" IS A GENERATION EFFICIENCY COEFFICIENT -- THE RATIO OF JOULES OF ENERGY IN TO JOULES OF ELECTRICITY OUT. BY DEFINITION, GUI=1 FOR NUCLEAR, HYDRO, AND SOLAR.
"HUIL" REFLECTS NONENERGY COSTS IN 1975 DOLLARS PER GJ.
"RUI" IS A LOGIT SUBSTITUTION PARAMETER GOVERNING THE RESPONSE OF UTILITIES TO PRICE INCREASES FOR A GIVEN TECHNOLOGY -- HYDRO ENTERS AS A FIXED AMOUNT.

FUEL						PARAMETER
OIL	GAS	COAL	NUCLEAR	SOLAR	HYDRO	
3.6580	3.6580	3.3250	1.0970	1.0970	1.0970	GUI
4.5330	4.5052	6.8660	1.7000	1.7000	1.7000	HUIL L=1
4.5330	4.5052	6.8660	1.7000	1.7000	1.7000	HUIL L=2
4.5330	4.5052	6.8660	1.7000	1.7000	1.7000	HUIL L=3
4.5330	4.5052	5.8630	1.7000	1.7000	1.7000	HUIL L=4
4.5330	4.5052	5.8630	1.7000	1.7000	1.7000	HUIL L=5
4.5330	4.5052	5.8630	1.7000	1.7000	1.7000	HUIL L=6
4.5330	4.5052	5.8630	1.7000	1.7000	1.7000	HUIL L=7
4.5330	4.5052	5.8630	1.7000	1.7000	1.7000	HUIL L=8
4.5330	4.5052	5.8630	1.7000	1.7000	1.7000	HUIL L=9
-3.0000	-3.0000	-3.0000	-3.0000	-3.0000		RUI

PAUIL -- ELECTRICITY GENERATION COEFFICIENTS
(PAUIL IS A MULTIPLICATIVE FACTOR WHICH ADJUSTS THE REFINED FOSSILE FUEL PRICE TO ACCOUNT FOR DIFFERENT FUEL TYPE (E.G. RESIDUAL US GASOLINE) AND DISTRIBUTION COSTS.)

FUEL			
LIQUID	GAS	SOLID	REGION
.4850	.7330	1.0000	US
.5747	.6195	.8293	WEUR+CAN
.5243	.9595	1.0000	OECD PAC
.4000	1.0000	1.0000	EUSSR
.4000	1.0000	1.0000	ACENP
1.0595	1.0000	1.0000	MIDEAST
.4185	1.0000	1.0000	AFRICA
.4013	1.0000	1.0000	L AMER
.6059	1.0000	1.0000	S&E ASIA

1975

OIL	GAS	COAL	NUCLEAR	SOLAR	REGION
.0915	.0274	.2000	.0346	.0253	US
.1680	.0694	.2000	.0192	.0172	WEUR+CAN
.1937	.2000	.0458	.0082	.0056	OECD PAC
.1157	.0565	.2000	.0060	.0060	EUSSR
.0547	.0074	.2000	.0000	.0011	ACENP
.2000	.0408	.0000	.0001	.0000	MIDEAST
.1851	.0128	.2000	.0000	.0009	AFRICA
.2000	.0453	.0319	.0080	.0061	L AMER
.1158	.0007	.2000	.0039	.0036	S&E ASIA

BSUILM: YEAR 2000

OIL	GAS	COAL	NUCLEAR	SOLAR	REGION
.0181	.0288	.2000	.0702	.0651	US
.1403	.0542	.2000	.0718	.0458	WEUR+CAN
.2000	.0667	.1178	.0433	.0347	OECD PAC
.2000	.1359	.2000	.0373	.0370	EUSSR
.1346	.0082	.2000	.0161	.0062	ACENP
.2000	.1102	.0200	.0045	.0045	MIDEAST
.2000	.0276	.2000	.0148	.0134	AFRICA
.2000	.1174	.0951	.0428	.0376	L AMER
.1600	.0118	.2000	.0291	.0280	S&E ASIA

BSUILM: YEAR 2025

OIL	GAS	COAL	NUCLEAR	SOLAR	REGION
.0850	.1274	.2000	.1754	.2000	US
.2000	.2000	.2000	.2000	.2000	WEUR+CAN
.2000	.2000	.2000	.2000	.2000	OECD PAC
.2000	.2000	.2000	.2000	.2000	EUSSR
.2000	.1000	.2000	.2000	.0353	ACENP
.2000	.2000	.1000	.2000	.2000	MIDEAST
.2000	.2000	.2000	.2000	.2000	AFRICA
.2000	.2000	.2000	.2000	.2000	L AMER
.2000	.2000	.2000	.2000	.2000	S&E ASIA

BSUILM: YEAR 2050

OIL	GAS	COAL	NUCLEAR	SOLAR	REGION
.1275	.2000	.2000	.2000	.2000	US
.2000	.2000	.2000	.2000	.2000	WEUR+CAN
.2000	.2000	.2000	.2000	.2000	OECD PAC
.2000	.2000	.2000	.2000	.2000	EUSSR
.2000	.2000	.2000	.2000	.2000	ACENP
.2000	.2000	.1000	.2000	.2000	MIDEAST
.2000	.2000	.2000	.2000	.2000	AFR
.2000	.2000	.2000	.2000	.2000	L AMER
.2000	.2000	.2000	.2000	.2000	S&E ASIA

BSUILM: YEAR 2075

OIL	GAS	COAL	NUCLEAR	SOLAR	REGION
.1275	.2000	.2000	.2000	.2000	US
.2000	.2000	.2000	.2000	.2000	WEUR+CAN
.2000	.2000	.2000	.2000	.2000	OECD PAC
.2000	.2000	.2000	.2000	.2000	EUSSR
.2000	.2000	.2000	.2000	.2000	ACENP
.2000	.2000	.1000	.2000	.2000	MIDEAST
.2000	.2000	.2000	.2000	.2000	AFR
.2000	.2000	.2000	.2000	.2000	L AMER
.2000	.2000	.2000	.2000	.2000	S&E ASIA

TABLE 7.4. INPUT VARIABLES (Continued)
(2=NOPT(2)

BSUILM: YEAR 2100

OIL	GAS	COAL	NUCLEAR	SOLAR	REGION
.1275	.2000	.2000	.2000	.2000	US
.2000	.2000	.2000	.2000	.2000	WEUR+CAN
.2000	.2000	.2000	.2000	.2000	OECD PAC
.2000	.2000	.2000	.2000	.2000	EUSSR
.2000	.2000	.2000	.2000	.2000	ACENP
.2000	.2000	.1000	.2000	.2000	MIDEAST
.2000	.2000	.2000	.2000	.2000	AFR
.2000	.2000	.2000	.2000	.2000	L AMER
.2000	.2000	.2000	.2000	.2000	S&E ASIA

THL--RATE OF END-USE ENERGY EFFICIENCY IMPROVEMENT BY SECTOR
AND REGION
UNITS=NONE

OECD REGIONS

RES/COM	INDUSTRY	TRANSPORT	REGION
.0100	.0100	.0100	1=USA
.0100	.0100	.0100	2=WEUR+CAN
.0100	.0100	.0100	3=OECD PAC

NON-OECD REGIONS

ALL SECTORS	REGION
.0100	4=EUSSR
.0100	5=ACENP
.0100	6=MIDEAST
.0100	7=AFRICA
.0100	8=L AMER
.0100	9=S&E ASIA

RIGISL--RESOURCES BY GRADE AND REGION
(UNITS=EXAJOULES)

GRADE: IG=1

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
77.	670.	7964.	4691.	109.	1=USA
100.	434.	2459.	2142.	200.	2=WEUR+CAN
3.	70.	1891.	1564.	97.	3=OECD PAC
190.	1324.	13536.	4294.	267.	4=EUSSR
62.	178.	4054.	2147.	128.	5=ACENP
400.	1054.	2.	537.	2.	6=MIDEAST
180.	346.	607.	6411.	442.	7=AFRICA
159.	366.	121.	3205.	1010.	8=L AMER
29.	160.	365.	1610.	21.	9=S&E ASIA

GRADE: IG=2

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
221.	227.	9763.	9170.	584.	1=USA
290.	179.	3015.	4188.	1068.	2=WEUR+CAN
9.	29.	2718.	3057.	518.	3=OECD PAC
550.	547.	16592.	8397.	1426.	4=EUSSR
151.	73.	4970.	4197.	682.	5=ACENP
1000.	435.	2.	1049.	12.	6=MIDEAST
436.	142.	745.	12532.	2356.	7=AFRICA
384.	151.	148.	6266.	5388.	8=L AMER
70.	66.	447.	3148.	113.	9=S&E ASIA

TABLE 7.4. INPUT VARIABLES (Continued) (2=NOPT(2)

GRADE: IG=3

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
441.	510.	13874.	80173.	100000.	1=USA
577.	330.	4284.	40266.	100000.	2=WEUR+CAN
17.	53.	3294.	29391.	100000.	3=OECD PAC
1095.	1007.	23578.	80708.	100000.	4=EUSSR
267.	175.	7062.	40354.	100000.	5=ACENF
880.	802.	3.	10088.	100000.	6=MIDEAST
771.	263.	1058.	120503.	100000.	7=AFRICA
679.	279.	211.	60252.	100000.	8=L AMER
123.	121.	635.	30266.	100000.	9=S&E ASIA

GRADE: IG=4

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
373.	582.	19012.	264516.	100000.	1=USA
488.	377.	5871.	120797.	100000.	2=WEUR+CAN
14.	61.	4515.	88173.	100000.	3=OECD PAC
925.	1150.	32311.	242123.	100000.	4=EUSSR
204.	155.	9678.	121062.	100000.	5=ACENF
3650.	916.	4.	30266.	100000.	6=MIDEAST
591.	301.	1450.	361510.	100000.	7=AFRICA
520.	318.	289.	180755.	100000.	8=L AMER
94.	139.	871.	90797.	100000.	9=S&E ASIA

GRADE: IG=5

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
292.	0.	19012.	0.	0.	1=USA
382.	0.	5871.	0.	0.	2=WEUR+CAN
11.	0.	4515.	0.	0.	3=OECD PAC
725.	0.	32311.	0.	0.	4=EUSSR
154.	0.	9678.	0.	0.	5=ACENF
1460.	0.	4.	0.	0.	6=MIDEAST
1444.	0.	1450.	0.	0.	7=AFRICA
391.	0.	289.	0.	0.	8=L AMER
371.	0.	871.	0.	0.	9=S&E ASIA

CIGIS--MINIMUM EXTRACTION COSTS BY GRADE AND FUEL
FINAL COST IS THE MAXIMUM EXTRACTION COST AT RESOURCE EXHAUSTION
(UNITS=1975 DOLLARS/GIGAJOULE)

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	GRADE
.16	.50	.30	3.80	6.83	IG=1
.82	1.50	.40	7.60	15.20	IG=2
3.80	2.50	.80	12.80	21.80	IG=3
5.10	3.60	1.60	25.60	22.00	IG=4
7.10	15.00	2.70	51.00	23.00	IG=5
12.30	16.00	5.30	52.00	24.00	FINAL

VISL--ENVIRONMENTAL COST AMOUNTS BY REGION AND FUEL
(UNITS=1975 DOLLARS/GIGAJOULE)

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
.00	.00	1.60	1.30	10.00	1=USA
.00	.00	1.60	1.30	10.00	2=WEUR+CAN
.00	.00	1.60	1.30	10.00	3=OECD PAC
.00	.00	.80	.90	10.00	4=EUSSR
.00	.00	.80	.90	10.00	5=ACENF
.00	.00	.80	.90	10.00	6=MIDEAST
.00	.00	.80	.90	10.00	7=AFRICA
.00	.00	.80	.90	10.00	8=L AMER
.00	.00	.80	.90	10.00	9=S&E ASIA

TABLE 7.4. INPUT VARIABLES (Continued)
(2=NOPT(2)

RIL--PRICE ELASTICITY OF SUPPLY, EVALUATED PREVIOUS PRICE
(BY SUPPLY TYPE AND REGION)

CONV OIL	CONV GAS	COAL	UNCON OIL	REGION
1.00	1.00	1.00	1.00	1=USA
1.00	1.00	1.00	1.00	2=WEUR+CAN
1.00	1.00	1.00	1.00	3=OECD PAC
1.00	1.00	1.00	1.00	4=EUSSR
1.00	1.00	1.00	1.00	5=ACENP
1.00	1.00	1.00	1.00	6=MIDEAST
1.00	1.00	1.00	1.00	7=AFRICA
1.00	1.00	1.00	1.00	8=L AMER
1.00	1.00	1.00	1.00	9=S&E ASIA

STISL--RATE OF TECHNOLOGICAL CHANGE BY SUPPLY TYPE
AND REGION

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
.0050	.0050	.0050	.0050	.0050	1=USA
.0050	.0050	.0050	.0050	.0050	2=WEUR+CAN
.0050	.0050	.0050	.0050	.0050	3=OECD PAC
.0050	.0050	.0050	.0050	.0050	4=EUSSR
.0050	.0050	.0050	.0050	.0050	5=ACENP
.0050	.0050	.0050	.0050	.0050	6=MIDEAST
.0050	.0050	.0050	.0050	.0050	7=AFRICA
.0050	.0050	.0050	.0050	.0050	8=L AMER
.0050	.0050	.0050	.0050	.0050	9=S&E ASIA

BESIL--MINIMUM LEVEL OF SHORT-TERM SUPPLY BY TYPE
AND REGION

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
.03	.03	.03	.03	.03	1=USA
.03	.03	.03	.03	.03	2=WEUR+CAN
.03	.03	.03	.03	.03	3=OECD PAC
.03	.03	.03	.03	.03	4=EUSSR
.03	.03	.03	.03	.03	5=ACENP
.03	.03	.03	.03	.03	6=MIDEAST
.03	.03	.03	.03	.03	7=AFRICA
.03	.03	.03	.03	.03	8=L AMER
.03	.03	.03	.03	.03	9=S&E ASIA

ESFIL--INITIAL ESTIMATE OF ENERGY SUPPLY
BY FUEL, REGION, AND PERIOD
(UNITS=EXAJOULES/YR)

YEAR=1975

CONV OIL	CONV GAS	COAL	UNCON OIL	NUCLEAR	REGION
20.4100	20.7300	17.1800	.0000	.6200	1=USA
4.7700	8.9800	9.6000	.0000	.5800	2=WEUR+CAN
.9600	.3100	2.6700	.0000	.0900	3=OECD PAC
22.7700	11.9100	25.7700	.0000	.0700	4=EUSSR
3.2300	.1400	15.0100	.0000	.0000	5=ACENP
42.3500	1.2100	.0300	.0000	.0000	6=MIDEAST
10.5900	.3900	2.1800	.0000	.0000	7=AFRICA
9.9200	1.5500	.3900	.0000	.0100	8=L AMER
3.7900	.7500	2.6800	.0000	.0100	9=S&E ASIA

TABLE 7.4. INPUT VARIABLES (Continued) (2=NOPT(2)

GAS FLARING

"FLRL1" IS THE FLARING RATE IN 1975, "FLRL2" IS THE ULTIMATE FLARING RATE, AND "FLRL3" IS THE NUMBER OF YEARS TO REACH "FLRL2." THE MODEL EXPONENTIALLY INTERPOLATES BETWEEN THE RATES.

FLRL1	FLRL2	FLRL3	REGION
.0550	.0500	10.0000	US
.0700	.0500	10.0000	WEUR+CAN
.0050	.0100	10.0000	JANZ
.0490	.0500	10.0000	EUSSR
.1070	.0500	10.0000	ACENP
.7270	.0500	50.0000	MIDEAST
.7360	.0500	50.0000	AFR
.5230	.0500	28.0000	LA
.3490	.0500	15.0000	SEASIA

RENEWABLE RESOURCE CONSTRAINED TECHNOLOGIES

PARAMETERS INCLUDE LOGISTICS FUNCTION PARAMETERS, COST, AND SHARE DATA. "HYDRO1L" ORIENTS THE PRODUCTION PATH IN TIME: "HYDRO2L" DETERMINES ITS SHAPE; "HYDRO3L" IS THE RESOURCE AMOUNT IN EJ; "HYDRO4L" IS PRODUCTION PRICE IN 1975 DOLLARS PER GJ: AND "HYDRO5L" IS THE ELECTRICITY SHARE OF HYDRO.

HYDRO1L	HYDRO2L	HYDRO3L	HYDRO4L	HYDRO5L	REGION
.4204	.0651	1.8300	4.0300	.1530	US
.3861	.0720	3.5100	4.0300	.3427	WEUR+CAN
.2416	.0688	.7700	4.0300	.2100	JANZ
-1.9979	.0931	4.9700	4.0300	.1159	EUSSR
-3.2069	.0900	5.7600	4.0300	.3467	ACENP
-3.6418	.1549	.6100	4.0300	.0969	MIDEAST
-3.9701	.0997	7.3100	4.0300	.2872	AFR
-2.5238	.0970	6.4800	4.0300	.5624	LA
-2.7723	.1006	4.1700	4.0300	.2693	SEASIA

SOLAR COSTS: CSLT(L,1) = PRODUCTION COST IN 1975
CSLT(L,2) = FINAL PRODUCTION COSTS
CSLT(L,3) = YEARS TO REACH FINAL PRODUCTION COSTS

CSLT1	CSLT2	CSLT3	REGION
200.6000	14.8500	50.0000	US
402.4000	14.8500	50.0000	WEUR+CAN
281.6000	14.8500	50.0000	OECD PAC
402.4000	14.8500	50.0000	EUSSR
321.4000	14.8500	50.0000	ACENP
128.6000	14.8500	50.0000	MIDEAST
144.0000	14.8500	50.0000	AFR
321.4000	14.8500	50.0000	LA
200.6000	14.8500	50.0000	SEASIA

SYNFUEL PARAMETERS

(PARAMETERS INCLUDE A CONVERSION EFFICIENCY (GCI), ADD ON COSTS (HCILT) AND AN ELASTICITY CONTROL PARAMETER (RCI). HCILT1 IS THE INITIAL VALUE, HCILT2 THE FINAL VALUE, AND HCILT3 THE NUMBER OF YEARS TO REACH THE FINAL VALUE. THE MODEL EXPONENTIALLY INTERPOLATES FOR INTERMEDIATE YEARS)

SYNCRUDE			SYNGAS			
HCILT1	HCILT2	HCILT3	HCILT1	HCILT2	HCILT3	REGION
100.00	4.55	25.00	100.00	3.30	25.00	US
100.00	4.55	25.00	100.00	3.30	25.00	WEUR+CAN
100.00	4.55	25.00	100.00	3.30	25.00	OECD PAC
100.00	4.55	25.00	100.00	3.30	25.00	EUSSR
100.00	4.55	50.00	100.00	3.30	50.00	ACENP
100.00	4.55	100.00	100.00	3.30	100.00	MIDEAST
12.54	4.55	25.00	100.00	3.30	25.00	AFRICA
12.54	4.55	25.00	100.00	3.30	25.00	L AMER
100.00	4.55	50.00	100.00	3.30	50.00	S&E ASIA

SYNCRUDE GCI = 1.50 SYNGAS GCI = 1.50
SYNCRUDE RCI = -6.00 SYNGAS RCI = -6.00

TABLE 7.4. INPUT VARIABLES (Continued)
(2=NOPT(2)

ENERGY SERVICE INPUT-OUTPUT COEFFICIENTS

TABLE 1.
ENERGY TRANSFORMATION BY SECTOR
(GJK, GJ)

OIL	GAS	COAL	ELECTRIC	SECTOR	VARIABLE	
1.6700	1.5400	2.5000	.8600	RES/COM	GJK,J=1,NJ	K=1
1.9200	1.9000	2.0000	1.0500	INDUSTRY	GJK,J=1,NJ	K=2
3.0000	3.0000	3.3300	1.0500	TRANSPORT	GJK,J=1,NJ	K=3
2.0000	1.7000	2.0500	.9500	AGGREGATE	GJ, J=1,NJ	

TABLE 2.
NON-ENERGY I-O COEFFICIENTS BY SECTOR
(HJK, HJ)

OIL	GAS	COAL	ELECTRIC	SECTOR	VARIABLE	
4.9800	3.2400	2.8700	3.4100	RES/COM	HJK,J=1,NJ	K=1
.4100	.3200	.8000	1.1600	INDUSTRY	HJK,J=1,NJ	K=2
98.8800	200.0000	200.0000	153.1700	TRANSPORT	HJK,J=1,NJ	K=3
2.1000	2.0300	1.1800	1.1500	AGGREGATE	HJ, J=1,NJ	

BASE ENERGY SERVICE CONSUMPTION WEIGHTS
BY FUEL BY SECTOR BY REGION
SJKLP (UNITS=UNDIMENTIONED) AND BSKL (UNITS=EXAJOULES)

OIL	GAS	COAL	ELECTRIC	BSKL	SECTOR	REGION
.1850	.6830	.0110	.3790	15.2377	RES/COM	USA
.0910	.3450	.1290	.1450	9.7881	INDUSTRY	USA
1.3690	.0000	.0000	.0010	6.6411	TRANSPORT	USA
.3590	.1220	.1120	.3720	11.1476	RES/COM	WEUR+CAN
.2600	.0650	.1310	.2120	9.4047	INDUSTRY	WEUR+CAN
1.9620	.0000	.0030	.0280	3.3974	TRANSPORT	WEUR+CAN
.4430	.0880	.2070	.4620	2.0876	RES/COM	OECD PAC
.2240	.0320	.2670	.2630	3.9391	INDUSTRY	OECD PAC
2.6720	.0000	.0010	.0500	.8941	TRANSPORT	OECD PAC
.2730	.1940	.3360	.1970	26.3832	AGGREGATE	USSR
.1560	.0050	.7640	.0740	9.1210	AGGREGATE	CHINA
.6870	.2120	.0090	.0930	1.8153	AGGREGATE	MIDEAST
.4370	.0090	.3400	.2140	2.2834	AGGREGATE	AFRICA
.6350	.1480	.0440	.1740	5.0414	AGGREGATE	L AMER
.5160	.0680	.1720	.2440	4.2498	AGGREGATE	S&E ASIA

BSJKLM -- LOGIT FUNCTION SCALE PARAMETERS
(UNITS BSJKLM=UNDIMENSIONED)
YEAR = 1975

OIL	GAS	COAL	ELECTRIC	SECTOR	REGION
.3585	.0548	.0008	.5858	RES/COM	USA
.1871	.0124	.0047	.7958	INDUSTRY	USA
.7030	.0000	.0004	.2966	TRANSPORT	USA
.5492	.0814	.0118	.3577	RES/COM	WEUR+CAN
.3184	.0831	.0122	.5863	INDUSTRY	WEUR+CAN
.0736	.0000	.5008	.4256	TRANSPORT	WEUR+CAN
.4533	.0622	.0058	.4787	RES/COM	OECD PAC
.1948	.0420	.0091	.7541	INDUSTRY	OECD PAC
.0299	.0000	.5779	.3922	TRANSPORT	OECD PAC
.4795	.0380	.0339	.4486	AGGREGATE	USSR
.5764	.0019	.1465	.2753	AGGREGATE	CHINA
.6032	.0451	.0025	.3492	AGGREGATE	MIDEAST
.7670	.0004	.0213	.2113	AGGREGATE	AFRICA
.7910	.0186	.0054	.1850	AGGREGATE	L AMER
.5508	.0089	.0260	.4143	AGGREGATE	S&E ASIA

TABLE 7.4. INPUT VARIABLES (Continued)
(2=NOPT(2)

BSJKLM -- LOGIT FUNCTION SCALE PARAMETERS
(UNITS BSJKLM=UNDIMENSIONED)
YEAR = 2000

OIL	GAS	COAL	ELECTRIC	SECTOR	REGION
.2600	.0548	.0008	.5858	RES/COM	USA
.1871	.0207	.0047	.7958	INDUSTRY	USA
.7030	.0000	.0004	.2966	TRANSPORT	USA
.5492	.0814	.0118	.3577	RES/COM	WEUR+CAN
.3184	.0831	.0122	.5863	INDUSTRY	WEUR+CAN
.0736	.0000	.5008	.4256	TRANSPORT	WEUR+CAN
.4533	.0622	.0058	.4787	RES/COM	OECD PAC
.1948	.0420	.0091	.7541	INDUSTRY	OECD PAC
.0299	.0000	.5779	.3922	TRANSPORT	OECD PAC
.4795	.0790	.0339	.4486	AGGREGATE	USSR
.5200	.0200	.1039	.2753	AGGREGATE	CHINA
.6032	.0451	.0025	.3492	AGGREGATE	MIDEAST
.6700	.0287	.0213	.2800	AGGREGATE	AFRICA
.6001	.0423	.0054	.2117	AGGREGATE	L AMER
.6500	.0187	.0260	.4400	AGGREGATE	S&E ASIA

BSJKLM -- LOGIT FUNCTION SCALE PARAMETERS
(UNITS BSJKLM=UNDIMENSIONED)
YEAR = 2025

OIL	GAS	COAL	ELECTRIC	SECTOR	REGION
.2600	.0548	.0008	.5858	RES/COM	USA
.1871	.0207	.0047	.7958	INDUSTRY	USA
.7030	.0000	.0004	.2966	TRANSPORT	USA
.5492	.0814	.0118	.3577	RES/COM	WEUR+CAN
.3184	.0831	.0122	.5863	INDUSTRY	WEUR+CAN
.0736	.0000	.5008	.4256	TRANSPORT	WEUR+CAN
.4533	.0622	.0058	.4787	RES/COM	OECD PAC
.1948	.0420	.0091	.7541	INDUSTRY	OECD PAC
.0299	.0000	.5779	.3922	TRANSPORT	OECD PAC
.4795	.1125	.0198	.4486	AGGREGATE	USSR
.5764	.0400	.0706	.2753	AGGREGATE	CHINA
.6032	.0451	.0025	.3492	AGGREGATE	MIDEAST
.5800	.0487	.0213	.3400	AGGREGATE	AFRICA
.6001	.0423	.0054	.2383	AGGREGATE	L AMER
.4500	.0273	.0260	.4500	AGGREGATE	S&E ASIA

BSJKLM -- LOGIT FUNCTION SCALE PARAMETERS
(UNITS BSJKLM=UNDIMENSIONED)
YEAR = 2050

OIL	GAS	COAL	ELECTRIC	SECTOR	REGION
.2600	.0548	.0008	.5858	RES/COM	USA
.1871	.0207	.0047	.7958	INDUSTRY	USA
.7030	.0000	.0004	.2966	TRANSPORT	USA
.5492	.0814	.0118	.3577	RES/COM	WEUR+CAN
.3184	.0831	.0122	.5863	INDUSTRY	WEUR+CAN
.0736	.0000	.5008	.4256	TRANSPORT	WEUR+CAN
.4533	.0622	.0058	.4787	RES/COM	OECD PAC
.1948	.0420	.0091	.7541	INDUSTRY	OECD PAC
.0299	.0000	.5779	.3922	TRANSPORT	OECD PAC
.4795	.1425	.0128	.4486	AGGREGATE	USSR
.4323	.0800	.0347	.2753	AGGREGATE	CHINA
.6032	.0451	.0025	.3492	AGGREGATE	MIDEAST
.4800	.0787	.0213	.4000	AGGREGATE	AFRICA
.6001	.0423	.0054	.2650	AGGREGATE	L AMER
.3900	.0374	.0260	.4600	AGGREGATE	S&E ASIA

TABLE 7.4. INPUT VARIABLES (Continued)
(2=NOPT(2)

BSJKLM -- LOGIT FUNCTION SCALE PARAMETERS
(UNITS BSJKLM=UNDIMENSIONED)
YEAR = 2075

OIL	GAS	COAL	ELECTRIC	SECTOR	REGION
.2600	.0548	.0008	.5858	RES/COM	USA
.1871	.0207	.0047	.7958	INDUSTRY	USA
.7030	.0000	.0004	.2966	TRANSPORT	USA
.5492	.0814	.0118	.3577	RES/COM	WEUR+CAN
.3184	.0831	.0122	.5863	INDUSTRY	WEUR+CAN
.0736	.0000	.5008	.4256	TRANSPORT	WEUR+CAN
.4533	.0622	.0058	.4787	RES/COM	OECD PAC
.1948	.0420	.0091	.7541	INDUSTRY	OECD PAC
.0299	.0000	.5779	.3922	TRANSPORT	OECD PAC
.4795	.1425	.0128	.4486	AGGREGATE	USSR
.4323	.0800	.0347	.2753	AGGREGATE	CHINA
.6032	.0451	.0025	.3492	AGGREGATE	MIDEAST
.4800	.0787	.0213	.4000	AGGREGATE	AFRICA
.6001	.0423	.0054	.2650	AGGREGATE	L AMER
.3900	.0374	.0260	.4600	AGGREGATE	S&E ASIA

BSJKLM -- LOGIT FUNCTION SCALE PARAMETERS
(UNITS BSJKLM=UNDIMENSIONED)
YEAR = 2100

OIL	GAS	COAL	ELECTRIC	SECTOR	REGION
.2600	.0548	.0008	.5858	RES/COM	USA
.1871	.0207	.0047	.7958	INDUSTRY	USA
.7030	.0000	.0004	.2966	TRANSPORT	USA
.5492	.0814	.0118	.3577	RES/COM	WEUR+CAN
.3184	.0831	.0122	.5863	INDUSTRY	WEUR+CAN
.0736	.0000	.5008	.4256	TRANSPORT	WEUR+CAN
.4533	.0622	.0058	.4787	RES/COM	OECD PAC
.1948	.0420	.0091	.7541	INDUSTRY	OECD PAC
.0299	.0000	.5779	.3922	TRANSPORT	OECD PAC
.4795	.1425	.0128	.4486	AGGREGATE	USSR
.4323	.0800	.0347	.2753	AGGREGATE	CHINA
.6032	.0451	.0025	.3492	AGGREGATE	MIDEAST
.4800	.0787	.0213	.4000	AGGREGATE	AFRICA
.6001	.0423	.0054	.2650	AGGREGATE	L AMER
.3900	.0374	.0260	.4600	AGGREGATE	S&E ASIA

PRICE ELASTICITY CONTROL PARAMETERS

AGG RPKK	OIL	GAS RPJK	COAL	ELECTRIC	SECTOR	
-.7000	-3.0000	-3.0000	-3.0000	-3.0000	RES/COM	RPKK,JK,K=1
-.7000	-3.0000	-3.0000	-3.0000	-3.0000	INDUSTRY	RPKK,JK,K=2
-.7000	-13.0000	-13.0000	-13.0000	-13.0000	TRANSPORT	RPKK,JK,K=3

RPK		RPJ				
-.7000	-2.5000	-2.5000	-2.5000	-2.5000	AGGREGATE	RPK,RPJ

INCOME ELASTICITY CONTROL PARAMETERS

AGG RYKK	OIL	GAS RYJK	COAL	ELECTRIC	SECTOR	
1.0000	-.1000	.3000	-.2000	.1000	RES/COM	RYKK,JK,K=1
1.0000	.0000	.1000	-.2000	.2000	INDUSTRY	RYKK,JK,K=2
1.0000	.0000	.0000	.0000	.0000	TRANSPORT	RYKK,JK,K=3

RYJ

-.1000	.1000	-.2000	.1000	RYJ,J=1,4

RYKLT--INCOME ELASTICITY FOR THE EUSSR (L=4) AND OTHER LDC'S (L>4)
INPUT IS THE INITIAL VALUE IN 1975. THE PROGRAM INTERPOLATES OVER A 75 YEAR PERIOD TO A FINAL VALUE 0.8 TIMES THE ORIGINAL FOR THE EUSSR AND 0.71 TIMES THE ORIGINAL FOR OTHER LDC'S

1.2500	EUSSR(L=4)
1.4000	LDC'S(L>4)

RYL--ENERGY-GNP FEEDBACK ELASTICITY, BY REGION

-.1500	1=USA
-.1500	2=WEUR+CAN
-.1500	3=OECD PAC
-.1500	4=EUSSR
-.2000	5=ACENP
.0500	6=MIDEAST
-.2000	7=AFRICA
-.2000	8=L AMER
-.2000	9=S&E ASIA

COI -- CARBON RELEASE BY SOURCE
(IN TERAGRAMS OF CARBON PER EXAJOULE)

OIL BURNUP	GAS BURNUP	COAL BURNUP	COAL LIQ-UIFACTION	COAL GAS-IFICATION	SHALE OIL PRODUCTION	BIOMASS
19.70	13.80	23.90	18.90	26.90	27.90	.00

PROPORTION OF FLARED GAS BURNED (SBURNLT T=1 IS INITIAL (1975) SHARE, T=2 IS ULTIMATE SHARE, T=3 IS NUMBER OF YEARS TO SBURNL2. PROPORTION OF BACKSTOP FUEL FROM CARBONATE ROCK (SHALET, T=1,2,3) HAS IDENTICAL INTERPRETATION.

SBURNL1	SBURNL2	SBURNL3	SHALE1	SHALE2	SHALE3	REGION
.13	.13	1.00	.01	.99	70.00	US
.47	.15	25.00	.01	.45	70.00	WEUR+CAN
1.00	.15	35.00	.01	.99	70.00	OECD PAC
1.00	.15	35.00	.01	.90	70.00	EUSSR
1.00	.15	35.00	.01	.25	70.00	ACENP
.90	.15	35.00	.01	.25	70.00	MIDEAST
.90	.15	35.00	.01	.25	70.00	AFRICA
.35	.15	25.00	.01	.25	70.00	L AMER
.85	.15	35.00	.01	.25	70.00	S&E ASIA

FEEDSTOCK USES OF FOSSIL FUELS (SFEDIL) -- SHARE OF EACH FOSSIL FUEL USED AS A FEEDSTOCK.

OIL	GAS	COAL	REGION
.0450	.0290	.0070	US
.0720	.0290	.0070	WEUR+CAN
.0920	.0290	.0070	OECD PAC
.0910	.0290	.0070	EUSSR
.0700	.0290	.0070	ACENP
.1410	.0290	.0070	MIDEAST
.0300	.0290	.0070	AFRICA
.0680	.0290	.0070	L AMER
.0820	.0290	.0070	S&E ASIA

BIOMASS COEFFICIENTS: THE SUPPLY FUNCTION FOR BIOMASS INCLUDES WASTE AND "ENERGY FARMS" AS SEPARATE TECHNOLOGIES. THE CODED FUNCTIONS ARE REPRESENTED BY LINEAR SEGMENTS. THE JPARAMETERS ARE CRITICAL POINTS FOR THE FUNCTION AND REGIONAL RESOURCES. BIOPSM ARE CRITICAL PRICE/SHARE COMBINATIONS. BIOLM ARE MAXIMUM RESOURCE AMOUNTS -- WASTE IS DEPENDENT ON ECONOMIC ACTIVITY. THE WASTE TOTAL IS BASED ON 1975 ECONOMIC ACTIVITY (PRICE--1975 $/GJ, QUANTITY--EJ)

WASTE (BIOPSM) PRICE	SHARE	ENERGY FARMS (BIOPSM) PRICE	SHARE
.1705	.0000	.0000	.0000
1.6000	.3000	2.1000	.0000
4.6000	.8000	2.6000	.2000
5.6000	.8000	4.6000	.8000

WASTE (BIOLM)	ENERGY FARMS (BIOLM)	REGION
5.48	82.29	US
7.95	.00	WEUR+CAN
2.71	13.19	OECD PAC
8.73	98.43	EUSSR
7.04	.00	ACENP
1.00	.00	MIDEAST
5.71	173.44	AFRICA
7.81	225.45	L AMER
10.40	.00	S&E ASIA

INCOME ELASTICITY OF BIOMASS SUPPLY

.5000 RYSHT

TABLE 7.5. INTERMEDIATE OUTPUT FROM SUBROUTINES XXXX AND REVISE (2=NOPT(3)

```
PERIOD 2     ITERATION  1

ESIMKT(1)=  156.4990  ESIMKT(2)=   50.5753  ESIMKT(3)=  156.1050
EDIMKT(1)=  153.8240  EDIMKT(2)=   47.1622  EDIMKT(3)=  152.5970

OIL PRICE=    2.6261  GAS PRICE=     .8298  COAL PRICE=     .6090

PERIOD 2     ITERATION  2

ESIMKT(1)=  154.4590  ESIMKT(2)=   49.1632  ESIMKT(3)=  153.5174
EDIMKT(1)=  154.4720  EDIMKT(2)=   49.1821  EDIMKT(3)=  153.5476

OIL PRICE=    2.6261  GAS PRICE=     .8298  COAL PRICE=     .6090

PERIOD 3     ITERATION  1

ESIMKT(1)=  213.0559  ESIMKT(2)=  113.8450  ESIMKT(3)=  227.1791
EDIMKT(1)=  207.3874  EDIMKT(2)=  113.8550  EDIMKT(3)=  226.4894

OIL PRICE=    3.7565  GAS PRICE=    1.3695  COAL PRICE=     .6997

PERIOD 3     ITERATION  2

ESIMKT(1)=  208.0376  ESIMKT(2)=  113.7986  ESIMKT(3)=  226.3838
EDIMKT(1)=  208.2547  EDIMKT(2)=  113.7981  EDIMKT(3)=  226.3892

OIL PRICE=    3.7565  GAS PRICE=    1.3695  COAL PRICE=     .6997

PERIOD 4     ITERATION  1

ESIMKT(1)=  268.1113  ESIMKT(2)=  158.0869  ESIMKT(3)=  306.0794
EDIMKT(1)=  259.8249  EDIMKT(2)=  174.3564  EDIMKT(3)=  342.2357

OIL PRICE=    4.7092  GAS PRICE=    2.2850  COAL PRICE=     .8876

PERIOD 4     ITERATION  2

ESIMKT(1)=  264.2573  ESIMKT(2)=  170.6741  ESIMKT(3)=  337.8772
EDIMKT(1)=  264.4636  EDIMKT(2)=  171.1327  EDIMKT(3)=  339.2784

OIL PRICE=    4.7096  GAS PRICE=    2.2866  COAL PRICE=     .8884

PERIOD 4     ITERATION  3

ESIMKT(1)=  264.5157  ESIMKT(2)=  171.0539  ESIMKT(3)=  339.1335
EDIMKT(1)=  264.5157  EDIMKT(2)=  171.0543  EDIMKT(3)=  339.1360

OIL PRICE=    4.7096  GAS PRICE=    2.2866  COAL PRICE=     .8884

PERIOD 5     ITERATION  1

ESIMKT(1)=  416.6687  ESIMKT(2)=  176.4800  ESIMKT(3)=  434.2164
EDIMKT(1)=  262.3570  EDIMKT(2)=  154.2692  EDIMKT(3)=  431.5201

OIL PRICE=    5.3051  GAS PRICE=    3.1468  COAL PRICE=     .9365

PERIOD 5     ITERATION  2

ESIMKT(1)=  250.8196  ESIMKT(2)=  158.0274  ESIMKT(3)=  369.0812
EDIMKT(1)=  295.5168  EDIMKT(2)=  163.6467  EDIMKT(3)=  459.6507

OIL PRICE=    5.4041  GAS PRICE=    3.1924  COAL PRICE=     .9858

PERIOD 5     ITERATION  3

ESIMKT(1)=  287.6771  ESIMKT(2)=  162.8863  ESIMKT(3)=  432.8671
EDIMKT(1)=  291.7336  EDIMKT(2)=  163.2914  EDIMKT(3)=  445.6838

OIL PRICE=    5.4129  GAS PRICE=    3.1968  COAL PRICE=     .9942

PERIOD 5     ITERATION  4

ESIMKT(1)=  291.6698  ESIMKT(2)=  163.4172  ESIMKT(3)=  447.0681
EDIMKT(1)=  291.6979  EDIMKT(2)=  163.4149  EDIMKT(3)=  443.1827

OIL PRICE=    5.4127  GAS PRICE=    3.1948  COAL PRICE=     .9942
```

TABLE 7.6. INTERMEDIATE OUTPUT FROM SUBROUTINE ELAS (2=NOPT(4))

PERIOD 2 GLOBAL PRICE ELASTICITIES

DEMAND	OIL	GAS	COAL	SUPPLY			
OIL	-.9307	.0591	.1943	OIL	1.4493	-.0001	-.000
4							
GAS	.2779	-.5549	.2146	GAS	-.0286	2.3311	-.009
1							
COAL	.2740	.0712	-.5346	COAL	-.0792	-.0030	.971
4							

PERIOD 3 GLOBAL PRICE ELASTICITIES

DEMAND	OIL	GAS	COAL	SUPPLY			
OIL	-1.1980	.1181	.1984	OIL	6.2824	-.0006	.884
7							
GAS	.1844	-.7019	.2220	GAS	-.0171	1.3235	.015
2							
COAL	.1718	.1543	-.6214	COAL	-.5298	-.0097	14.510
9							

PERIOD 4 GLOBAL PRICE ELASTICITIES

DEMAND	OIL	GAS	COAL	SUPPLY			
OIL	-1.3906	.1753	.2194	OIL	4.3156	-.0130	.731
3							
GAS	.1063	-.9325	.2496	GAS	-.0260	3.1719	.047
4							
COAL	.1177	.2466	-.6860	COAL	-1.3256	-.0666	4.751
1							

PERIOD 4 GLOBAL PRICE ELASTICITIES

DEMAND	OIL	GAS	COAL	SUPPLY			
OIL	-1.3807	.1740	.2196	OIL	4.4063	-.0154	.696
3							
GAS	.1163	-.9505	.2493	GAS	-.0276	3.0294	.048
8							
COAL	.1282	.2450	-.6979	COAL	-1.2569	-.0742	4.458
7							

TABLE 7.6. INTERMEDIATE OUTPUT FROM SUBROUTINE ELAS (Continued)
(2=NOPT(4)

PERIOD 5 GLOBAL PRICE ELASTICITIES

DEMAND		OIL	GAS	COAL	SUPPLY			
	OIL	-1.5597	.1478	.2571	OIL	3.3507	-.2026	.210
3								
	GAS	.0270	-1.2511	.2891	GAS	-.4920	1.6153	-.005
6								
	COAL	.0479	.2157	-.7303	COAL	-2.5234	-.3703	1.936
7								

PERIOD 5 GLOBAL PRICE ELASTICITIES

DEMAND		OIL	GAS	COAL	SUPPLY			
	OIL	-1.4872	.1455	.2449	OIL	4.1727	-.1704	1.442
1								
	GAS	.0588	-1.2012	.2737	GAS	-.2830	1.3609	.354
1								
	COAL	.0789	.2102	-.6754	COAL	-1.9147	-.3470	4.357
6								

PERIOD 5 GLOBAL PRICE ELASTICITIES

DEMAND		OIL	GAS	COAL	SUPPLY			
	OIL	-1.4964	.1484	.2457	OIL	4.0283	-.1770	.881
5								
	GAS	.0586	-1.2075	.2743	GAS	-.3247	1.4548	.202
8								
	COAL	.0796	.2141	-.7044	COAL	-1.9607	-.2298	3.165
9								

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (2=NOPT(5))

1975 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: USA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	20.41	19.59	17.18	2.15	.00	3.82	63.15
UNCONVENTIONAL	.00	.00	.00	N/A	N/A	N/A	.00
TOTAL PRIMARY	20.41	19.59	17.18	2.15	.00	3.82	63.15
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	20.41	19.59	17.18	2.15	.00	3.82	63.15

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	4.04	3.89	11.08	2.15	.00	3.82	24.98
RESIDEN-COMMERC	6.02	9.48	.22	.00	.00	.00	15.72
INDUSTRIAL	3.77	7.84	2.48	.00	.00	.00	14.09
TRANSPORT	11.89	.00	.00	.00	.00	.00	11.89
TOTAL DEMAND	25.72	21.21	13.78	2.15	.00	3.82	66.67

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	4.04	3.89	11.08	2.15	.00	3.82	24.98
RESIDEN-COMMERC	6.02	9.48	.22	.00	.00	.00	15.72
INDUSTRIAL	3.77	7.84	2.48	.00	.00	.00	14.09
TRANSPORT	11.89	.00	.00	.00	.00	.00	11.89
TOTAL DEMAND	25.72	21.21	13.78	2.15	.00	3.82	66.67
TOTAL SUPPLY	20.41	19.59	17.18	2.15	.00	3.82	63.15
NET IMPORTS	5.31	1.62	-3.40	.00	.00	.00	3.52

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	6.02	9.48	.22	4.63	20.75
INDUSTRIAL	3.77	7.84	2.48	2.58	16.67
TRANSPORT	11.89	.00	.00	.01	11.90
TOTAL DEMAND	21.68	17.32	2.70	7.27	48.92

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

1975 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: CANADA & EUR

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	4.77	8.35	9.60	1.30	.00	7.24	31.26
UNCONVENTIONAL	.00	.00	.00	N/A	N/A	N/A	.00
TOTAL PRIMARY	4.77	8.35	9.60	1.30	.00	7.24	31.26
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	4.77	8.35	9.60	1.30	.00	7.24	31.26

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.64	.52	5.24	1.30	.00	7.24	17.95
RESIDEN-COMMERC	5.42	.57	.64	.00	.00	.00	6.63
INDUSTRIAL	9.04	.74	2.13	.00	.00	.00	11.92
TRANSPORT	3.09	.00	.01	.00	.00	.00	3.10
TOTAL DEMAND	21.20	1.83	8.02	1.30	.00	7.24	39.59

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.64	.52	5.24	1.30	.00	7.24	17.95
RESIDEN-COMMERC	5.42	.57	.64	.00	.00	.00	6.63
INDUSTRIAL	9.04	.74	2.13	.00	.00	.00	11.92
TRANSPORT	3.09	.00	.01	.00	.00	.00	3.10
TOTAL DEMAND	21.20	1.83	8.02	1.30	.00	7.24	39.59
TOTAL SUPPLY	4.77	8.35	9.60	1.30	.00	7.24	31.26
NET IMPORTS	16.43	-6.52	-1.58	.00	.00	.00	8.33

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	5.42	.57	.64	1.74	8.37
INDUSTRIAL	9.04	.74	2.13	3.40	15.32
TRANSPORT	3.09	.00	.01	.04	3.14
TOTAL DEMAND	17.55	1.31	2.78	5.18	26.83

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

1975 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: OECD PACIFIC

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	.96	.31	2.67	.42	.00	1.55	5.90
UNCONVENTIONAL	.00	.00	.00	N/A	N/A	N/A	.00
TOTAL PRIMARY	.96	.31	2.67	.42	.00	1.55	5.90
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	.96	.31	2.67	.42	.00	1.55	5.90

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	5.22	.36	1.42	.42	.00	1.55	8.97
RESIDEN-COMMERC	3.13	.21	.44	.00	.00	.00	3.78
INDUSTRIAL	3.03	.11	2.09	.00	.00	.00	5.23
TRANSPORT	2.50	.00	.02	.00	.00	.00	2.51
TOTAL DEMAND	13.87	.68	3.97	.42	.00	1.55	20.49

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	5.22	.36	1.42	.42	.00	1.55	8.97
RESIDEN-COMMERC	3.13	.21	.44	.00	.00	.00	3.78
INDUSTRIAL	3.03	.11	2.09	.00	.00	.00	5.23
TRANSPORT	2.50	.00	.02	.00	.00	.00	2.51
TOTAL DEMAND	13.87	.68	3.97	.42	.00	1.55	20.49
TOTAL SUPPLY	.96	.31	2.67	.42	.00	1.55	5.90
NET IMPORTS	12.91	.37	1.30	.00	.00	.00	14.59

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	3.13	.21	.44	1.12	4.90
INDUSTRIAL	3.03	.11	2.09	1.32	6.55
TRANSPORT	2.50	.00	.02	.06	2.57
TOTAL DEMAND	8.65	.32	2.55	2.50	14.02

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

1975 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: USSR/E. EUR.

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	22.77	11.33	25.77	.23	.00	2.06	62.15
UNCONVENTIONAL	.00	.00	.00	N/A	N/A	N/A	.00
TOTAL PRIMARY	22.77	11.33	25.77	.23	.00	2.06	62.15
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	22.77	11.33	25.77	.23	.00	2.06	62.15

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	4.49	3.37	9.40	.23	.00	2.06	19.55
END-USE DEMAND	14.30	8.08	17.53	.00	.00	.00	39.90
TOTAL DEMAND	18.79	11.45	26.93	.23	.00	2.06	59.45

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	4.49	3.37	9.40	.23	.00	2.06	19.55
END-USE DEMAND	14.30	8.08	17.53	.00	.00	.00	39.90
TOTAL DEMAND	18.79	11.45	26.93	.23	.00	2.06	59.45
TOTAL SUPPLY	22.77	11.33	25.77	.23	.00	2.06	62.15
NET IMPORTS	-3.98	.12	1.16	.00	.00	.00	-2.70

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	14.30	8.08	17.53	5.64	45.54
TOTAL DEMAND	14.30	8.08	17.53	5.64	45.54

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

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REGION: CHINA/ET.AL.

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	3.23	.13	15.01	.00	.00	.76	19.12
UNCONVENTIONAL	.00	.00	.00	N/A	N/A	N/A	.00
TOTAL PRIMARY	3.23	.13	15.01	.00	.00	.76	19.12
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	3.23	.13	15.01	.00	.00	.76	19.12

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.29	.06	1.39	.00	.00	.76	2.50
END-USE DEMAND	2.89	.07	14.06	.00	.00	.00	17.02
TOTAL DEMAND	3.18	.13	15.45	.00	.00	.76	19.52

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.29	.06	1.39	.00	.00	.76	2.50
END-USE DEMAND	2.89	.07	14.06	.00	.00	.00	17.02
TOTAL DEMAND	3.18	.13	15.45	.00	.00	.76	19.52
TOTAL SUPPLY	3.23	.13	15.01	.00	.00	.76	19.12
NET IMPORTS	-.05	.01	.44	.00	.00	.00	.40

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	2.89	.07	14.06	.74	17.76
TOTAL DEMAND	2.89	.07	14.06	.74	17.76

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

1975 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: MIDDLE EAST

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	42.35	.33	.03	.00	.00	.06	42.77
UNCONVENTIONAL	.00	.00	.00	N/A	N/A	N/A	.00
TOTAL PRIMARY	42.35	.33	.03	.00	.00	.06	42.77
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	42.35	.33	.03	.00	.00	.06	42.77

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.31	.23	.00	.00	.00	.06	.60
END-USE DEMAND	2.55	.60	.03	.00	.00	.00	3.18
TOTAL DEMAND	2.86	.83	.03	.00	.00	.06	3.78

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.31	.23	.00	.00	.00	.06	.60
END-USE DEMAND	2.55	.60	.03	.00	.00	.00	3.18
TOTAL DEMAND	2.86	.83	.03	.00	.00	.06	3.78
TOTAL SUPPLY	42.35	.33	.03	.00	.00	.06	42.77
NET IMPORTS	-39.49	.50	.00	.00	.00	.00	-38.99

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	2.55	.60	.03	.16	3.34
TOTAL DEMAND	2.55	.60	.03	.16	3.34

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

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****

REGION: AFRICA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	10.59	.10	2.18	.00	.00	.47	13.34
UNCONVENTIONAL	.00	.00	.00	N/A	N/A	N/A	.00
TOTAL PRIMARY	10.59	.10	2.18	.00	.00	.47	13.34
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	10.59	.10	2.18	.00	.00	.47	13.34

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.36	.10	.84	.00	.00	.47	1.77
END-USE DEMAND	1.99	.02	1.51	.00	.00	.00	3.52
TOTAL DEMAND	2.35	.12	2.35	.00	.00	.47	5.29

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.36	.10	.84	.00	.00	.47	1.77
END-USE DEMAND	1.99	.02	1.51	.00	.00	.00	3.52
TOTAL DEMAND	2.35	.12	2.35	.00	.00	.47	5.29
TOTAL SUPPLY	10.59	.10	2.18	.00	.00	.47	13.34
NET IMPORTS	-8.24	.02	.17	.00	.00	.00	-8.05

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	1.99	.02	1.51	.52	4.03
TOTAL DEMAND	1.99	.02	1.51	.52	4.03

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

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****

REGION: S.&E. ASIA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	3.79	.49	2.68	.04	.00	.84	7.84
UNCONVENTIONAL	.00	.00	.00	N/A	N/A	N/A	.00
TOTAL PRIMARY	3.79	.49	2.68	.04	.00	.84	7.84
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	3.79	.49	2.68	.04	.00	.84	7.84

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.73	.01	1.81	.04	.00	.84	3.43
END-USE DEMAND	4.24	.44	1.66	.00	.00	.00	6.34
TOTAL DEMAND	4.97	.46	3.47	.04	.00	.84	9.78

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.73	.01	1.81	.04	.00	.84	3.43
END-USE DEMAND	4.24	.44	1.66	.00	.00	.00	6.34
TOTAL DEMAND	4.97	.46	3.47	.04	.00	.84	9.78
TOTAL SUPPLY	3.79	.49	2.68	.04	.00	.84	7.84
NET IMPORTS	1.18	-.03	.79	.00	.00	.00	1.94

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	4.24	.44	1.66	1.01	7.35
TOTAL DEMAND	4.24	.44	1.66	1.01	7.35

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

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****

REGION: LATIN AMER

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	9.92	.74	.39	.04	.00	1.74	12.83
UNCONVENTIONAL	.00	.00	.00	N/A	N/A	N/A	.00
TOTAL PRIMARY	9.92	.74	.39	.04	.00	1.74	12.83
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	9.92	.74	.39	.04	.00	1.74	12.83

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.91	.34	.12	.04	.00	1.74	3.15
END-USE DEMAND	6.46	1.17	.43	.00	.00	.00	8.06
TOTAL DEMAND	7.37	1.50	.55	.04	.00	1.74	11.21

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.91	.34	.12	.04	.00	1.74	3.15
END-USE DEMAND	6.46	1.17	.43	.00	.00	.00	8.06
TOTAL DEMAND	7.37	1.50	.55	.04	.00	1.74	11.21
TOTAL SUPPLY	9.92	.74	.39	.04	.00	1.74	12.83
NET IMPORTS	-2.55	.76	.16	.00	.00	.00	-1.63

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	6.46	1.17	.43	.87	8.93
TOTAL DEMAND	6.46	1.17	.43	.87	8.93

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

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****

REGION: USA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	.00	3.79	.00	7.95	.05	5.46	17.26
UNCONVENTIONAL	.00	.00	1.02	N/A	N/A	N/A	1.02
TOTAL PRIMARY	.00	3.79	1.02	7.95	.05	5.46	18.28
SYNFUELS	.01	.00	-.01	.00	.00	.00	.01
TOTAL SUPPLY	.01	3.79	1.01	7.95	.05	5.46	18.27

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	2.06	3.60	31.46	7.95	.05	5.46	50.58
RESIDEN-COMMERC	7.07	7.61	.32	.00	.00	.00	15.00
INDUSTRIAL	6.11	2.81	3.27	.00	.00	.00	12.19
TRANSPORT	17.49	.00	.00	.00	.00	.00	17.49
TOTAL DEMAND	32.72	14.02	35.05	7.95	.05	5.46	95.25

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	2.06	3.60	31.24	7.95	.05	5.46	50.36
RESIDEN-COMMERC	7.08	7.61	.31	.00	.00	.00	15.00
INDUSTRIAL	6.12	2.81	3.25	.00	.00	.00	12.17
TRANSPORT	17.52	.00	.00	.00	.00	.00	17.52
TOTAL DEMAND	32.77	14.02	34.80	7.95	.05	5.46	95.05
TOTAL SUPPLY	.01	3.79	1.01	7.95	.05	5.46	18.27
NET IMPORTS	32.76	10.22	33.79	.00	.00	.00	76.77

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	7.08	7.61	.31	8.82	23.82
INDUSTRIAL	6.12	2.81	3.25	6.10	18.27
TRANSPORT	17.52	.00	.00	.02	17.53
TOTAL DEMAND	30.71	10.42	3.56	14.93	59.63

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2000 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: CANADA & EUR

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	13.94	6.58	.00	5.04	.01	10.82	36.40
UNCONVENTIONAL	.00	.00	3.44	N/A	N/A	N/A	3.44
TOTAL PRIMARY	13.94	6.58	3.44	5.04	.01	10.82	39.83
SYNFUELS	.03	.00	-.04	.00	.00	.00	.03
TOTAL SUPPLY	13.97	6.58	3.40	5.04	.01	10.82	39.82

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	4.00	2.06	12.13	5.04	.01	10.82	34.06
RESIDEN-COMMERC	5.82	2.72	1.14	.00	.00	.00	9.68
INDUSTRIAL	8.05	4.24	3.69	.00	.00	.00	15.98
TRANSPORT	4.32	.00	.02	.00	.00	.00	4.34
TOTAL DEMAND	22.19	9.02	16.98	5.04	.01	10.82	64.06

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	4.01	2.06	12.03	5.04	.01	10.82	33.97
RESIDEN-COMMERC	5.83	2.72	1.13	.00	.00	.00	9.68
INDUSTRIAL	8.07	4.24	3.66	.00	.00	.00	15.97
TRANSPORT	4.33	.00	.02	.00	.00	.00	4.34
TOTAL DEMAND	22.23	9.02	16.84	5.04	.01	10.82	63.97
TOTAL SUPPLY	13.97	6.58	3.40	5.04	.01	10.82	39.82
NET IMPORTS	8.26	2.44	13.45	.00	.00	.00	24.15

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	5.83	2.72	1.13	3.13	12.81
INDUSTRIAL	8.07	4.24	3.66	6.69	22.66
TRANSPORT	4.33	.00	.02	.09	4.43
TOTAL DEMAND	18.22	6.96	4.81	9.91	39.90

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

2000 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: OECD PACIFIC

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	.00	.82	.00	1.60	.01	2.36	4.78
UNCONVENTIONAL	.00	.00	.49	N/A	N/A	N/A	.49
TOTAL PRIMARY	.00	.82	.49	1.60	.01	2.36	5.27
SYNFUELS	.00	.00	-.01	.00	.00	.00	.00
TOTAL SUPPLY	.00	.82	.49	1.60	.01	2.36	5.27

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	5.48	.68	5.85	1.60	.01	2.36	15.98
RESIDEN-COMMERC	3.38	1.28	.71	.00	.00	.00	5.37
INDUSTRIAL	2.81	.99	3.42	.00	.00	.00	7.23
TRANSPORT	3.39	.00	.03	.00	.00	.00	3.42
TOTAL DEMAND	15.07	2.96	10.02	1.60	.01	2.36	32.00

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	5.49	.68	5.81	1.60	.01	2.36	15.95
RESIDEN-COMMERC	3.38	1.28	.70	.00	.00	.00	5.37
INDUSTRIAL	2.82	.99	3.40	.00	.00	.00	7.21
TRANSPORT	3.39	.00	.03	.00	.00	.00	3.43
TOTAL DEMAND	15.09	2.96	9.94	1.60	.01	2.36	31.95
TOTAL SUPPLY	.00	.82	.49	1.60	.01	2.36	5.27
NET IMPORTS	15.08	2.14	9.46	.00-	.00	.00	26.68

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	3.38	1.28	.70	1.91	7.28
INDUSTRIAL	2.82	.99	3.40	2.55	9.76
TRANSPORT	3.39	.00	.03	.11	3.53
TOTAL DEMAND	9.60	2.27	4.13	4.57	20.57

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2000 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: USSR/E. EUR.

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	24.25	29.03	62.33	1.14	.00	10.07	126.82
UNCONVENTIONAL	.00	.00	1.59	N/A	N/A	N/A	1.59
TOTAL PRIMARY	24.25	29.03	63.92	1.14	.00	10.07	128.41
SYNFUELS	.52	.00	-.78	.00	.00	.00	.52
TOTAL SUPPLY	24.77	29.03	63.14	1.14	.00	10.07	128.15

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	8.25	2.44	11.26	1.14	.00	10.07	33.16
END-USE DEMAND	19.70	10.17	24.08	.00	.00	.00	53.94
TOTAL DEMAND	27.95	12.61	35.33	1.14	.00	10.07	87.10

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	8.40	2.44	11.12	1.14	.00	10.07	33.18
END-USE DEMAND	20.07	10.17	23.78	.00	.00	.00	54.02
TOTAL DEMAND	28.47	12.61	34.90	1.14	.00	10.07	87.19
TOTAL SUPPLY	24.77	29.03	63.14	1.14	.00	10.07	128.15
NET IMPORTS	3.70	-16.42	-28.23	.00	.00	.00	-40.95

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	20.07	10.17	23.78	9.53	63.55
TOTAL DEMAND	20.07	10.17	23.78	9.53	63.55

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2000 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: CHINA/ET.AL.

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	10.47	.48	54.52	.19	.00	5.49	71.14
UNCONVENTIONAL	.00	.00	1.57	N/A	N/A	N/A	1.57
TOTAL PRIMARY	10.47	.48	56.09	.19	.00	5.49	72.71
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	10.47	.48	56.09	.19	.00	5.49	72.71

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	2.19	.06	4.30	.19	.00	5.49	12.22
END-USE DEMAND	9.12	1.14	29.73	.00	.00	.00	39.98
TOTAL DEMAND	11.30	1.20	34.03	.19	.00	5.49	52.20

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	2.19	.06	4.30	.19	.00	5.49	12.22
END-USE DEMAND	9.12	1.14	29.73	.00	.00	.00	39.98
TOTAL DEMAND	11.31	1.20	34.03	.19	.00	5.49	52.20
TOTAL SUPPLY	10.47	.48	56.09	.19	.00	5.49	72.71
NET IMPORTS	.84	.71	-22.06	.00	.00	.00	-20.51

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	9.12	1.14	29.73	3.56	43.54
TOTAL DEMAND	9.12	1.14	29.73	3.56	43.54

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

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****

REGION: MIDDLE EAST

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	47.50	1.53	.14	.02	.00	1.23	50.41
UNCONVENTIONAL	.00	.00	.27	N/A	N/A	N/A	.27
TOTAL PRIMARY	47.50	1.53	.40	.02	.00	1.23	50.68
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	47.50	1.53	.40	.02	.00	1.23	50.68

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.53	.54	.17	.02	.00	1.23	2.49
END-USE DEMAND	8.31	1.31	.22	.00	.00	.00	9.83
TOTAL DEMAND	8.84	1.85	.39	.02	.00	1.23	12.32

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.53	.54	.17	.02	.00	1.23	2.49
END-USE DEMAND	8.31	1.31	.22	.00	.00	.00	9.83
TOTAL DEMAND	8.84	1.85	.39	.02	.00	1.23	12.32
TOTAL SUPPLY	47.50	1.53	.40	.02	.00	1.23	50.68
NET IMPORTS	-38.66	.32	-.02	.00	.00	.00	-38.36

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	8.31	1.31	.22	.69	10.52
TOTAL DEMAND	8.31	1.31	.22	.69	10.52

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

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REGION: AFRICA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	29.03	.40	9.50	.09	.00	4.65	43.68
UNCONVENTIONAL	.00	.00	1.40	N/A	N/A	N/A	1.40
TOTAL PRIMARY	29.03	.40	10.90	.09	.00	4.65	45.08
SYNFUELS	.09	.00	-.13	.00	.00	.00	.09
TOTAL SUPPLY	29.12	.41	10.77	.09	.00	4.65	45.03

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.91	.10	2.24	.09	.00	4.65	7.99
END-USE DEMAND	5.06	1.24	4.78	.00	.00	.00	11.08
TOTAL DEMAND	5.97	1.34	7.02	.09	.00	4.65	19.07

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.92	.10	2.21	.09	.00	4.65	7.96
END-USE DEMAND	5.07	1.24	4.72	.00	.00	.00	11.04
TOTAL DEMAND	5.99	1.34	6.93	.09	.00	4.65	19.00
TOTAL SUPPLY	29.12	.41	10.77	.09	.00	4.65	45.03
NET IMPORTS	-23.13	.94	-3.83	.00	.00	.00	-26.03

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	5.07	1.24	4.72	2.33	13.36
TOTAL DEMAND	5.07	1.24	4.72	2.33	13.36

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2000 ENERGY PRODUCTION AND USAGE REPORT
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REGION: LATIN AMER

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	25.01	3.42	1.73	.40	.00	10.91	41.47
UNCONVENTIONAL	.00	.00	2.02	N/A	N/A	N/A	2.02
TOTAL PRIMARY	25.01	3.42	3.75	.40	.00	10.91	43.49
SYNFUELS	.03	.00	-.05	.00	.00	.00	.03
TOTAL SUPPLY	25.04	3.42	3.71	.40	.00	10.91	43.48

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	2.46	.64	1.56	.40	.00	10.91	15.97
END-USE DEMAND	15.37	3.59	2.25	.00	.00	.00	21.21
TOTAL DEMAND	17.83	4.23	3.81	.40	.00	10.91	37.18

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	2.46	.64	1.54	.40	.00	10.91	15.95
END-USE DEMAND	15.39	3.59	2.22	.00	.00	.00	21.20
TOTAL DEMAND	17.86	4.23	3.76	.40	.00	10.91	37.15
TOTAL SUPPLY	25.04	3.42	3.71	.40	.00	10.91	43.48
NET IMPORTS	-7.19	.81	.05	.00	.00	.00	-6.33

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	15.39	3.59	2.22	4.51	25.71
TOTAL DEMAND	15.39	3.59	2.22	4.51	25.71

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2000 ENERGY PRODUCTION AND USAGE REPORT
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REGION: S.&E. ASIA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	2.58	2.11	10.94	.40	.00	6.18	22.21
UNCONVENTIONAL	.00	.00	2.59	N/A	N/A	N/A	2.59
TOTAL PRIMARY	2.58	2.11	13.53	.40	.00	6.18	24.80
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	2.58	2.11	13.53	.40	.00	6.18	24.80

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	1.44	.10	4.99	.40	.00	6.18	13.11
END-USE DEMAND	9.48	.87	5.96	.00	.00	.00	16.31
TOTAL DEMAND	10.92	.97	10.95	.40	.00	6.18	29.43

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	1.44	.10	4.99	.40	.00	6.18	13.12
END-USE DEMAND	9.49	.87	5.96	.00	.00	.00	16.32
TOTAL DEMAND	10.93	.97	10.95	.40	.00	6.18	29.43
TOTAL SUPPLY	2.58	2.11	13.53	.40	.00	6.18	24.80
NET IMPORTS	8.35	-1.14	-2.57	.00	.00	.00	4.63

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	9.49	.87	5.96	3.86	20.18
TOTAL DEMAND	9.49	.87	5.96	3.86	20.18

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

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REGION: USA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	.04	10.59	.00	12.92	5.89	6.14	35.59
UNCONVENTIONAL	.04	.00	1.56	N/A	N/A	N/A	1.61
TOTAL PRIMARY	.09	10.59	1.56	12.92	5.89	6.14	37.19
SYNFUELS	.09	.00	-.13	.00	.00	.00	.09
TOTAL SUPPLY	.17	10.59	1.43	12.92	5.89	6.14	37.15

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	5.49	10.73	30.15	12.92	5.89	6.14	71.32
RESIDEN-COMMERC	6.78	10.50	.46	.00	.00	.00	17.74
INDUSTRIAL	5.20	3.12	4.63	.00	.00	.00	12.95
TRANSPORT	19.33	.00	.00	.00	.00	.00	19.33
TOTAL DEMAND	36.81	24.35	35.24	12.92	5.89	6.14	121.35

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	5.83	10.74	27.60	12.92	5.89	6.14	69.12
RESIDEN-COMMERC	7.19	10.51	.42	.00	.00	.00	18.12
INDUSTRIAL	5.52	3.12	4.24	.00	.00	.00	12.88
TRANSPORT	20.50	.00	.00	.00	.00	.00	20.50
TOTAL DEMAND	39.04	24.37	32.27	12.92	5.89	6.14	120.63
TOTAL SUPPLY	.17	10.59	1.43	12.92	5.89	6.14	37.15
NET IMPORTS	38.87	13.78	30.83	.00	.00	.00	83.48

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	7.19	10.51	.42	11.33	29.45
INDUSTRIAL	5.52	3.12	4.24	8.72	21.60
TRANSPORT	20.50	.00	.00	.03	20.53
TOTAL DEMAND	33.21	13.63	4.66	20.08	71.59

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

2025 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: CANADA & EUR

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	34.78	15.72	.00	9.12	3.64	11.97	75.23
UNCONVENTIONAL	.04	.00	4.30	N/A	N/A	N/A	4.34
TOTAL PRIMARY	34.82	15.72	4.30	9.12	3.64	11.97	79.56
SYNFUELS	.24	.00	-.36	.00	.00	.00	.24
TOTAL SUPPLY	35.06	15.73	3.93	9.12	3.64	11.97	79.44

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.02	7.87	13.55	9.12	3.64	11.97	49.17
RESIDEN-COMMERC	4.79	5.02	1.85	.00	.00	.00	11.65
INDUSTRIAL	5.39	7.19	5.77	.00	.00	.00	18.36
TRANSPORT	4.77	.00	.04	.00	.00	.00	4.81
TOTAL DEMAND	17.98	20.08	21.21	9.12	3.64	11.97	83.99

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.04	7.87	12.41	9.12	3.64	11.97	48.05
RESIDEN-COMMERC	4.82	5.02	1.69	.00	.00	.00	11.53
INDUSTRIAL	5.43	7.20	5.28	.00	.00	.00	17.91
TRANSPORT	4.80	.00	.03	.00	.00	.00	4.84
TOTAL DEMAND	18.10	20.09	19.42	9.12	3.64	11.97	82.33
TOTAL SUPPLY	35.06	15.73	3.93	9.12	3.64	11.97	79.44
NET IMPORTS	-16.96	4.36	15.48	.00	.00	.00	2.88

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	4.82	5.02	1.69	4.24	15.77
INDUSTRIAL	5.43	7.20	5.28	9.44	27.35
TRANSPORT	4.80	.00	.03	.16	5.00
TOTAL DEMAND	15.06	12.21	7.01	13.83	48.11

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2025 ENERGY PRODUCTION AND USAGE REPORT
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REGION: OECD PACIFIC

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	.04	2.43	.00	4.70	1.88	2.59	11.63
UNCONVENTIONAL	.04	.00	.76	N/A	N/A	N/A	.80
TOTAL PRIMARY	.09	2.43	.76	4.70	1.88	2.59	12.44
SYNFUELS	.04	.00	-.06	.00	.00	.00	.04
TOTAL SUPPLY	.13	2.43	.70	4.70	1.88	2.59	12.41

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.03	2.00	9.62	4.70	1.88	2.59	23.81
RESIDEN-COMMERC	3.15	2.50	1.01	.00	.00	.00	6.67
INDUSTRIAL	2.18	1.76	4.43	.00	.00	.00	8.36
TRANSPORT	3.83	.00	.06	.00	.00	.00	3.89
TOTAL DEMAND	12.19	6.25	15.12	4.70	1.88	2.59	42.72

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.22	2.00	8.80	4.70	1.88	2.59	23.18
RESIDEN-COMMERC	3.34	2.50	.93	.00	.00	.00	6.78
INDUSTRIAL	2.31	1.76	4.05	.00	.00	.00	8.12
TRANSPORT	4.07	.00	.06	.00	.00	.00	4.12
TOTAL DEMAND	12.94	6.26	13.84	4.70	1.88	2.59	42.20
TOTAL SUPPLY	.13	2.43	.70	4.70	1.88	2.59	12.41
NET IMPORTS	12.81	3.83	13.15	.00	.00	.00	29.79

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	3.34	2.50	.93	2.70	9.48
INDUSTRIAL	2.31	1.76	4.05	3.85	11.98
TRANSPORT	4.07	.00	.06	.18	4.30
TOTAL DEMAND	9.72	4.26	5.04	6.74	25.76

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2025 ENERGY PRODUCTION AND USAGE REPORT
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REGION: USSR/E. EUR.

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	56.70	43.96	123.38	5.08	2.03	16.08	247.23
UNCONVENTIONAL	.04	.00	2.40	N/A	N/A	N/A	2.44
TOTAL PRIMARY	56.74	43.96	125.78	5.08	2.03	16.08	249.67
SYNFUELS	7.00	.07	-10.61	.00	.00	.00	7.07
TOTAL SUPPLY	63.74	44.04	115.17	5.08	2.03	16.08	246.13

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	6.09	3.04	13.90	5.08	2.03	16.08	46.23
END-USE DEMAND	18.84	19.63	21.86	.00	.00	.00	60.34
TOTAL DEMAND	24.93	22.67	35.77	5.08	2.03	16.08	106.56

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	6.84	3.05	12.73	5.08	2.03	16.08	45.81
END-USE DEMAND	21.17	19.66	20.02	.00	.00	.00	60.85
TOTAL DEMAND	28.01	22.71	32.75	5.08	2.03	16.08	106.66
TOTAL SUPPLY	63.74	44.04	115.17	5.08	2.03	16.08	246.13
NET IMPORTS	-35.73	-21.32	-82.42	.00	.00	.00	-139.47

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	21.17	19.66	20.02	13.23	74.08
TOTAL DEMAND	21.17	19.66	20.02	13.23	74.08

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2025 ENERGY PRODUCTION AND USAGE REPORT
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REGION: CHINA/ET.AL.

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	9.65	2.00	85.44	3.43	.24	15.59	116.35
UNCONVENTIONAL	.04	.00	2.94	N/A	N/A	N/A	2.99
TOTAL PRIMARY	9.69	2.00	88.38	3.43	.24	15.59	119.34
SYNFUELS	4.92	.05	-7.46	.00	.00	.00	4.97
TOTAL SUPPLY	14.61	2.05	80.93	3.43	.24	15.59	116.85

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.56	1.03	9.44	3.43	.24	15.59	33.29
END-USE DEMAND	14.26	5.71	53.56	.00	.00	.00	73.54
TOTAL DEMAND	17.83	6.74	63.00	3.43	.24	15.59	106.83

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	4.64	1.03	8.64	3.43	.24	15.59	33.58
END-USE DEMAND	18.58	5.76	49.04	.00	.00	.00	73.39
TOTAL DEMAND	23.22	6.80	57.68	3.43	.24	15.59	106.97
TOTAL SUPPLY	14.61	2.05	80.93	3.43	.24	15.59	116.85
NET IMPORTS	8.61	4.74	-23.24	.00	.00	.00	-9.88

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	18.58	5.76	49.04	9.74	83.12
TOTAL DEMAND	18.58	5.76	49.04	9.74	83.12

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2025 ENERGY PRODUCTION AND USAGE REPORT
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REGION: MIDDLE EAST

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	29.91	9.16	.00	2.77	1.10	2.08	45.03
UNCONVENTIONAL	.04	.00	.60	N/A	N/A	N/A	.64
TOTAL PRIMARY	29.96	9.16	.60	2.77	1.10	2.08	45.67
SYNFUELS	.00	.00	.00	.00	.00	.00	.00
TOTAL SUPPLY	29.96	9.16	.60	2.77	1.10	2.08	45.67

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.79	2.24	3.73	2.77	1.10	2.08	12.72
END-USE DEMAND	16.19	4.49	.92	.00	.00	.00	21.60
TOTAL DEMAND	16.99	6.73	4.65	2.77	1.10	2.08	34.32

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.79	2.24	3.46	2.77	1.10	2.08	12.44
END-USE DEMAND	16.19	4.49	.85	.00	.00	.00	21.53
TOTAL DEMAND	16.99	6.73	4.31	2.77	1.10	2.08	33.98
TOTAL SUPPLY	29.96	9.16	.60	2.77	1.10	2.08	45.67
NET IMPORTS	-12.97	-2.43	3.71	.00	.00	.00	-11.69

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	16.19	4.49	.85	3.58	25.12
TOTAL DEMAND	16.19	4.49	.85	3.58	25.12

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2025 ENERGY PRODUCTION AND USAGE REPORT
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REGION: AFRICA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	29.04	2.26	10.18	1.55	.62	18.55	62.19
UNCONVENTIONAL	.04	.00	3.03	N/A	N/A	N/A	3.07
TOTAL PRIMARY	29.09	2.26	13.20	1.55	.62	18.55	65.26
SYNFUELS	.73	.01	-1.11	.00	.00	.00	.74
TOTAL SUPPLY	29.82	2.26	12.09	1.55	.62	18.55	64.89

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	1.87	.93	4.25	1.55	.62	18.55	27.77
END-USE DEMAND	14.03	5.51	12.30	.00	.00	.00	31.85
TOTAL DEMAND	15.90	6.44	16.54	1.55	.62	18.55	59.61

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	1.92	.93	3.89	1.55	.62	18.55	27.46
END-USE DEMAND	14.39	5.53	11.26	.00	.00	.00	31.17
TOTAL DEMAND	16.31	6.46	15.15	1.55	.62	18.55	58.63
TOTAL SUPPLY	29.82	2.26	12.09	1.55	.62	18.55	64.89
NET IMPORTS	-13.51	4.19	3.06	.00	.00	.00	-6.26

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	14.39	5.53	11:26	7.94	39.11
TOTAL DEMAND	14.39	5.53	11.26	7.94	39.11

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

2025 ENERGY PRODUCTION AND USAGE REPORT
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REGION: LATIN AMER

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	26.13	17.67	2.41	5.70	2.27	20.44	74.62
UNCONVENTIONAL	.04	.00	4.02	N/A	N/A	N/A	4.06
TOTAL PRIMARY	26.17	17.67	6.43	5.70	2.27	20.44	78.68
SYNFUELS	.36	.00	-.54	.00	.00	.00	.36
TOTAL SUPPLY	26.53	17.67	5.88	5.70	2.27	20.44	78.50

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	7.44	3.42	15.60	5.70	2.27	20.44	54.87
END-USE DEMAND	27.65	9.08	5.95	.00	.00	.00	42.68
TOTAL DEMAND	35.09	12.50	21.55	5.70	2.27	20.44	97.55

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	7.63	3.42	14.28	5.70	2.27	20.44	53.74
END-USE DEMAND	28.34	9.08	5.45	.00	.00	.00	42.87
TOTAL DEMAND	35.96	12.50	19.73	5.70	2.27	20.44	96.61
TOTAL SUPPLY	26.53	17.67	5.88	5.70	2.27	20.44	78.50
NET IMPORTS	9.43	-5.17	13.85	.00	.00	.00	18.11

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	28.34	9.08	5.45	15.52	58.39
TOTAL DEMAND	28.34	9.08	5.45	15.52	58.39

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

[illegible] ENERGY PRODUCTION AND USAGE REPORT
****

REGION: S.&E. ASIA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	6.70	8.87	.00	5.26	2.10	12.93	35.86
UNCONVENTIONAL	.04	.00	5.09	N/A	N/A	N/A	[illegible]
TOTAL PRIMARY	6.74	8.87	5.09	5.26	2.10	12.93	[illegible]
SYNFUELS	.28	.00	-.43	.00	.00	.00	.27
TOTAL SUPPLY	7.02	8.87	4.66	5.26	2.10	12.93	40.84

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	2.94	3.19	14.57	5.26	2.10	12.93	40.99
END-USE DEMAND	12.93	3.69	18.46	.00	.00	.00	35.08
TOTAL DEMAND	15.87	6.89	33.03	5.26	2.10	12.93	76.08

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.09	3.19	13.34	5.26	2.10	12.93	39.92
END-USE DEMAND	13.59	3.70	16.90	.00	.00	.00	34.19
TOTAL DEMAND	16.68	6.89	30.24	5.26	2.10	12.93	74.11
TOTAL SUPPLY	7.02	8.87	4.66	5.26	2.10	12.93	40.84
NET IMPORTS	9.66	-1.98	25.59	.00	.00	.00	33.27

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	13.59	3.70	16.90	11.66	45.85
TOTAL DEMAND	13.59	3.70	16.90	11.66	45.85

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

2050 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: USA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	.09	27.78	.00	16.90	8.87	6.29	59.9[illegible]
UNCONVENTIONAL	.09	.00	2.55	N/A	N/A	N/A	2.64
TOTAL PRIMARY	.18	27.78	2.55	16.90	8.87	6.29	62.57
SYNFUELS	.35	.02	-.56	.00	.00	.00	.3[illegible]
TOTAL SUPPLY	.53	27.80	2.00	16.90	8.87	6.29	62.38

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	7.90	14.99	44.59	16.90	8.87	6.29	99.54
RESIDEN-COMMERC	6.23	11.11	.57	.00	.00	.00	17.91
INDUSTRIAL	4.33	2.35	4.95	.00	.00	.00	11.62
TRANSPORT	20.79	.00	.00	.00	.00	.00	20.79
TOTAL DEMAND	39.26	28.45	50.11	16.90	8.87	6.29	149.87

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	9.29	15.01	34.90	16.90	8.87	6.29	91.25
RESIDEN-COMMERC	7.33	11.12	.45	.00	.00	.00	18.90
INDUSTRIAL	5.09	2.35	3.87	.00	.00	.00	11.31
TRANSPORT	24.44	.00	.00	.00	.00	.00	24.44
TOTAL DEMAND	46.15	28.48	39.21	16.90	8.87	6.29	145.90
TOTAL SUPPLY	.53	27.80	2.00	16.90	8.87	6.29	62.38
NET IMPORTS	45.62	.68	37.22	.00	.00	.00	83.52

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	7.33	11.12	.45	14.51	33.41
INDUSTRIAL	5.09	2.35	3.87	11.87	23.18
TRANSPORT	24.44	.00	.00	.04	24.48
TOTAL DEMAND	36.86	13.47	4.32	26.42	81.07

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

2050 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: CANADA & EUR

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	9.23	13.95	.00	12.25	6.43	12.08	53.94
UNCONVENTIONAL	.09	.00	5.80	N/A	N/A	N/A	5.89
TOTAL PRIMARY	9.32	13.95	5.80	12.25	6.43	12.08	59.83
SYNFUELS	.80	.04	-1.26	.00	.00	.00	.84
TOTAL SUPPLY	10.12	13.99	4.54	12.25	6.43	12.08	59.41

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.15	10.80	26.90	12.25	6.43	12.08	71.62
RESIDEN-COMMERC	3.78	6.08	2.51	.00	.00	.00	12.37
INDUSTRIAL	3.92	7.24	7.37	.00	.00	.00	18.52
TRANSPORT	4.76	.00	.07	.00	.00	.00	4.84
TOTAL DEMAND	15.61	24.11	36.86	12.25	6.43	12.08	107.35

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.53	10.89	21.06	12.25	6.43	12.08	66.23
RESIDEN-COMMERC	4.23	6.13	1.97	.00	.00	.00	12.32
INDUSTRIAL	4.38	7.30	5.77	.00	.00	.00	17.45
TRANSPORT	5.33	.00	.06	.00	.00	.00	5.39
TOTAL DEMAND	17.47	24.32	28.85	12.25	6.43	12.08	101.39
TOTAL SUPPLY	10.12	13.99	4.54	12.25	6.43	12.08	59.41
NET IMPORTS	7.35	10.33	24.31	.00	.00	.00	41.99

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	4.23	6.13	1.97	5.54	17.87
INDUSTRIAL	4.38	7.30	5.77	13.38	30.82
TRANSPORT	5.33	.00	.06	.26	5.65
TOTAL DEMAND	13.94	13.43	7.79	19.18	54.34

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2050 ENERGY PRODUCTION AND USAGE REPORT

REGION: OECD PACIFIC

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	.09	4.22	.00	5.91	3.10	2.63	15.95
UNCONVENTIONAL	.09	.00	1.22	N/A	N/A	N/A	1.31
TOTAL PRIMARY	.17	4.22	1.22	5.91	3.10	2.63	17.26
SYNFUELS	.17	.01	-.27	.00	.00	.00	.18
TOTAL SUPPLY	.34	4.23	.96	5.91	3.10	2.63	17.17

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.12	2.89	15.69	5.91	3.10	2.63	33.34
RESIDEN-COMMERC	2.58	3.43	1.15	.00	.00	.00	7.16
INDUSTRIAL	1.70	2.20	4.53	.00	.00	.00	8.43
TRANSPORT	3.82	.00	.11	.00	.00	.00	3.93
TOTAL DEMAND	11.22	8.52	21.47	5.91	3.10	2.63	52.86

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.68	2.92	12.28	5.91	3.10	2.63	30.52
RESIDEN-COMMERC	3.05	3.46	.90	.00	.00	.00	7.40
INDUSTRIAL	2.00	2.22	3.54	.00	.00	.00	7.77
TRANSPORT	4.51	.00	.08	.00	.00	.00	4.60
TOTAL DEMAND	13.24	8.60	16.80	5.91	3.10	2.63	50.29
TOTAL SUPPLY	.34	4.23	.96	5.91	3.10	2.63	17.17
NET IMPORTS	12.90	4.37	15.85	.00	.00	.00	33.12

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	3.05	3.46	.90	3.32	10.72
INDUSTRIAL	2.00	2.22	3.54	5.30	13.07
TRANSPORT	4.51	.00	.08	.27	4.86
TOTAL DEMAND	9.56	5.68	4.53	8.89	28.65

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2050 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: USSR/E. EUR.

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	26.74	46.43	242.30	6.91	3.63	17.01	343.03
UNCONVENTIONAL	.08	.00	3.79	N/A	N/A	N/A	3.87
TOTAL PRIMARY	26.82	46.43	246.09	6.91	3.63	17.01	346.90
SYNFUELS	33.81	1.86	-53.50	.00	.00	.00	35.67
TOTAL SUPPLY	60.63	48.29	192.59	6.91	3.63	17.01	329.06

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	3.93	2.97	24.19	6.91	3.63	17.01	58.64
END-USE DEMAND	9.18	22.39	17.02	.00	.00	.00	48.59
TOTAL DEMAND	13.11	25.37	41.21	6.91	3.63	17.01	107.23

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	8.89	3.09	18.93	6.91	3.63	17.01	58.46
END-USE DEMAND	20.74	23.29	13.32	.00	.00	.00	57.35
TOTAL DEMAND	29.63	26.38	32.25	6.91	3.63	17.01	115.81
TOTAL SUPPLY	60.63	48.29	192.59	6.91	3.63	17.01	329.06
NET IMPORTS	-31.00	-21.91	-160.34	.00	.00	.00	-213.25

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	20.74	23.29	13.32	16.96	74.31
TOTAL DEMAND	20.74	23.29	13.32	16.96	74.31

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

2050 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: CHINA/ET.AL.

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	9.19	7.21	120.22	9.75	5.12	19.29	170.78
UNCONVENTIONAL	.12	.00	5.63	N/A	N/A	N/A	5.75
TOTAL PRIMARY	9.32	7.21	125.85	9.75	5.12	19.29	176.53
SYNFUELS	17.29	.95	-27.36	.00	.00	.00	18.24
TOTAL SUPPLY	26.61	8.16	98.49	9.75	5.12	19.29	167.41

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	6.18	4.15	34.12	9.75	5.12	19.29	78.61
END-USE DEMAND	12.06	19.70	54.95	.00	.00	.00	86.71
TOTAL DEMAND	18.24	23.85	89.07	9.75	5.12	19.29	165.32

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	12.54	4.36	26.70	9.75	5.12	19.29	77.76
END-USE DEMAND	24.49	20.71	43.00	.00	.00	.00	88.19
TOTAL DEMAND	37.02	25.07	69.70	9.75	5.12	19.29	165.96
TOTAL SUPPLY	26.61	8.16	98.49	9.75	5.12	19.29	167.41
NET IMPORTS	10.42	16.91	-28.78	.00	.00	.00	-1.46

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	24.49	20.71	43.00	22.56	110.76
TOTAL DEMAND	24.49	20.71	43.00	22.56	110.76

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2050 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: MIDDLE EAST

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	108.66	42.09	.03	8.92	4.68	2.08	166.46
UNCONVENTIONAL	.16	.00	1.29	N/A	N/A	N/A	1.44
TOTAL PRIMARY	108.81	42.09	1.32	8.92	4.68	2.08	167.91
SYNFUELS	.00	.00	-.01	.00	.00	.00	.01
TOTAL SUPPLY	108.82	42.09	1.31	8.92	4.68	2.08	167.90

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	1.25	4.03	15.42	8.92	4.68	2.08	36.38
END-USE DEMAND	18.71	7.02	2.03	.00	.00	.00	27.76
TOTAL DEMAND	19.95	11.05	17.45	8.92	4.68	2.08	64.13

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	1.25	4.03	12.31	8.92	4.68	2.08	33.27
END-USE DEMAND	18.71	7.02	1.62	.00	.00	.00	27.35
TOTAL DEMAND	19.96	11.05	13.93	8.92	4.68	2.08	60.62
TOTAL SUPPLY	108.82	42.09	1.31	8.92	4.68	2.08	167.90
NET IMPORTS	-88.86	-31.05	12.63	.00	.00	.00	-107.28

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	18.71	7.02	1.62	9.73	37.08
TOTAL DEMAND	18.71	7.02	1.62	9.73	37.08

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2050 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: AFRICA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	25.50	9.62	20.63	6.61	3.47	24.42	90.26
UNCONVENTIONAL	.14	.00	6.30	N/A	N/A	N/A	6.45
TOTAL PRIMARY	25.64	9.62	26.93	6.61	3.47	24.42	96.71
SYNFUELS	3.70	.20	-5.86	.00	.00	.00	3.90
TOTAL SUPPLY	29.34	9.83	21.08	6.61	3.47	24.42	94.75

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	6.79	2.91	23.18	6.61	3.47	24.42	67.38
END-USE DEMAND	14.09	12.34	19.61	.00	.00	.00	46.04
TOTAL DEMAND	20.89	15.25	42.79	6.61	3.47	24.42	113.43

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	7.77	2.96	18.14	6.61	3.47	24.42	63.38
END-USE DEMAND	16.13	12.58	15.35	.00	.00	.00	44.05
TOTAL DEMAND	23.90	15.54	33.48	6.61	3.47	24.42	107.44
TOTAL SUPPLY	29.34	9.83	21.08	6.61	3.47	24.42	94.75
NET IMPORTS	-5.44	5.71	12.41	.00	.00	.00	12.68

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	16.13	12.58	15.35	18.42	62.47
TOTAL DEMAND	16.13	12.58	15.35	18.42	62.47

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2050 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: LATIN AMER

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	21.87	13.31	3.72	14.65	7.69	22.14	83.38
UNCONVENTIONAL	.13	.00	8.03	N/A	N/A	N/A	8.16
TOTAL PRIMARY	22.00	13.31	11.75	14.65	7.69	22.14	91.54
SYNFUELS	1.61	.09	-2.55	.00	.00	.00	1.70
TOTAL SUPPLY	23.61	13.39	9.20	14.65	7.69	22.14	90.69

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	16.66	6.50	51.29	14.65	7.69	22.14	118.94
END-USE DEMAND	31.15	11.42	8.72	.00	.00	.00	51.29
TOTAL DEMAND	47.81	17.92	60.01	14.65	7.69	22.14	170.23

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	18.73	6.56	40.14	14.65	7.69	22.14	109.92
END-USE DEMAND	35.02	11.52	6.82	.00	.00	.00	53.37
TOTAL DEMAND	53.75	18.08	46.97	14.65	7.69	22.14	163.29
TOTAL SUPPLY	23.61	13.39	9.20	14.65	7.69	22.14	90.69
NET IMPORTS	30.14	4.69	37.77	.00	.00	.00	72.60

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	35.02	11.52	6.82	31.89	85.26
TOTAL DEMAND	35.02	11.52	6.82	31.89	85.26

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

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REGION: S.&E. ASIA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	1.99	2.19	.04	12.24	6.42	14.09	36.96
UNCONVENTIONAL	.13	.00	10.16	N/A	N/A	N/A	10.29
TOTAL PRIMARY	2.12	2.19	10.19	12.24	6.42	14.09	47.25
SYNFUELS	1.40	.08	-2.22	.00	.00	.00	1.48
TOTAL SUPPLY	3.52	2.26	7.98	12.24	6.42	14.09	46.51

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	5.37	5.44	43.35	12.24	6.42	14.09	86.90
END-USE DEMAND	12.92	6.85	29.40	.00	.00	.00	49.17
TOTAL DEMAND	18.29	12.28	72.75	12.24	6.42	14.09	136.07

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	6.57	5.54	33.92	12.24	6.42	14.09	78.79
END-USE DEMAND	15.83	6.98	23.01	.00	.00	.00	45.82
TOTAL DEMAND	22.40	12.52	56.93	12.24	6.42	14.09	124.61
TOTAL SUPPLY	3.52	2.26	7.98	12.24	6.42	14.09	46.51
NET IMPORTS	18.88	10.26	48.96	.00	.00	.00	78.09

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	15.83	6.98	23.01	23.13	68.94
TOTAL DEMAND	15.83	6.98	23.01	23.13	68.94

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2075 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: USA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	.15	12.56	.00	29.76	11.69	6.28	60.45
UNCONVENTIONAL	.15	.00	3.52	N/A	N/A	N/A	3.67
TOTAL PRIMARY	.31	12.56	3.52	29.76	11.69	6.28	64.12
SYNFUELS	.76	.13	-1.33	.00	.00	.00	.88
TOTAL SUPPLY	1.07	12.69	2.19	29.76	11.69	6.28	63.68

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	5.40	12.68	67.75	29.76	11.69	6.28	133.56
RESIDEN-COMMERC	3.81	10.03	.71	.00	.00	.00	14.55
INDUSTRIAL	2.34	1.53	5.22	.00	.00	.00	9.09
TRANSPORT	15.23	.00	.00	.00	.00	.00	15.23
TOTAL DEMAND	26.78	24.24	73.68	29.76	11.69	6.28	172.43

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	9.77	12.80	42.19	29.76	11.69	6.28	112.50
RESIDEN-COMMERC	6.89	10.13	.44	.00	.00	.00	17.46
INDUSTRIAL	4.23	1.54	3.25	.00	.00	.00	9.02
TRANSPORT	27.55	.00	.00	.00	.00	.00	27.55
TOTAL DEMAND	48.43	24.47	45.89	29.76	11.69	6.28	166.52
TOTAL SUPPLY	1.07	12.69	2.19	29.76	11.69	6.28	63.68
NET IMPORTS	47.37	11.78	43.70	.00	.00	.00	102.85

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	6.89	10.13	.44	17.98	35.44
INDUSTRIAL	4.23	1.54	3.25	14.72	23.74
TRANSPORT	27.55	.00	.00	.06	27.61
TOTAL DEMAND	38.66	11.67	3.69	32.76	86.79

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

2075 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: CANADA & EUR

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	6.38	.00	.00	24.94	9.80	12.03	53.16
UNCONVENTIONAL	.16	.00	7.89	N/A	N/A	N/A	8.05
TOTAL PRIMARY	6.54	.00	7.89	24.94	9.80	12.03	61.21
SYNFUELS	1.70	.29	-2.98	.00	.00	.00	1.98
TOTAL SUPPLY	8.24	.29	4.92	24.94	9.80	12.03	60.22

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	2.73	10.45	46.56	24.94	9.80	12.03	106.51
RESIDEN-COMMERC	2.73	5.75	3.25	.00	.00	.00	11.73
INDUSTRIAL	2.57	5.07	8.19	.00	.00	.00	15.83
TRANSPORT	3.92	.00	.13	.00	.00	.00	4.05
TOTAL DEMAND	11.95	21.26	58.14	24.94	9.80	12.03	138.12

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	4.09	10.68	29.00	24.94	9.80	12.03	90.54
RESIDEN-COMMERC	4.09	5.87	2.03	.00	.00	.00	11.99
INDUSTRIAL	3.85	5.18	5.10	.00	.00	.00	14.13
TRANSPORT	5.87	.00	.08	.00	.00	.00	5.95
TOTAL DEMAND	17.91	21.73	36.21	24.94	9.80	12.03	122.62
TOTAL SUPPLY	8.24	.29	4.92	24.94	9.80	12.03	60.22
NET IMPORTS	9.66	21.44	31.29	.00	.00	.00	62.40

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	4.09	5.87	2.03	7.49	19.48
INDUSTRIAL	3.85	5.18	5.10	18.50	32.64
TRANSPORT	5.87	.00	.08	.40	6.35
TOTAL DEMAND	13.81	11.05	7.21	26.39	58.47

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

2075 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: OECD PACIFIC

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	.15	.00	.00	11.34	4.46	2.63	18.58
UNCONVENTIONAL	.15	.00	1.69	N/A	N/A	N/A	1.84
TOTAL PRIMARY	.30	.00	1.69	11.34	4.46	2.63	20.42
SYNFUELS	.36	.06	-.64	.00	.00	.00	.42
TOTAL SUPPLY	.66	.06	1.05	11.34	4.46	2.63	20.20

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	2.30	2.58	25.95	11.34	4.46	2.63	49.26
RESIDEN-COMMERC	1.65	3.26	1.50	.00	.00	.00	6.41
INDUSTRIAL	.98	1.54	5.12	.00	.00	.00	7.65
TRANSPORT	2.72	.00	.19	.00	.00	.00	2.90
TOTAL DEMAND	7.65	7.39	32.76	11.34	4.46	2.63	66.22

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	4.16	2.63	16.16	11.34	4.46	2.63	41.37
RESIDEN-COMMERC	2.97	3.31	.94	.00	.00	.00	7.22
INDUSTRIAL	1.77	1.57	3.19	.00	.00	.00	6.53
TRANSPORT	4.91	.00	.12	.00	.00	.00	5.02
TOTAL DEMAND	13.81	7.51	20.40	11.34	4.46	2.63	60.15
TOTAL SUPPLY	.66	.06	1.05	11.34	4.46	2.63	20.20
NET IMPORTS	13.14	7.45	19.35	.00	.00	.00	39.94

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
RESIDEN-COMMERC	2.97	3.31	.94	4.43	11.65
INDUSTRIAL	1.77	1.57	3.19	7.31	13.84
TRANSPORT	4.91	.00	.12	.37	5.39
TOTAL DEMAND	9.65	4.88	4.24	12.11	30.88

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

2075 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: USSR/E. EUR.

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	2.88	.00	391.65	12.06	4.74	17.05	428.39
UNCONVENTIONAL	.14	.00	5.10	N/A	N/A	N/A	5.23
TOTAL PRIMARY	3.02	.00	396.75	12.06	4.74	17.05	433.62
SYNFUELS	85.23	14.53	-149.64	.00	.00	.00	99.76
TOTAL SUPPLY	88.25	14.53	247.11	12.06	4.74	17.05	383.74

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.32	.80	36.03	12.06	4.74	17.05	71.00
END-USE DEMAND	.63	5.99	20.29	.00	.00	.00	26.92
TOTAL DEMAND	.96	6.80	56.32	12.06	4.74	17.05	97.92

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	9.37	2.52	22.44	12.06	4.74	17.05	68.18
END-USE DEMAND	18.53	18.87	12.64	.00	.00	.00	50.03
TOTAL DEMAND	27.90	21.39	35.08	12.06	4.74	17.05	118.22
TOTAL SUPPLY	88.25	14.53	247.11	12.06	4.74	17.05	383.74
NET IMPORTS	-60.35	6.85	-212.03	.00	.00	.00	-265.53

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	18.53	18.87	12.64	19.86	69.89
TOTAL DEMAND	18.53	18.87	12.64	19.86	69.89

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

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****

REGION: CHINA/ET.AL.

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	.00	12.03	212.83	22.61	8.88	19.72	276.07
UNCONVENTIONAL	.28	.00	8.93	N/A	N/A	N/A	9.21
TOTAL PRIMARY	.28	12.03	221.76	22.61	8.88	19.72	285.28
SYNFUELS	47.64	8.12	-83.64	.00	.00	.00	55.76
TOTAL SUPPLY	47.92	20.16	138.12	22.61	8.88	19.72	257.40

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	.10	3.24	67.52	22.61	8.88	19.72	122.07
END-USE DEMAND	.15	14.58	75.34	.00	.00	.00	90.07
TOTAL DEMAND	.26	17.82	142.86	22.61	8.88	19.72	212.14

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	17.56	4.72	42.05	22.61	8.88	19.72	115.54
END-USE DEMAND	25.99	21.26	46.93	.00	.00	.00	94.18
TOTAL DEMAND	43.55	25.99	88.98	22.61	8.88	19.72	209.72
TOTAL SUPPLY	47.92	20.16	138.12	22.61	8.88	19.72	257.40
NET IMPORTS	-4.37	5.83	-49.14	.00	.00	.00	-47.68

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	25.99	21.26	46.93	33.65	127.83
TOTAL DEMAND	25.99	21.26	46.93	33.65	127.83

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

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****

REGION: MIDDLE EAST

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	100.64	80.78	.08	22.00	8.64	2.07	214.21
UNCONVENTIONAL	.45	.00	2.28	N/A	N/A	N/A	2.73
TOTAL PRIMARY	101.09	80.78	2.36	22.00	8.64	2.07	216.94
SYNFUELS	.51	.09	-.89	.00	.00	.00	.59
TOTAL SUPPLY	101.60	80.86	1.47	22.00	8.64	2.07	216.64

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	1.76	4.64	33.19	22.00	8.64	2.07	72.30
END-USE DEMAND	21.60	8.21	3.04	.00	.00	.00	32.84
TOTAL DEMAND	23.35	12.84	36.22	22.00	8.64	2.07	105.14

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	1.77	4.64	20.67	22.00	8.64	2.07	59.79
END-USE DEMAND	21.71	8.21	1.89	.00	.00	.00	31.81
TOTAL DEMAND	23.47	12.86	22.56	22.00	8.64	2.07	91.61
TOTAL SUPPLY	101.60	80.86	1.47	22.00	8.64	2.07	216.64
NET IMPORTS	-78.12	-68.00	21.09	.00	.00	.00	-125.04

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	21.71	8.21	1.89	17.60	49.41
TOTAL DEMAND	21.71	8.21	1.89	17.60	49.41

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2075 ENERGY PRODUCTION AND USAGE REPORT
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REGION: AFRICA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	20.79	29.27	29.29	18.48	7.26	25.00	130.09
UNCONVENTIONAL	.38	.00	10.68	N/A	N/A	N/A	11.06
TOTAL PRIMARY	21.17	29.27	39.97	18.48	7.26	25.00	141.15
SYNFUELS	8.59	1.46	-15.07	.00	.00	.00	10.05
TOTAL SUPPLY	29.76	30.73	24.89	18.48	7.26	25.00	136.12

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	9.21	3.68	55.27	18.48	7.26	25.00	118.91
END-USE DEMAND	12.78	13.32	28.19	.00	.00	.00	54.29
TOTAL DEMAND	21.99	17.01	83.47	18.48	7.26	25.00	173.20

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	13.08	3.87	34.43	18.48	7.26	25.00	102.11
END-USE DEMAND	18.14	13.99	17.56	.00	.00	.00	49.69
TOTAL DEMAND	31.22	17.86	51.98	18.48	7.26	25.00	151.81
TOTAL SUPPLY	29.76	30.73	24.89	18.48	7.26	25.00	136.12
NET IMPORTS	1.47	-12.88	27.09	.00	.00	.00	15.68

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	18.14	13.99	17.56	29.79	79.48
TOTAL DEMAND	18.14	13.99	17.56	29.79	79.48

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued) (2=NOPT(5)

2075 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: LATIN AMER

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	.00	.00	6.20	31.66	12.44	22.23	72.52
UNCONVENTIONAL	.32	.00	13.01	N/A	N/A	N/A	13.33
TOTAL PRIMARY	.32	.00	19.20	31.66	12.44	22.23	85.84
SYNFUELS	4.12	.70	-7.24	.00	.00	.00	4.83
TOTAL SUPPLY	4.45	.70	11.96	31.66	12.44	22.23	83.43

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	12.76	6.30	94.54	31.66	12.44	22.23	179.92
END-USE DEMAND	18.34	10.71	11.25	.00	.00	.00	40.31
TOTAL DEMAND	31.10	17.01	105.79	31.66	12.44	22.23	220.23

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	24.42	6.61	58.88	31.66	12.44	22.23	156.24
END-USE DEMAND	35.11	11.25	7.01	.00	.00	.00	53.37
TOTAL DEMAND	59.53	17.86	65.89	31.66	12.44	22.23	209.61
TOTAL SUPPLY	4.45	.70	11.96	31.66	12.44	22.23	83.43
NET IMPORTS	55.08	17.16	53.93	.00	.00	.00	126.18

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	35.11	11.25	7.01	45.51	98.88
TOTAL DEMAND	35.11	11.25	7.01	45.51	98.88

TABLE 7.7. REGIONAL ENERGY BALANCE TABLES FOR PERIOD M (Continued)
(2=NOPT(5)

2075 ENERGY PRODUCTION AND USAGE REPORT
****

REGION: S.&E. ASIA

ENERGY SUPPLY TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
CONVENTIONAL	4.84	1.77	.09	27.01	10.61	14.14	58.45
UNCONVENTIONAL	.32	.00	16.55	N/A	N/A	N/A	16.87
TOTAL PRIMARY	5.16	1.77	16.64	27.01	10.61	14.14	75.32
SYNFUELS	3.57	.61	-6.28	.00	.00	.00	4.18
TOTAL SUPPLY	8.74	2.38	10.36	27.01	10.61	14.14	73.23

PRIMARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	4.86	5.40	81.61	27.01	10.61	14.14	143.61
END-USE DEMAND	9.33	6.65	39.11	.00	.00	.00	55.09
TOTAL DEMAND	14.19	12.05	120.72	27.01	10.61	14.14	198.70

REFINABLE ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
ELECTRIC POWER	8.52	5.71	50.83	27.01	10.61	14.14	116.81
END-USE DEMAND	16.36	7.04	24.36	.00	.00	.00	47.76
TOTAL DEMAND	24.88	12.74	75.19	27.01	10.61	14.14	164.57
TOTAL SUPPLY	8.74	2.38	10.36	27.01	10.61	14.14	73.23
NET IMPORTS	16.15	10.36	64.83	.00	.00	.00	91.33

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL
END-USE DEMAND	16.36	7.04	24.36	34.43	82.19
TOTAL DEMAND	16.36	7.04	24.36	34.43	82.19

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (2=NOPT(6)

1975 ENERGY PRODUCTION AND USAGE REPORT
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PRIMARY ENERGY DEMAND SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	25.72	21.21	13.78	2.15	.00	3.82	66.67
CANADA & EUR	21.20	1.83	8.02	1.30	.00	7.24	39.59
OECD PACIFIC	13.87	.68	3.97	.42	.00	1.55	20.49
USSR/E. EUR.	18.79	11.45	26.93	.23	.00	2.06	59.45
CHINA/ET.AL.	3.18	.13	15.45	.00	.00	.76	19.52
MIDDLE EAST	2.86	.83	.03	.00	.00	.06	3.78
AFRICA	2.35	.12	2.35	.00	.00	.47	5.29
LATIN AMER	7.37	1.50	.55	.04	.00	1.74	11.21
S.&E. ASIA	4.97	.46	3.47	.04	.00	.84	9.78
ALL REGIONS	100.30	38.22	74.55	4.19	.00	18.53	235.78

PRIMARY ENERGY SUPPLY SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	20.41	19.59	17.18	2.15	.00	3.82	63.15
CANADA & EUR	4.77	8.35	9.60	1.30	.00	7.24	31.26
OECD PACIFIC	.96	.31	2.67	.42	.00	1.55	5.90
USSR/E. EUR.	22.77	11.33	25.77	.23	.00	2.06	62.15
CHINA/ET.AL.	3.23	.13	15.01	.00	.00	.76	19.12
MIDDLE EAST	42.35	.33	.03	.00	.00	.06	42.77
AFRICA	10.59	.10	2.18	.00	.00	.47	13.34
LATIN AMER	9.92	.74	.39	.04	.00	1.74	12.83
S.&E. ASIA	3.79	.49	2.68	.04	.00	.84	7.84
ALL REGIONS	118.79	41.36	75.51	4.19	.00	18.53	258.37

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL PURCHASED FUELS	CONSERV& NONELEC SOLAR	TOTAL
USA	21.68	17.32	2.70	7.23	48.92	.00	48.92
CANADA & EUR	17.55	1.31	2.78	5.18	26.83	.00	26.83
OECD PACIFIC	8.65	.32	2.55	2.50	14.02	.00	14.02
USSR/E. EUR.	14.30	8.08	17.53	5.64	45.54	.00	45.54
CHINA/ET.AL.	2.89	.07	14.06	.74	17.76	.00	17.76
MIDDLE EAST	2.55	.60	.03	.16	3.34	.00	3.34
AFRICA	1.99	.02	1.51	.52	4.03	.00	4.03
LATIN AMER	6.46	1.17	.43	.87	8.93	.00	8.93
S.&E. ASIA	4.24	.44	1.66	1.01	7.35	.00	7.35
ALL REGIONS	80.31	29.32	43.25	23.84	176.72	.00	176.72

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

1975 ENERGY PRODUCTION AND USAGE REPORT

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REFINABLE ENERGY DEMAND SUMMARY, BY REGION AND TYPE (UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	25.72	21.21	13.78	2.15	.00	3.82	66.67
CANADA & EUR	21.20	1.83	8.02	1.30	.00	7.24	39.59
OECD PACIFIC	13.87	.68	3.97	.42	.00	1.55	20.49
USSR/E. EUR.	18.79	11.45	26.93	.23	.00	2.06	59.45
CHINA/ET.AL.	3.18	.13	15.45	.00	.00	.76	19.52
MIDDLE EAST	2.86	.83	.03	.00	.00	.06	3.78
AFRICA	2.35	.12	2.35	.00	.00	.47	5.29
LATIN AMER	7.37	1.50	.55	.04	.00	1.74	11.21
S.&E. ASIA	4.97	.46	3.47	.04	.00	.84	9.78
ALL REGIONS	100.30	38.22	74.55	4.19	.00	18.53	235.78

REFINABLE ENERGY SUPPLY SUMMARY, BY REGION AND TYPE (UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	20.41	19.59	17.18	2.15	.00	3.82	63.15
CANADA & EUR	4.77	8.35	9.60	1.30	.00	7.24	31.26
OECD PACIFIC	.96	.31	2.67	.42	.00	1.55	5.90
USSR/E. EUR.	22.77	11.33	25.77	.23	.00	2.06	62.15
CHINA/ET.AL.	3.23	.13	15.01	.00	.00	.76	19.12
MIDDLE EAST	42.35	.33	.03	.00	.00	.06	42.77
AFRICA	10.59	.10	2.18	.00	.00	.47	13.34
LATIN AMER	9.92	.74	.39	.04	.00	1.74	12.83
S.&E. ASIA	3.79	.49	2.68	.04	.00	.84	7.84
ALL REGIONS	118.79	41.36	75.51	4.19	.00	18.53	258.37

REFINABLE OIL SUPPLY SUMMARY BY REGION AND TYPE (UNITS=EXAJOULES (J*10**18))

	CONVEN-TIONAL	UNCONVEN-TIONAL	SYNOIL	TOTAL
USA	20.41	.00	.00	20.41
CANADA & EUR	4.77	.00	.00	4.77
OECD PACIFIC	.96	.00	.00	.96
USSR/E. EUR.	22.77	.00	.00	22.77
CHINA/ET.AL.	3.23	.00	.00	3.23
MIDDLE EAST	42.35	.00	.00	42.35
AFRICA	10.59	.00	.00	10.59
LATIN AMER	9.92	.00	.00	9.92
S.&E. ASIA	3.79	.00	.00	3.79
ALL REGIONS	118.79	.00	.00	118.79

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

1975 ENERGY PRODUCTION AND USAGE REPORT

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REFINABLE GAS SUPPLY SUMMARY BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	CONVEN- TIONAL	UNCONVEN- TIONAL	SYNGAS	TOTAL
USA	19.59	.00	.00	19.59
CANADA & EUR	8.35	.00	.00	8.35
OECD PACIFIC	.31	.00	.00	.31
USSR/E. EUR.	11.33	.00	.00	11.33
CHINA/ET.AL.	.13	.00	.00	.13
MIDDLE EAST	.33	.00	.00	.33
AFRICA	.10	.00	.00	.10
LATIN AMER	.74	.00	.00	.74
S.&E. ASIA	.49	.00	.00	.49
ALL REGIONS	41.36	.00	.00	41.36

REFINABLE SOLIDS SUPPLY SUMMARY BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	COAL	BIOMASS	TOTAL
USA	17.18	.00	17.18
CANADA & EUR	9.60	.00	9.60
OECD PACIFIC	2.67	.00	2.67
USSR/E. EUR.	25.77	.00	25.77
CHINA/ET.AL.	15.01	.00	15.01
MIDDLE EAST	.03	.00	.03
AFRICA	2.18	.00	2.18
LATIN AMER	.39	.00	.39
S.&E. ASIA	2.68	.00	2.68
ALL REGIONS	75.51	.00	75.51

IMPORT SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	COAL	TOTAL
USA	5.31	1.62	-3.40	3.52
CANADA & EUR	16.43	-6.52	-1.58	8.33
OECD PACIFIC	12.91	.37	1.30	14.59
USSR/E. EUR.	-3.98	.12	1.16	-2.70
CHINA/ET.AL.	-.05	.01	.44	.40
MIDDLE EAST	-39.49	.50	.00	-38.99
AFRICA	-8.24	.02	.17	-8.05
LATIN AMER	-2.55	.76	.16	-1.63
S.&E. ASIA	1.18	-.03	.79	1.94
TOTAL TRADE	54.31	6.55	4.98	65.84

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED)
(2=NOPT(6)

1975 ENERGY PRODUCTION AND USAGE REPORT
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ELECTRICITY DEMAND SUMMARY, BY REGION AND TYPE
UNITS=EXAJOULES (J*10**18) OF PRIMARY EQUIVALENTS

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	4.04	3.89	11.08	2.15	.00	3.82	24.98
CANADA & EUR	3.64	.52	5.24	1.30	.00	7.24	17.95
OECD PACIFIC	5.22	.36	1.42	.42	.00	1.55	8.97
USSR/E. EUR.	4.49	3.37	9.40	.23	.00	2.06	19.55
CHINA/ET.AL.	.29	.06	1.39	.00	.00	.76	2.50
MIDDLE EAST	.31	.23	.00	.00	.00	.06	.60
AFRICA	.36	.10	.84	.00	.00	.47	1.77
LATIN AMER	.91	.34	.12	.04	.00	1.74	3.15
S.&E. ASIA	.73	.01	1.81	.04	.00	.84	3.43
ALL REGIONS	19.99	8.89	31.30	4.19	.00	18.53	82.90

ELECTRICITY SUPPLY SUMMARY, BY REGION AND TYPE
UNITS=EXAJOULES (J*10**18) OF HEAT EQUIVALENTS

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	1.10	1.06	3.33	.62	.00	1.10	7.23
CANADA & EUR	1.00	.14	1.58	.38	.00	2.09	5.18
OECD PACIFIC	1.43	.10	.43	.12	.00	.43	2.50
USSR/E. EUR.	1.23	.92	2.83	.07	.00	.59	5.64
CHINA/ET.AL.	.08	.02	.42	.00	.00	.22	.74
MIDDLE EAST	.08	.06	.00	.00	.00	.02	.16
AFRICA	.10	.03	.25	.00	.00	.14	.52
LATIN AMER	.25	.09	.04	.01	.00	.48	.87
S.&E. ASIA	.20	.00	.54	.01	.00	.25	1.01
ALL REGIONS	5.46	2.43	9.41	1.21	.00	5.32	23.84

SYNFUEL PRODUCTION SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	TOTAL	SOLIDS
USA	.00	.00	.00	.00
CANADA & EUR	.00	.00	.00	.00
OECD PACIFIC	.00	.00	.00	.00
USSR/E. EUR.	.00	.00	.00	.00
CHINA/ET.AL.	.00	.00	.00	.00
MIDDLE EAST	.00	.00	.00	.00
AFRICA	.00	.00	.00	.00
LATIN AMER	.00	.00	.00	.00
S.&E. ASIA	.00	.00	.00	.00
ALL REGIONS	.00	.00	.00	.00

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED)
(2=NOPT(6)

1975 ENERGY USE PER DOLLAR GNP AND PER CAPITA
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REGION	POPUL. (MIL)	BASE GNP (BIL 1975 US DOL)	FINAL GNP (BIL 1975 US DOL)	ENERGY USE (EXAJOULES)	E/GNP J*10**9/$	E/CAPITA J*10**9/CAP	GNP/CAP $/CAP
USA	214.	1520.	1520.	66.67	43.87	311.55	7102.
CANADA & EUR	405.	1818.	1818.	39.59	21.78	97.76	4489.
OECD PACIFIC	128.	586.	586.	20.49	34.95	160.12	4581.
USSR/E. EUR.	395.	966.	966.	59.45	61.52	150.52	2447.
CHINA/ET.AL.	911.	324.	324.	19.52	60.32	21.43	355.
MIDDLE EAST	81.	138.	138.	3.78	27.31	46.66	1709.
AFRICA	399.	155.	155.	5.29	34.17	13.25	388.
LATIN AMER	313.	315.	315.	11.21	35.52	35.80	1008.
S.&E. ASIA	1130.	234.	234.	9.78	41.86	8.65	207.
ALL REGIONS	3976.	6056.	6056.	235.78	38.93	59.30	1523.

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

2000 ENERGY PRODUCTION AND USAGE REPORT

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PRIMARY ENERGY DEMAND SUMMARY, BY REGION AND TYPE (UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	32.72	14.02	35.05	7.95	.05	5.46	95.25
CANADA & EUR	22.19	9.02	16.98	5.04	.01	10.82	64.06
OECD PACIFIC	15.07	2.96	10.02	1.60	.01	2.36	32.00
USSR/E. EUR.	27.95	12.61	35.33	1.14	.00	10.07	87.10
CHINA/ET.AL.	11.30	1.20	34.03	.19	.00	5.49	52.20
MIDDLE EAST	8.84	1.85	.39	.02	.00	1.23	12.32
AFRICA	5.97	1.34	7.02	.09	.00	4.65	19.07
LATIN AMER	17.83	4.23	3.81	.40	.00	10.91	37.18
S.&E. ASIA	10.92	.97	10.95	.40	.00	6.18	29.43
ALL REGIONS	152.79	48.18	153.57	16.84	.07	57.15	428.61

PRIMARY ENERGY SUPPLY SUMMARY, BY REGION AND TYPE (UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	.00	3.79	1.02	7.95	.05	5.46	18.28
CANADA & EUR	13.94	6.58	3.44	5.04	.01	10.82	39.83
OECD PACIFIC	.00	.82	.49	1.60	.01	2.36	5.27
USSR/E. EUR.	24.25	29.03	63.92	1.14	.00	10.07	128.41
CHINA/ET.AL.	10.47	.48	56.09	.19	.00	5.49	72.71
MIDDLE EAST	47.50	1.53	.40	.02	.00	1.23	50.68
AFRICA	29.03	.40	10.90	.09	.00	4.65	45.08
LATIN AMER	25.01	3.42	3.75	.40	.00	10.91	43.49
S.&E. ASIA	2.58	2.11	13.53	.40	.00	6.18	24.80
ALL REGIONS	152.78	48.16	153.54	16.84	.07	57.15	428.55

SECONDARY ENERGY DEMAND TABLE (UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL PURCHASED FUELS	CONSERV& NONELEC SOLAR	TOTAL
USA	30.71	10.42	3.56	14.93	59.63	21.46	81.08
CANADA & EUR	18.22	6.96	4.81	9.91	39.90	2.38	42.28
OECD PACIFIC	9.60	2.27	4.13	4.57	20.57	1.01	21.58
USSR/E. EUR.	20.07	10.17	23.78	9.53	63.55	14.87	78.42
CHINA/ET.AL.	9.12	1.14	29.73	3.56	43.54	7.76	51.31
MIDDLE EAST	8.31	1.31	.22	.69	10.52	3.71	14.23
AFRICA	5.07	1.24	4.72	2.33	13.36	.06	13.43
LATIN AMER	15.39	3.59	2.22	4.51	25.71	4.99	30.69
S.&E. ASIA	9.49	.87	5.96	3.86	20.18	3.65	23.83
ALL REGIONS	125.98	37.97	79.13	53.88	296.96	59.83	356.84

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED)
(2=NOPT(6)

2000 ENERGY PRODUCTION AND USAGE REPORT
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REFINABLE ENERGY DEMAND SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	32.77	14.02	34.80	7.95	.05	5.46	95.05
CANADA & EUR	22.23	9.02	16.84	5.04	.01	10.82	63.97
OECD PACIFIC	15.09	2.96	9.94	1.60	.01	2.36	31.95
USSR/E. EUR.	28.47	12.61	34.90	1.14	.00	10.07	87.19
CHINA/ET.AL.	11.31	1.20	34.03	.19	.00	5.49	52.20
MIDDLE EAST	8.84	1.85	.39	.02	.00	1.23	12.32
AFRICA	5.99	1.34	6.93	.09	.00	4.65	19.00
LATIN AMER	17.86	4.23	3.76	.40	.00	10.91	37.15
S.&E. ASIA	10.93	.97	10.95	.40	.00	6.18	29.43
ALL REGIONS	153.47	48.18	152.55	16.84	.07	57.15	428.27

REFINABLE ENERGY SUPPLY SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	.01	3.79	1.01	7.95	.05	5.46	18.27
CANADA & EUR	13.97	6.58	3.40	5.04	.01	10.82	39.82
OECD PACIFIC	.00	.82	.49	1.60	.01	2.36	5.27
USSR/E. EUR.	24.77	29.03	63.14	1.14	.00	10.07	128.15
CHINA/ET.AL.	10.47	.48	56.09	.19	.00	5.49	72.71
MIDDLE EAST	47.50	1.53	.40	.02	.00	1.23	50.68
AFRICA	29.12	.41	10.77	.09	.00	4.65	45.03
LATIN AMER	25.04	3.42	3.71	.40	.00	10.91	43.48
S.&E. ASIA	2.58	2.11	13.53	.40	.00	6.18	24.80
ALL REGIONS	153.46	48.16	152.52	16.84	.07	57.15	428.21

REFINABLE OIL SUPPLY SUMMARY BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	CONVEN-TIONAL	UNCONVEN-TIONAL	SYNOIL	TOTAL
USA	.00	.00	.01	.01
CANADA & EUR	13.94	.00	.03	13.97
OECD PACIFIC	.00	.00	.00	.00
USSR/E. EUR.	24.25	.00	.52	24.77
CHINA/ET.AL.	10.47	.00	.00	10.47
MIDDLE EAST	47.50	.00	.00	47.50
AFRICA	29.03	.00	.09	29.12
LATIN AMER	25.01	.00	.03	25.04
S.&E. ASIA	2.58	.00	.00	2.58
ALL REGIONS	152.78	.00	.68	153.46

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

2000 ENERGY PRODUCTION AND USAGE REPORT

REFINABLE GAS SUPPLY SUMMARY BY REGION AND TYPE (UNITS=EXAJOULES (J*10**18))

	CONVEN-TIONAL	UNCONVEN-TIONAL	SYNGAS	TOTAL
USA	3.79	.00	.00	3.79
CANADA & EUR	6.58	.00	.00	6.58
OECD PACIFIC	.82	.00	.00	.82
USSR/E. EUR.	29.03	.00	.00	29.03
CHINA/ET.AL.	.48	.00	.00	.48
MIDDLE EAST	1.53	.00	.00	1.53
AFRICA	.40	.00	.00	.41
LATIN AMER	3.42	.00	.00	3.42
S.&E. ASIA	2.11	.00	.00	2.11
ALL REGIONS	48.16	.00	.00	48.16

REFINABLE SOLIDS SUPPLY SUMMARY BY REGION AND TYPE (UNITS=EXAJOULES (J*10**18))

	COAL	BIOMASS	TOTAL
USA	.00	1.01	1.01
CANADA & EUR	.00	3.40	3.40
OECD PACIFIC	.00	.49	.49
USSR/E. EUR.	61.56	1.57	63.14
CHINA/ET.AL.	54.52	1.57	56.09
MIDDLE EAST	.14	.27	.40
AFRICA	9.39	1.38	10.77
LATIN AMER	1.71	2.00	3.71
S.&E. ASIA	10.94	2.59	13.53
ALL REGIONS	138.25	14.27	152.52

IMPORT SUMMARY, BY REGION AND TYPE (UNITS=EXAJOULES (J*10**18))

	OIL	GAS	COAL	TOTAL
USA	32.76	10.22	33.79	76.77
CANADA & EUR	8.26	2.44	13.45	24.15
OECD PACIFIC	15.08	2.14	9.46	26.68
USSR/E. EUR.	3.70	-16.42	-28.23	-40.95
CHINA/ET.AL.	.84	.71	-22.06	-20.51
MIDDLE EAST	-38.66	.32	-.02	-38.36
AFRICA	-23.13	.94	-3.83	-26.03
LATIN AMER	-7.19	.81	.05	-6.33
S.&E. ASIA	8.35	-1.14	-2.57	4.63
TOTAL TRADE	68.98	17.57	56.72	143.27

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

2000 ENERGY PRODUCTION AND USAGE REPORT
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ELECTRICITY DEMAND SUMMARY, BY REGION AND TYPE
UNITS=EXAJOULES (J*10**18) OF PRIMARY EQUIVALENTS

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	2.06	3.60	31.24	7.95	.05	5.46	50.36
CANADA & EUR	4.01	2.06	12.03	5.04	.01	10.82	33.97
OECD PACIFIC	5.49	.68	5.81	1.60	.01	2.36	15.95
USSR/E. EUR.	8.40	2.44	11.12	1.14	.00	10.07	33.18
CHINA/ET.AL.	2.19	.06	4.30	.19	.00	5.49	12.22
MIDDLE EAST	.53	.54	.17	.02	.00	1.23	2.49
AFRICA	.92	.10	2.21	.09	.00	4.65	7.96
LATIN AMER	2.46	.64	1.54	.40	.00	10.91	15.95
S.&E. ASIA	1.44	.10	4.99	.40	.00	6.18	13.12
ALL REGIONS	27.49	10.21	73.42	16.84	.07	57.15	185.19

ELECTRICITY SUPPLY SUMMARY, BY REGION AND TYPE
UNITS=EXAJOULES (J*10**18) OF HEAT EQUIVALENTS

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	.56	.98	9.39	2.36	.01	1.62	14.93
CANADA & EUR	1.10	.56	3.62	1.47	.00	3.16	9.91
OECD PACIFIC	1.50	.19	1.75	.46	.00	.68	4.57
USSR/E. EUR.	2.30	.67	3.34	.33	.00	2.89	9.53
CHINA/ET.AL.	.60	.02	1.29	.05	.00	1.60	3.56
MIDDLE EAST	.14	.15	.05	.01	.00	.34	.69
AFRICA	.25	.03	.67	.03	.00	1.36	2.33
LATIN AMER	.67	.17	.46	.11	.00	3.08	4.51
S.&E. ASIA	.39	.03	1.50	.12	.00	1.82	3.86
ALL REGIONS	7.52	2.79	22.08	4.94	.02	16.54	53.88

SYNFUEL PRODUCTION SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	TOTAL	SOLIDS
USA	.01	.00	.01	-.01
CANADA & EUR	.03	.00	.03	-.04
OECD PACIFIC	.00	.00	.00	-.01
USSR/E. EUR.	.52	.00	.52	-.78
CHINA/ET.AL.	.00	.00	.00	.00
MIDDLE EAST	.00	.00	.00	.00
AFRICA	.09	.00	.09	-.13
LATIN AMER	.03	.00	.03	-.05
S.&E. ASIA	.00	.00	.00	.00
ALL REGIONS	.68	.00	.68	-1.02

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED)
(2=NOPT(6)

2000 ENERGY USE PER DOLLAR GNP AND PER CAPITA
****

REGION	POPUL. (MIL)	BASE GNP (BIL 1975 US DOL)	FINAL GNP	ENERGY USE (EXAJOULES)	E/GNP J*10**9/$	E/CAPITA J*10**9/CAP	GNP/CAP $/CAP
USA	254.	3256.	3227.	95.25	29.52	375.00	12704.
CANADA & EUR	476.	3737.	3723.	64.06	17.21	134.59	7821.
OECD PACIFIC	154.	1188.	1184.	32.00	27.02	207.79	7691.
USSR/E. EUR.	472.	2033.	1966.	87.10	44.31	184.54	4164.
CHINA/ET.AL.	1248.	1020.	988.	52.20	52.82	41.83	792.
MIDDLE EAST	147.	587.	596.	12.32	20.68	83.83	4055.
AFRICA	697.	568.	567.	19.07	33.62	27.36	814.
LATIN AMER	540.	1217.	1175.	37.18	31.64	68.84	2176.
S.&E. ASIA	1904.	826.	802.	29.43	36.70	15.45	421.
ALL REGIONS	5892.	14433.	14228.	428.61	30.12	72.74	2415.

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

2025 ENERGY PRODUCTION AND USAGE REPORT
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PRIMARY ENERGY DEMAND SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	36.81	24.35	35.24	12.92	5.89	6.14	121.35
CANADA & EUR	17.98	20.08	21.21	9.12	3.64	11.97	83.99
OECD PACIFIC	12.19	6.25	15.12	4.70	1.88	2.59	42.72
USSR/E. EUR.	24.93	22.67	35.77	5.08	2.03	16.08	106.56
CHINA/ET.AL.	17.83	6.74	63.00	3.43	.24	15.59	106.83
MIDDLE EAST	16.99	6.73	4.65	2.77	1.10	2.08	34.32
AFRICA	15.90	6.44	16.54	1.55	.62	18.55	59.61
LATIN AMER	35.09	12.50	21.55	5.70	2.27	20.44	97.55
S.&E. ASIA	15.87	6.89	33.03	5.26	2.10	12.93	76.08
ALL REGIONS	193.58	112.65	246.10	50.52	19.77	106.38	729.01

PRIMARY ENERGY SUPPLY SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	.09	10.59	1.56	12.92	5.89	6.14	37.19
CANADA & EUR	34.82	15.72	4.30	9.12	3.64	11.97	79.56
OECD PACIFIC	.09	2.43	.76	4.70	1.88	2.59	12.44
USSR/E. EUR.	56.74	43.96	125.78	5.08	2.03	16.08	249.67
CHINA/ET.AL.	9.69	2.00	88.38	3.43	.24	15.59	119.34
MIDDLE EAST	29.96	9.16	.60	2.77	1.10	2.08	45.67
AFRICA	29.09	2.26	13.20	1.55	.62	18.55	65.26
LATIN AMER	26.17	17.67	6.43	5.70	2.27	20.44	78.68
S.&E. ASIA	6.74	8.87	5.09	5.26	2.10	12.93	40.99
ALL REGIONS	193.38	112.65	246.09	50.52	19.77	106.38	728.80

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL PURCHASED FUELS	CONSERV& NONELEC SOLAR	TOTAL
USA	33.21	13.63	4.66	20.08	71.59	39.55	111.14
CANADA & EUR	15.06	12.21	7.01	13.83	48.11	9.01	57.12
OECD PACIFIC	9.72	4.26	5.04	6.74	25.76	4.56	30.41
USSR/E. EUR.	21.17	19.66	20.02	13.23	74.08	30.31	104.39
CHINA/ET.AL.	18.58	5.76	49.04	9.74	83.12	24.77	107.89
MIDDLE EAST	16.19	4.49	.85	3.58	25.12	21.16	46.27
AFRICA	14.39	5.53	11.26	7.94	39.11	.37	39.48
LATIN AMER	28.34	9.08	5.45	15.52	58.39	25.14	83.52
S.&E. ASIA	13.59	3.70	16.90	11.66	45.85	16.30	62.15
ALL REGIONS	170.26	78.33	120.23	102.31	471.13	171.26	642.38

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED)
(2=NOPT(6)

2025 ENERGY PRODUCTION AND USAGE REPORT
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REFINABLE ENERGY DEMAND SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	39.04	24.37	32.27	12.92	5.89	6.14	120.63
CANADA & EUR	18.10	20.09	19.42	9.12	3.64	11.97	82.33
OECD PACIFIC	12.94	6.26	13.84	4.70	1.88	2.59	42.20
USSR/E. EUR.	28.01	22.71	32.75	5.08	2.03	16.08	106.66
CHINA/ET.AL.	23.22	6.80	57.68	3.43	.24	15.59	106.97
MIDDLE EAST	16.99	6.73	4.31	2.77	1.10	2.08	33.98
AFRICA	16.31	6.46	15.15	1.55	.62	18.55	58.63
LATIN AMER	35.96	12.50	19.73	5.70	2.27	20.44	96.61
S.&E. ASIA	16.68	6.89	30.24	5.26	2.10	12.93	74.11
ALL REGIONS	207.25	112.80	225.39	50.52	19.77	106.38	722.11

REFINABLE ENERGY SUPPLY SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	.17	10.59	1.43	12.92	5.89	6.14	37.15
CANADA & EUR	35.06	15.73	3.93	9.12	3.64	11.97	79.44
OECD PACIFIC	.13	2.43	.70	4.70	1.88	2.59	12.41
USSR/E. EUR.	63.74	44.04	115.17	5.08	2.03	16.08	246.13
CHINA/ET.AL.	14.61	2.05	80.93	3.43	.24	15.59	116.85
MIDDLE EAST	29.96	9.16	.60	2.77	1.10	2.08	45.67
AFRICA	29.82	2.26	12.09	1.55	.62	18.55	64.89
LATIN AMER	26.53	17.67	5.88	5.70	2.27	20.44	78.50
S.&E. ASIA	7.02	8.87	4.66	5.26	2.10	12.93	40.84
ALL REGIONS	207.04	112.80	225.38	50.52	19.77	106.38	721.89

REFINABLE OIL SUPPLY SUMMARY BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	CONVEN-TIONAL	UNCONVEN-TIONAL	SYNOIL	TOTAL
USA	.04	.04	.09	.17
CANADA & EUR	34.78	.04	.24	35.06
OECD PACIFIC	.04	.04	.04	.13
USSR/E. EUR.	56.70	.04	7.00	63.74
CHINA/ET.AL.	9.65	.04	4.92	14.61
MIDDLE EAST	29.91	.04	.00	29.96
AFRICA	29.04	.04	.73	29.82
LATIN AMER	26.13	.04	.36	26.53
S.&E. ASIA	6.70	.04	.28	7.02
ALL REGIONS	192.99	.39	13.66	207.04

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED)
(2=NOPT(6)

2025 ENERGY PRODUCTION AND USAGE REPORT
****

REFINABLE GAS SUPPLY SUMMARY BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	CONVEN-TIONAL	UNCONVEN-TIONAL	SYNGAS	TOTAL
USA	10.59	.00	.00	10.59
CANADA & EUR	15.72	.00	.00	15.73
OECD PACIFIC	2.43	.00	.00	2.43
USSR/E. EUR.	43.96	.00	.07	44.04
CHINA/ET.AL.	2.00	.00	.05	2.05
MIDDLE EAST	9.16	.00	.00	9.16
AFRICA	2.26	.00	.01	2.26
LATIN AMER	17.67	.00	.00	17.67
S.&E. ASIA	8.87	.00	.00	8.87
ALL REGIONS	112.65	.00	.15	112.80

REFINABLE SOLIDS SUFFLY SUMMARY BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	COAL	BIOMASS	TOTAL
USA	.00	1.43	1.43
CANADA & EUR	.00	3.93	3.93
OECD FACIFIC	.00	.70	.70
USSR/E. EUR.	112.97	2.20	115.17
CHINA/ET.AL.	78.23	2.69	80.93
MIDDLE EAST	.00	.60	.60
AFRICA	9.32	2.77	12.09
LATIN AMER	2.20	3.68	5.88
S.&E. ASIA	.00	4.66	4.66
ALL REGIONS	202.73	22.66	225.38

IMFORT SUMMARY, BY REGION AND TYFE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	COAL	TOTAL
USA	38.87	13.78	30.83	83.48
CANADA & EUR	-16.96	4.36	15.48	2.88
OECD PACIFIC	12.81	3.83	13.15	29.79
USSR/E. EUR.	-35.73	-21.32	-82.42	-139.47
CHINA/ET.AL.	8.61	4.74	-23.24	-9.98
MIDDLE EAST	-12.97	-2.43	3.71	-11.69
AFRICA	-13.51	4.19	3.06	-6.26
LATIN AMER	9.43	-5.17	13.85	18.11
S.&E. ASIA	9.66	-1.98	25.59	33.27
TOTAL TRADE	79.17	30.91	105.66	215.74

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED)
(2=NOPT(6)

2025 ENERGY PRODUCTION AND USAGE REPORT
****

ELECTRICITY DEMAND SUMMARY, BY REGION AND TYPE
UNITS=EXAJOULES (J*10**18) OF PRIMARY EQUIVALENTS

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	5.83	10.74	27.60	12.92	5.89	6.14	69.12
CANADA & EUR	3.04	7.87	12.41	9.12	3.64	11.97	48.05
OECD PACIFIC	3.22	2.00	8.80	4.70	1.88	2.59	23.18
USSR/E. EUR.	6.84	3.05	12.73	5.08	2.03	16.08	45.81
CHINA/ET.AL.	4.64	1.03	8.64	3.43	.24	15.59	33.58
MIDDLE EAST	.79	2.24	3.46	2.77	1.10	2.08	12.44
AFRICA	1.92	.93	3.89	1.55	.62	18.55	27.46
LATIN AMER	7.63	3.42	14.28	5.70	2.27	20.44	53.74
S.&E. ASIA	3.09	3.19	13.34	5.26	2.10	12.93	39.92
ALL REGIONS	37.00	34.47	105.16	50.52	19.77	106.38	353.30

ELECTRICITY SUPPLY SUMMARY, BY REGION AND TYPE
UNITS=EXAJOULES (J*10**18) OF HEAT EQUIVALENTS

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	1.59	2.94	8.30	3.75	1.71	1.78	20.08
CANADA & EUR	.83	2.15	3.73	2.62	1.05	3.45	13.83
OECD PACIFIC	.88	.55	2.65	1.37	.55	.75	6.74
USSR/E. EUR.	1.87	.83	3.83	1.47	.59	4.64	13.23
CHINA/ET.AL.	1.27	.28	2.60	1.00	.07	4.52	9.74
MIDDLE EAST	.22	.61	1.04	.80	.32	.60	3.58
AFRICA	.52	.25	1.17	.45	.18	5.36	7.94
LATIN AMER	2.09	.93	4.30	1.65	.66	5.90	15.52
S.&E. ASIA	.84	.87	4.01	1.54	.61	3.78	11.66
ALL REGIONS	10.11	9.42	31.63	14.63	5.73	30.79	102.31

SYNFUEL PRODUCTION SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	TOTAL	SOLIDS
USA	.09	.00	.09	-.13
CANADA & EUR	.24	.00	.24	-.36
OECD PACIFIC	.04	.00	.04	-.06
USSR/E. EUR.	7.00	.07	7.07	-10.61
CHINA/ET.AL.	4.92	.05	4.97	-7.46
MIDDLE EAST	.00	.00	.00	.00
AFRICA	.73	.01	.74	-1.11
LATIN AMER	.36	.00	.36	-.54
S.&E. ASIA	.28	.00	.29	-.43
ALL REGIONS	13.66	.15	13.81	-20.71

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

2025 ENERGY USE PER DOLLAR GNP AND PER CAPITA
****

REGION	POPUL. (MIL)	BASE GNP (BIL 1975 US DOL)	FINAL GNP (BIL 1975 US DOL)	ENERGY USE (EXAJOULES)	E/GNP J*10**9/$	E/CAPITA J*10**9/CAP	GNP/CAP $/CAP
USA	282.	5837.	5745.	121.35	21.12	430.31	20371.
CANADA & EUR	528.	6669.	6587.	83.99	12.75	159.06	12476.
OECD PACIFIC	164.	2172.	2151.	42.72	19.87	260.50	13113.
USSR/E. EUR.	516.	3580.	3386.	106.56	31.47	206.52	6562.
CHINA/ET.AL.	1499.	2767.	2622.	106.83	40.75	71.27	1749.
MIDDLE EAST	199.	2211.	2280.	34.32	15.05	172.46	11458.
AFRICA	943.	2025.	2016.	59.61	29.57	63.22	2138.
LATIN AMER	718.	4143.	3874.	97.55	25.18	135.86	5395.
S.&E. ASIA	2515.	2761.	2591.	76.08	29.36	30.25	1030.
ALL REGIONS	7364.	32163.	31252.	729.01	23.33	99.00	4244.

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED)
(2=NOPT(6)

2050 ENERGY PRODUCTION AND USAGE REPORT
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PRIMARY ENERGY DEMAND SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	39.26	28.45	50.11	16.90	8.87	6.29	149.87
CANADA & EUR	15.61	24.11	36.86	12.25	6.43	12.08	107.35
OECD PACIFIC	11.22	8.52	21.47	5.91	3.10	2.63	52.86
USSR/E. EUR.	13.11	25.37	41.21	6.91	3.63	17.01	107.23
CHINA/ET.AL.	18.24	23.85	89.07	9.75	5.12	19.29	165.32
MIDDLE EAST	19.95	11.05	17.45	8.92	4.68	2.08	64.13
AFRICA	20.89	15.25	42.79	6.61	3.47	24.42	113.43
LATIN AMER	47.81	17.92	60.01	14.65	7.69	22.14	170.23
S.&E. ASIA	18.29	12.28	72.75	12.24	6.42	14.09	136.07
ALL REGIONS	204.38	166.81	431.71	94.14	49.40	120.05	1066.49

PRIMARY ENERGY SUPPLY SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	.18	27.78	2.55	16.90	8.87	6.29	62.57
CANADA & EUR	9.32	13.95	5.80	12.25	6.43	12.08	59.83
OECD PACIFIC	.17	4.22	1.22	5.91	3.10	2.63	17.26
USSR/E. EUR.	26.82	46.43	246.09	6.91	3.63	17.01	346.90
CHINA/ET.AL.	9.32	7.21	125.85	9.75	5.12	19.29	176.53
MIDDLE EAST	108.81	42.09	1.32	8.92	4.68	2.08	167.91
AFRICA	25.64	9.62	26.93	6.61	3.47	24.42	96.71
LATIN AMER	22.00	13.31	11.75	14.65	7.69	22.14	91.54
S.&E. ASIA	2.12	2.19	10.19	12.24	6.42	14.09	47.25
ALL REGIONS	204.38	166.81	431.71	94.14	49.40	120.05	1066.49

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL PURCHASED FUELS	CONSERV& NONELEC SOLAR	TOTAL
USA	36.86	13.47	4.32	26.42	81.07	61.83	142.90
CANADA & EUR	13.94	13.43	7.79	19.18	-54.34	17.52	71.86
OECD PACIFIC	9.56	5.68	4.53	8.89	28.65	8.66	37.32
USSR/E. EUR.	20.74	23.29	13.32	16.96	74.31	45.64	119.95
CHINA/ET.AL.	24.49	20.71	43.00	22.56	110.76	52.96	163.72
MIDDLE EAST	18.71	7.02	1.62	9.73	37.08	56.04	93.12
AFRICA	16.13	12.58	15.35	18.42	62.47	11.85	74.32
LATIN AMER	35.02	11.52	6.82	31.89	85.26	57.73	142.99
S.&E. ASIA	15.83	6.98	23.01	23.13	68.94	38.00	106.95
ALL REGIONS	191.27	114.68	119.76	177.19	602.90	350.24	953.13

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

2050 ENERGY PRODUCTION AND USAGE REPORT

REFINABLE ENERGY DEMAND SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	46.15	28.48	39.21	16.90	8.87	6.29	145.90
CANADA & EUR	17.47	24.32	28.85	12.25	6.43	12.08	101.39
OECD PACIFIC	13.24	8.60	16.80	5.91	3.10	2.63	50.29
USSR/E. EUR.	29.63	26.38	32.25	6.91	3.63	17.01	115.81
CHINA/ET.AL.	37.02	25.07	69.70	9.75	5.12	19.29	165.96
MIDDLE EAST	19.96	11.05	13.93	8.92	4.68	2.08	60.62
AFRICA	23.90	15.54	33.48	6.61	3.47	24.42	107.44
LATIN AMER	53.75	18.08	46.97	14.65	7.69	22.14	163.29
S.&E. ASIA	22.40	12.52	56.93	12.24	6.42	14.09	124.61
ALL REGIONS	263.52	170.05	338.14	94.14	49.40	120.05	1035.30

REFINABLE ENERGY SUPPLY SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	.53	27.80	2.00	16.90	8.87	6.29	62.38
CANADA & EUR	10.12	13.99	4.54	12.25	6.43	12.08	59.41
OECD PACIFIC	.34	4.23	.96	5.91	3.10	2.63	17.17
USSR/E. EUR.	60.63	48.29	192.59	6.91	3.63	17.01	329.06
CHINA/ET.AL.	26.61	8.16	98.49	9.75	5.12	19.29	167.41
MIDDLE EAST	108.82	42.09	1.31	8.92	4.68	2.09	167.90
AFRICA	29.34	9.83	21.08	6.61	3.47	24.42	94.75
LATIN AMER	23.61	13.39	9.20	14.65	7.69	22.14	90.69
S.&E. ASIA	3.52	2.26	7.98	12.24	6.42	14.09	46.51
ALL REGIONS	263.52	170.05	338.13	94.14	49.40	120.05	1035.30

REFINABLE OIL SUPPLY SUMMARY BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	CONVEN-TIONAL	UNCONVEN-TIONAL	SYNOIL	TOTAL
USA	.09	.09	.35	.53
CANADA & EUR	9.23	.09	.80	10.12
OECD PACIFIC	.09	.09	-.17	.34
USSR/E. EUR.	26.74	.08	33.81	60.63
CHINA/ET.AL.	9.19	.12	17.29	26.61
MIDDLE EAST	108.66	.16	.00	108.82
AFRICA	25.50	.14	3.70	29.34
LATIN AMER	21.87	.13	1.61	23.61
S.&E. ASIA	1.99	.13	1.40	3.52
ALL REGIONS	203.34	1.04	59.14	263.52

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

2050 ENERGY PRODUCTION AND USAGE REPORT

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REFINABLE GAS SUPPLY SUMMARY BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	CONVEN-TIONAL	UNCONVEN-TIONAL	SYNGAS	TOTAL
USA	27.78	.00	.02	27.80
CANADA & EUR	13.95	.00	.04	13.99
OECD PACIFIC	4.22	.00	.01	4.23
USSR/E. EUR.	46.43	.00	1.86	48.29
CHINA/ET.AL.	7.21	.00	.95	8.16
MIDDLE EAST	42.09	.00	.00	42.09
AFRICA	9.62	.00	.20	9.83
LATIN AMER	13.31	.00	.09	13.39
S.&E. ASIA	2.19	.00	.08	2.26
ALL REGIONS	166.81	.00	3.25	170.05

REFINABLE SOLIDS SUPPLY SUMMARY BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	COAL	BIOMASS	TOTAL
USA	.00	2.00	2.00
CANADA & EUR	.00	4.54	4.54
OECD PACIFIC	.00	.96	.96
USSR/E. EUR.	189.63	2.97	192.59
CHINA/ET.AL.	94.08	4.41	98.49
MIDDLE EAST	.03	1.28	1.31
AFRICA	16.15	4.93	21.08
LATIN AMER	2.91	6.28	9.20
S.&E. ASIA	.03	7.95	7.98
ALL REGIONS	302.82	35.31	338.13

IMPORT SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	COAL	TOTAL
USA	45.62	.68	37.22	83.52
CANADA & EUR	7.35	10.33	24.31	41.99
OECD PACIFIC	12.90	4.37	15.85	33.12
USSR/E. EUR.	-31.00	-21.91	-160.34	-213.25
CHINA/ET.AL.	10.42	16.91	-28.78	-1.46
MIDDLE EAST	-88.86	-31.05	12.63	-107.29
AFRICA	-5.44	5.71	12.41	12.68
LATIN AMER	30.14	4.69	37.77	72.60
S.&E. ASIA	18.88	10.26	48.96	78.09
TOTAL TRADE	125.31	52.95	189.13	367.39

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

2050 ENERGY PRODUCTION AND USAGE REPORT
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ELECTRICITY DEMAND SUMMARY, BY REGION AND TYPE
UNITS=EXAJOULES (J*10**18) OF PRIMARY EQUIVALENTS

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	9.29	15.01	34.90	16.90	8.87	6.29	91.25
CANADA & EUR	3.53	10.89	21.06	12.25	6.43	12.08	66.23
OECD PACIFIC	3.68	2.92	12.28	5.91	3.10	2.63	30.52
USSR/E. EUR.	8.89	3.09	18.93	6.91	3.63	17.01	58.46
CHINA/ET.AL.	12.54	4.36	26.70	9.75	5.12	19.29	77.76
MIDDLE EAST	1.25	4.03	12.31	8.92	4.68	2.08	33.27
AFRICA	7.77	2.96	18.14	6.61	3.47	24.42	63.38
LATIN AMER	18.73	6.56	40.14	14.65	7.69	22.14	109.92
S.&E. ASIA	6.57	5.54	33.92	12.24	6.42	14.09	78.79
ALL REGIONS	72.25	55.37	218.38	94.14	49.40	120.05	609.59

ELECTRICITY SUPPLY SUMMARY, BY REGION AND TYPE
UNITS=EXAJOULES (J*10**18) OF HEAT EQUIVALENTS

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	2.54	4.10	10.50	4.89	2.57	1.82	26.42
CANADA & EUR	.96	2.98	6.33	3.55	1.86	3.50	19.18
OECD PACIFIC	1.01	.80	3.69	1.72	.90	.77	8.89
USSR/E. EUR.	2.43	.85	5.69	2.01	1.05	4.94	16.96
CHINA/ET.AL.	3.43	1.19	8.03	2.83	1.48	5.60	22.56
MIDDLE EAST	.34	1.10	3.70	2.61	1.37	.61	9.73
AFRICA	2.13	.81	5.45	1.92	1.01	7.10	18.42
LATIN AMER	5.12	1.79	12.07	4.25	2.23	6.42	31.89
S.&E. ASIA	1.80	1.52	10.20	3.59	1.89	4.14	23.13
ALL REGIONS	19.75	15.14	65.68	27.37	14.36	34.89	177.19

SYNFUEL PRODUCTION SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	TOTAL	SOLIDS
USA	.35	.02	.37	-.56
CANADA & EUR	.80	.04	.84	-1.26
OECD PACIFIC	.17	.01	.18	-.27
USSR/E. EUR.	33.81	1.86	35.67	-53.50
CHINA/ET.AL.	17.29	.95	18.24	-27.76
MIDDLE EAST	.00	.00	.01	-.01
AFRICA	3.70	.20	3.90	-5.96
LATIN AMER	1.61	.09	1.70	-2.55
S.&E. ASIA	1.40	.08	1.48	-2.22
ALL REGIONS	59.14	3.25	62.38	-93.57

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED)
(2=NOPT(6)

2050 ENERGY USE PER DOLLAR GNP AND PER CAPITA
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REGION	POPUL. (MIL)	BASE GNP (BIL 1975 US DOL)	FINAL GNP (BIL 1975 US DOL)	ENERGY USE (EXAJOULES)	E/GNP J*10**9/$	E/CAPITA J*10**9/CAP	GNP/CAP $/CAP
USA	288.	9721.	9502.	149.87	15.77	520.38	32992.
CANADA & EUR	553.	11137.	10925.	107.33	9.83	194.11	19757.
OECD PACIFIC	167.	3491.	3437.	52.86	15.38	316.52	20582.
USSR/E. EUR.	533.	5642.	5238.	107.23	20.47	201.19	9827.
CHINA/ET.AL.	1612.	6435.	5956.	165.32	27.76	102.55	3695.
MIDDLE EAST	232.	6308.	6606.	64.13	9.71	276.44	28476.
AFRICA	1101.	5574.	5424.	113.43	20.91	103.02	4926.
LATIN AMER	823.	10526.	9587.	170.23	17.76	206.84	11649.
S.&E. ASIA	2888.	6994.	6410.	136.07	21.23	47.12	2220.
ALL REGIONS	8197.	65827.	63086.	1066.49	16.91	130.11	7696.

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

2075 ENERGY PRODUCTION AND USAGE REPORT

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PRIMARY ENERGY DEMAND SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	26.78	24.24	73.68	29.76	11.69	6.28	172.43
CANADA & EUR	11.95	21.26	58.14	24.94	9.80	12.03	138.12
OECD PACIFIC	7.65	7.39	32.76	11.34	4.46.	2.63	66.22
USSR/E. EUR.	.96	6.80	56.32	12.06	4.74	17.05	97.92
CHINA/ET.AL.	.26	17.82	142.86	22.61	8.88	19.72	212.14
MIDDLE EAST	23.35	12.84	36.22	22.00	8.64	2.07	105.14
AFRICA	21.99	17.01	83.47	18.48	7.26	25.00	173.20
LATIN AMER	31.10	17.01	105.79	31.66	12.44	22.23	220.23
S.&E. ASIA	14.19	12.05	120.72	27.01	10.61	14.14	198.70
ALL REGIONS	138.22	136.42	709.96	199.87	78.51	121.14	1384.11

PRIMARY ENERGY SUPPLY SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	.31	12.56	3.52	29.76	11.69	6.28	64.12
CANADA & EUR	6.54	.00	7.89	24.94	9.80	12.03	61.21
OECD PACIFIC	.30	.00	1.69	11.34	4.46	2.63	20.42
USSR/E. EUR.	3.02	.00	396.75	12.06	4.74	17.05	433.62
CHINA/ET.AL.	.28	12.03	221.76	22.61	8.88	19.72	285.28
MIDDLE EAST	101.09	80.78	2.36	22.00	8.64	2.07	216.94
AFRICA	21.17	29.27	39.97	18.48	7.26	25.00	141.15
LATIN AMER	.32	.00	19.20	31.66	12.44	22.23	85.84
S.&E. ASIA	5.16	1.77	16.64	27.01	10.61	14.14	75.32
ALL REGIONS	138.20	136.41	709.77	199.87	78.51	121.14	1383.91

SECONDARY ENERGY DEMAND TABLE
(UNITS=EXAJOULES (J*10**18))

	LIQUIDS	GASES	SOLIDS	ELECTRIC	TOTAL PURCHASED FUELS	CONSERV. NONELEC SOLAR	TOTAL
USA	38.66	11.67	3.69	32.76	86.79	81.53	168.32
CANADA & EUR	13.81	11.05	7.21	26.39	58.47	27.41	85.88
OECD PACIFIC	9.65	4.88	4.24	12.11	30.88	12.79	43.68
USSR/E. EUR.	18.53	18.87	12.64	19.86	69.89	54.28	124.17
CHINA/ET.AL.	25.99	21.26	46.93	33.65	127.83	78.15	205.98
MIDDLE EAST	21.71	8.21	1.89	17.60	49.41	90.80	140.21
AFRICA	18.14	13.99	17.56	29.79	79.48	25.64	105.12
LATIN AMER	35.11	11.25	7.01	45.51	98.88	87.07	185.94
S.&E. ASIA	16.36	7.04	24.36	34.43	82.19	58.86	141.05
ALL REGIONS	197.96	108.23	125.53	252.11	683.83	516.53	1200.36

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

2075 ENERGY PRODUCTION AND USAGE REPORT

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REFINABLE ENERGY DEMAND SUMMARY, BY REGION AND TYPE (UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	48.43	24.47	45.89	29.76	11.69	6.28	166.52
CANADA & EUR	17.91	21.73	36.21	24.94	9.80	12.03	122.62
OECD PACIFIC	13.81	7.51	20.40	11.34	4.46	2.63	60.15
USSR/E. EUR.	27.90	21.39	35.08	12.06	4.74	17.05	118.22
CHINA/ET.AL.	43.55	25.99	88.98	22.61	8.88	19.72	209.72
MIDDLE EAST	23.47	12.86	22.56	22.00	8.64	2.07	91.61
AFRICA	31.22	17.86	51.98	18.48	7.26	25.00	151.81
LATIN AMER	59.53	17.86	65.89	31.66	12.44	22.23	209.61
S.&E. ASIA	24.88	12.74	75.19	27.01	10.61	14.14	164.57
ALL REGIONS	290.70	162.41	442.18	199.87	78.51	121.14	1294.82

REFINABLE ENERGY SUPPLY SUMMARY, BY REGION AND TYPE (UNITS=EXAJOULES (J*10**18))

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	1.07	12.69	2.19	29.76	11.69	6.28	63.68
CANADA & EUR	8.24	.29	4.92	24.94	9.80	12.03	60.22
OECD PACIFIC	.66	.06	1.05	11.34	4.46	2.63	20.20
USSR/E. EUR.	88.25	14.53	247.11	12.06	4.74	17.05	383.74
CHINA/ET.AL.	47.92	20.16	138.12	22.61	8.88	19.72	257.40
MIDDLE EAST	101.60	80.86	1.47	22.00	8.64	2.07	216.64
AFRICA	29.76	30.73	24.89	18.48	7.26	25.00	136.12
LATIN AMER	4.45	.70	11.96	31.66	12.44	22.23	83.43
S.&E. ASIA	8.74	2.38	10.36	27.01	10.61	14.14	73.23
ALL REGIONS	290.67	162.41	442.07	199.87	78.51	121.14	1294.67

REFINABLE OIL SUPPLY SUMMARY BY REGION AND TYPE (UNITS=EXAJOULES (J*10**18))

	CONVEN-TIONAL	UNCONVEN-TIONAL	SYNOIL	TOTAL
USA	.15	.15	.76	1.07
CANADA & EUR	6.38	.16	1.70	8.24
OECD PACIFIC	.15	.15	.36	.66
USSR/E. EUR.	2.88	.14	85.23	88.25
CHINA/ET.AL.	.00	.29	47.64	47.92
MIDDLE EAST	100.64	.45	.51	101.60
AFRICA	20.79	.38	8.59	29.76
LATIN AMER	.00	.32	4.12	4.45
S.&E. ASIA	4.84	.32	3.57	8.74
ALL REGIONS	135.84	2.36	152.47	290.67

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

2075 ENERGY PRODUCTION AND USAGE REPORT
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REFINABLE GAS SUPPLY SUMMARY BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	CONVEN-TIONAL	UNCONVEN-TIONAL	SYNGAS	TOTAL
USA	12.56	.00	.13	12.69
CANADA & EUR	.00	.00	.29	.29
OECD PACIFIC	.00	.00	.06	.06
USSR/E. EUR.	.00	.00	14.53	14.53
CHINA/ET.AL.	12.03	.00	8.12	20.16
MIDDLE EAST	80.78	.00	.09	80.86
AFRICA	29.27	.00	1.46	30.73
LATIN AMER	.00	.00	.70	.70
S.&E. ASIA	1.77	.00	.61	2.38
ALL REGIONS	136.41	.00	26.00	162.41

REFINABLE SOLIDS SUPPLY SUMMARY BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	COAL	BIOMASS	TOTAL
USA	.00	2.19	2.19
CANADA % EUR	.00	4.92	4.92
OECD PACIFIC	.00	1.05	1.05
USSR/E. EUR.	243.93	3.17	247.11
CHINA/ET.AL.	132.56	5.56	138.12
MIDDLE EAST	.05	1.42	1.47
AFRICA	18.24	6.65	24.89
LATIN AMER	3.86	8.10	11.96
S.&E. ASIA	.06	10.31	10.36
ALL REGIONS	398.69	43.37	442.07

IMPORT SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	COAL	TOTAL
USA	47.37	11.78	43.70	102.85
CANADA & EUR	9.66	21.44	31.29	62.40
OECD PACIFIC	13.14	7.45	19.35	39.94
USSR/E. EUR.	-60.35	6.85	-212.03	-265.53
CHINA/ET.AL.	-4.37	5.83	-49.14	-47.68
MIDDLE EAST	-78.12	-68.00	21.09	-125.04
AFRICA	1.47	-12.88	27.09	15.68
LATIN AMER	55.08	17.16	53.93	126.18
S.&E. ASIA	16.15	10.36	64.83	91.33
TOTAL TRADE	142.85	80.88	261.17	484.90

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED) (2=NOPT(6)

2075 ENERGY PRODUCTION AND USAGE REPORT
****

ELECTRICITY DEMAND SUMMARY, BY REGION AND TYPE
UNITS=EXAJOULES (J*10**18) OF PRIMARY EQUIVALENTS

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	9.77	12.80	42.19	29.76	11.69	6.28	112.50
CANADA & EUR	4.09	10.68	29.00	24.94	9.80	12.03	90.54
OECD PACIFIC	4.16	2.63	16.16	11.34	4.46	2.63	41.37
USSR/E. EUR.	9.37	2.52	22.44	12.06	4.74	17.05	68.18
CHINA/ET.AL.	17.56	4.72	42.05	22.61	8.88	19.72	115.54
MIDDLE EAST	1.77	4.64	20.67	22.00	8.64	2.07	59.79
AFRICA	13.08	3.87	34.43	18.48	7.26	25.00	102.11
LATIN AMER	24.42	6.61	58.88	31.66	12.44	22.23	156.24
S.&E. ASIA	8.52	5.71	50.83	27.01	10.61	14.14	116.81
ALL REGIONS	92.74	54.19	316.65	199.87	78.51	121.14	863.10

ELECTRICITY SUPPLY SUMMARY, BY REGION AND TYPE
UNITS=EXAJOULES (J*10**18) OF HEAT EQUIVALENTS

	OIL	GAS	SOLIDS	NUCLEAR	SOLAR	HYDRO	TOTAL
USA	2.67	3.50	12.69	8.67	3.40	1.83	32.76
CANADA & EUR	1.12	2.92	8.72	7.27	2.86	3.51	26.39
OECD PACIFIC	1.14	.72	4.86	3.32	1.30	.77	12.11
USSR/E. EUR.	2.56	.69	6.75	3.51	1.38	4.97	19.86
CHINA/ET.AL.	4.80	1.29	12.65	6.59	2.59	5.74	33.65
MIDDLE EAST	.48	1.27	6.22	6.47	2.54	.61	17.60
AFRICA	3.58	1.06	10.35	5.39	2.12	7.29	29.79
LATIN AMER	6.68	1.81	17.71	9.22	3.62	6.48	45.51
S.&E. ASIA	2.33	1.56	15.29	7.96	3.13	4.17	34.43
ALL REGIONS	23.35	14.81	95.23	58.41	22.94	35.36	252.11

SYNFUEL PRODUCTION SUMMARY, BY REGION AND TYPE
(UNITS=EXAJOULES (J*10**18))

	OIL	GAS	TOTAL	SOLIDS
USA	.76	.13	.89	-1.33
CANADA & EUR	1.70	.29	1.98	-2.98
OECD PACIFIC	.36	.06	.42	-.64
USSR/E. EUR.	85.23	14.53	99.76	-147.64
CHINA/ET.AL.	47.64	8.12	55.76	-83.64
MIDDLE EAST	.51	.09	.59	-.89
AFRICA	8.59	1.46	10.05	-15.07
LATIN AMER	4.12	.70	4.83	-7.24
S.&E. ASIA	3.57	.61	4.18	-6.28
ALL REGIONS	152.47	26.00	178.47	-267.70

TABLE 7.8. SUMMARY TABLES FOR PERIOD M (CONTINUED)
(2=NOPT(6)

2075 ENERGY USE PER DOLLAR GNP AND PER CAPITA
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REGION	POPUL. (MIL)	BASE GNP (BIL 1975 US DOL)	FINAL GNP (BIL 1975 US DOL)	ENERGY USE (EXAJOULES)	E/GNP J*10**9/$	E/CAPITA J*10**9/CAP	GNP/CAP $/CAP
USA	292.	14790.	14386.	172.43	11.99	590.52	49266.
CANADA & EUR	562.	17440.	17022.	138.12	8.11	245.76	30288.
OECD PACIFIC	169.	5335.	5233.	66.22	12.65	391.82	30967.
USSR/E. EUR.	541.	8246.	7565.	97.92	12.94	181.01	13983.
CHINA/ET.AL.	1647.	13089.	11962.	212.14	17.73	128.80	7263.
MIDDLE EAST	241.	15739.	16560.	105.14	6.35	436.25	68715.
AFRICA	1150.	12941.	12420.	173.20	13.95	150.61	10800.
LATIN AMER	849.	22457.	20097.	220.23	10.96	259.40	23671.
S.&E. ASIA	2995.	15042.	13587.	198.70	14.62	66.35	4537.
ALL REGIONS	8446.	125080.	118833.	1384.11	11.65	163.88	14070.

TABLE 7.9. PRICE DATA TABLES FOR PERIOD M (2=NOPT(7)

1975 ENERGY PRICE REPORT

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PRIMARY ENERGY PRICES BY MODE (1975 U.S. DOLLARS PER GIGAJOULE)

REGION	OIL	GAS	SOLIDS	NUCLEAR	SOLAR-ELEC	HYDRO
WORLD	1.84	.63	.51			
USA	1.94	.63	.51	6.83	200.60	4.03
CANADA & EUR	2.93	6.25	1.77	6.83	402.40	4.03
OECD PACIFIC	2.18	6.39	.85	6.83	281.60	4.03
USSR/E. EUR.	1.84	.63	.52	6.83	402.40	4.03
CHINA/ET.AL.	1.98	.63	.51	6.83	321.40	4.03
MIDDLE EAST	.18	.31	.85	6.83	128.60	4.03
AFRICA	3.96	.63	.85	6.83	144.00	4.03
LATIN AMER	1.97	.63	.92	6.83	321.40	4.03
S.&E. ASIA	1.68	.63	.92	6.83	200.60	4.03

ELECTRIC POWER GENERATION COSTS BY MODE (1975 U.S. DOLLARS PER GIGAJOULE)

REGION	OIL	GAS	SOLIDS	NUCLEAR	SOLAR-ELEC	HYDRO
USA	10.50	7.12	9.43	9.19	221.76	6.12
CANADA & EUR	13.69	19.46	12.45	9.19	443.13	6.12
OECD PACIFIC	11.44	28.15	10.57	9.19	310.62	6.12
USSR/E. EUR.	9.31	8.07	8.46	9.19	443.13	6.12
CHINA/ET.AL.	9.51	8.07	8.43	9.19	354.28	6.12
MIDDLE EAST	10.77	6.92	9.56	9.19	142.77	6.12
AFRICA	12.77	8.07	9.56	9.19	159.67	6.12
LATIN AMER	9.51	8.07	9.79	9.19	354.28	6.12
S.&E. ASIA	11.42	8.07	9.79	9.19	221.76	6.12

SECONDARY ENERGY PRICES BY MODE (1975 U.S. DOLLARS PER GIGAJOULE)

REGION	LIQUIDS	GASES	SOLIDS	ELECTRIC
USA	3.36	.97	.77	8.73
CANADA & EUR	4.35	6.60	2.03	10.50
OECD PACIFIC	3.60	6.74	1.11	10.71
USSR/E. EUR.	3.26	.97	.78	8.22
CHINA/ET.AL.	3.40	.97	.77	7.72
MIDDLE EAST	1.61	.66	1.11	8.81
AFRICA	5.38	.97	1.11	9.09
LATIN AMER	3.39	.97	1.18	7.46
S.&E. ASIA	3.11	.97	1.18	9.10

TABLE 7.9. PRICE DATA TABLES FOR PERIOD M (Continued) (2=NOPT(7)

2000 ENERGY PRICE REPORT
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PRIMARY ENERGY PRICES
BY MODE
(1975 U.S. DOLLARS PER GIGAJOULE)

REGION	OIL	GAS	SOLIDS	NUCLEAR	SOLAR-ELEC	HYDRO
WORLD	2.63	.83	.61			
USA	2.70	2.25	.78	8.97	54.58	4.03
CANADA & EUR	3.99	4.05	1.61	8.97	77.30	4.03
OECD PACIFIC	2.97	3.49	.78	8.97	64.67	4.03
USSR/E. EUR.	2.70	2.25	.78	8.97	77.30	4.03
CHINA/ET.AL.	2.70	2.25	.78	8.97	69.09	4.03
MIDDLE EAST	1.08	1.58	.78	8.97	43.70	4.03
AFRICA	4.04	2.25	.78	8.97	46.24	4.03
LATIN AMER	2.75	2.25	.81	8.97	69.09	4.03
S.&E. ASIA	2.70	2.25	.81	8.97	54.58	4.03

ELECTRIC POWER GENERATION COSTS
BY MODE
(1975 U.S. DOLLARS PER GIGAJOULE)

REGION	OIL	GAS	SOLIDS	NUCLEAR	SOLAR-ELEC	HYDRO
USA	11.84	11.48	10.32	11.54	61.57	6.12
CANADA & EUR	15.92	14.48	12.03	11.54	86.50	6.12
OECD PACIFIC	12.95	17.98	10.32	11.54	72.64	6.12
USSR/E. EUR.	10.56	14.02	9.32	11.54	86.50	6.12
CHINA/ET.AL.	10.56	14.02	9.32	11.54	77.49	6.12
MIDDLE EAST	14.24	11.55	9.32	11.54	49.64	6.12
AFRICA	12.91	14.02	9.32	11.54	52.43	6.12
LATIN AMER	10.66	14.02	9.42	11.54	77.49	6.12
S.&E. ASIA	13.67	14.02	9.42	11.54	61.57	6.12

SECONDARY ENERGY PRICES
BY MODE
(1975 U.S. DOLLARS PER GIGAJOULE)

REGION	LIQUIDS	GASES	SOLIDS	ELECTRIC
USA	4.12	2.60	1.04	10.94
CANADA & EUR	5.42	4.40	1.87	10.50
OECD PACIFIC	4.39	3.84	1.04	10.66
USSR/E. EUR.	4.12	2.60	1.04	9.65
CHINA/ET.AL.	4.12	2.60	1.04	8.52
MIDDLE EAST	2.50	1.93	1.04	11.72
AFRICA	5.47	2.60	1.04	9.20
LATIN AMER	4.17	2.60	1.07	8.15
S.&E. ASIA	4.12	2.60	1.07	9.28

TABLE 7.9. PRICE DATA TABLES FOR PERIOD M (Continued) (2=NOPT(7)

2025 ENERGY PRICE REPORT

PRIMARY ENERGY PRICES
BY MODE
(1975 U.S. DOLLARS PER GIGAJOULE)

REGION	OIL	GAS	SOLIDS	NUCLEAR	SOLAR-ELEC	HYDRO
WORLD	3.76	1.37	.70			
USA	3.83	2.79	.87	10.53	14.85	4.03
CANADA & EUR	5.66	3.91	1.52	10.53	14.85	4.03
OECD PACIFIC	4.21	3.49	.87	10.53	14.85	4.03
USSR/E. EUR.	3.83	2.79	.87	10.53	14.85	4.03
CHINA/ET.AL.	3.83	2.79	.87	10.53	14.85	4.03
MIDDLE EAST	2.68	2.37	.87	10.53	14.85	4.03
AFRICA	3.83	2.79	.87	10.53	14.85	4.03
LATIN AMER	3.83	2.79	.87	10.53	14.85	4.03
S.&E. ASIA	3.83	2.79	.87	10.53	14.85	4.03

ELECTRIC POWER GENERATION COSTS
BY MODE
(1975 U.S. DOLLARS PER GIGAJOULE)

REGION	OIL	GAS	SOLIDS	NUCLEAR	SOLAR-ELEC	HYDRO
USA	13.85	12.93	10.62	13.25	17.99	6.12
CANADA & EUR	19.43	14.15	11.78	13.25	17.99	6.12
OECD PACIFIC	15.34	17.98	10.62	13.25	17.99	6.12
USSR/E. EUR.	12.22	16.00	9.62	13.25	17.99	6.12
CHINA/ET.AL.	12.22	16.00	9.62	13.25	17.99	6.12
MIDDLE EAST	20.44	14.46	9.62	13.25	17.99	6.12
AFRICA	12.57	16.00	9.62	13.25	17.99	6.12
LATIN AMER	12.24	16.00	9.62	13.25	17.99	6.12
S.&E. ASIA	16.17	16.00	9.62	13.25	17.99	6.12

SECONDARY ENERGY PRICES
BY MODE
(1975 U.S. DOLLARS PER GIGAJOULE)

REGION	LIQUIDS	GASES	SOLIDS	ELECTRIC
USA	5.25	3.14	1.13	11.53
CANADA & EUR	7.09	4.26	1.78	11.22
OECD PACIFIC	5.63	3.84	1.13	11.76
USSR/E. EUR.	5.25	3.14	1.13	11.31
CHINA/ET.AL.	5.25	3.14	1.13	9.57
MIDDLE EAST	4.10	2.72	1.13	12.57
AFRICA	5.25	3.14	1.13	10.36
LATIN AMER	5.25	3.14	1.13	8.69
S.&E. ASIA	5.25	3.14	1.13	10.70

TABLE 7.9. PRICE DATA TABLES FOR PERIOD M (Continued)
(2=NOPT(7)

2050 ENERGY PRICE REPORT
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PRIMARY ENERGY PRICES
BY MODE
(1975 U.S. DOLLARS PER GIGAJOULE)

REGION	OIL	GAS	SOLIDS	NUCLEAR	SOLAR-ELEC	HYDRO
WORLD	4.71	2.29	.89			
USA	4.78	3.71	1.06	11.68	14.85	4.03
CANADA & EUR	7.07	4.45	1.59	11.68	14.85	4.03
OECD PACIFIC	5.26	3.71	1.06	11.68	14.85	4.03
USSR/E. EUR.	4.78	3.71	1.06	11.68	14.85	4.03
CHINA/ET.AL.	4.78	3.71	1.06	11.68	14.85	4.03
MIDDLE EAST	4.78	3.71	1.06	11.68	14.85	4.03
AFRICA	4.78	3.71	1.06	11.68	14.85	4.03
LATIN AMER	4.78	3.71	1.06	11.68	14.85	4.03
S.&E. ASIA	4.78	3.71	1.06	11.68	14.85	4.03

ELECTRIC POWER GENERATION COSTS
BY MODE
(1975 U.S. DOLLARS PER GIGAJOULE)

REGION	OIL	GAS	SOLIDS	NUCLEAR	SOLAR-ELEC	HYDRO
USA	15.54	15.39	11.25	14.51	17.99	6.12
CANADA & EUR	22.40	15.38	11.96	14.51	17.99	6.12
OECD PACIFIC	17.35	18.75	11.25	14.51	17.99	6.12
USSR/E. EUR.	13.61	19.35	10.25	14.51	17.99	6.12
CHINA/ET.AL.	13.61	19.35	10.25	14.51	17.99	6.12
MIDDLE EAST	28.58	19.35	10.25	14.51	17.99	6.12
AFRICA	14.03	19.35	10.25	14.51	17.99	6.12
LATIN AMER	13.64	19.35	10.25	14.51	17.99	6.12
S.&E. ASIA	18.28	19.35	10.25	14.51	17.99	6.12

SECONDARY ENERGY PRICES
BY MODE
(1975 U.S. DOLLARS PER GIGAJOULE)

REGION	LIQUIDS	GASES	SOLIDS	ELECTRIC
USA	6.20	4.06	1.32	12.57
CANADA & EUR	8.50	4.80	1.85	11.66
OECD PACIFIC	6.68	4.06	1.32	12.49
USSR/E. EUR.	6.20	4.06	1.32	12.16
CHINA/ET.AL.	6.20	4.06	1.32	10.59
MIDDLE EAST	6.20	4.06	1.32	12.61
AFRICA	6.20	4.06	1.32	11.04
LATIN AMER	6.20	4.06	1.32	9.11
S.&E. ASIA	6.20	4.06	1.32	11.37

TABLE 7.9. PRICE DATA TABLES FOR PERIOD M (Continued)
(2=NOPT(7)

2075 ENERGY PRICE REPORT
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PRIMARY ENERGY PRICES
BY MODE
(1975 U.S. DOLLARS PER GIGAJOULE)

REGION	OIL	GAS	SOLIDS	NUCLEAR	SOLAR-ELEC	HYDRO
WORLD	5.41	3.20	.99	10.46	14.85	4.03
USA	5.48	4.62	1.16	10.46	14.85	4.03
CANADA & EUR	8.11	5.54	1.75	10.46	14.85	4.03
OECD PACIFIC	6.03	4.62	1.16	10.46	14.85	4.03
USSR/E. EUR.	5.48	4.62	1.16	10.46	14.85	4.03
CHINA/ET.AL.	5.48	4.62	1.16	10.46	14.85	4.03
MIDDLE EAST	5.48	4.62	1.16	10.46	14.85	4.03
AFRICA	5.48	4.62	1.16	10.46	14.85	4.03
LATIN AMER	5.48	4.62	1.16	10.46	14.85	4.03
S.&E. ASIA	5.48	4.62	1.16			

ELECTRIC POWER GENERATION COSTS
BY MODE
(1975 U.S. DOLLARS PER GIGAJOULE)

REGION	OIL	GAS	SOLIDS	NUCLEAR	SOLAR-ELEC	HYDRO
USA	16.79	17.83	11.60	13.18	17.99	6.12
CANADA & EUR	24.59	17.86	12.40	13.18	17.99	6.12
OECD PACIFIC	18.83	21.94	11.60	13.18	17.99	6.12
USSR/E. EUR.	14.64	22.68	10.60	13.18	17.99	6.12
CHINA/ET.AL.	14.64	22.68	10.60	13.18	17.99	6.12
MIDDLE EAST	31.31	22.68	10.60	13.18	17.99	6.12
AFRICA	15.11	22.68	10.60	13.18	17.99	6.12
LATIN AMER	14.67	22.68	10.60	13.18	17.99	6.12
S.&E. ASIA	19.84	22.68	10.60			

SECONDARY ENERGY PRICES
BY MODE
(1975 U.S. DOLLARS PER GIGAJOULE)

REGION	LIQUIDS	GASES	SOLIDS	ELECTRIC
USA	6.91	4.97	1.42	12.71
CANADA & EUR	9.54	5.89	2.01	11.72
OECD PACIFIC	7.46	4.97	1.42	12.49
USSR/E. EUR.	6.91	4.97	1.42	12.33
CHINA/ET.AL.	6.91	4.97	1.42	10.71
MIDDLE EAST	6.91	4.97	1.42	13.40
AFRICA	6.91	4.97	1.42	11.16
LATIN AMER	6.91	4.97	1.42	9.20
S.&E. ASIA	6.91	4.97	1.42	11.42

TABLE 7.10. CARBON DIOXIDE OUTPUT FOR PERIOD M (2=NOPT(8))

1975 CO2 EMISSIONS REPORT

CO2 EMISSIONS BY REGION AND PRIMARY ENERGY SOURCE
UNITS: 10**6 TONNES OF CARBON

REGION	CONV OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
USA	384.	0.	0.	408.	0.	265.	1056.
W EUR + CAN	87.	0.	0.	228.	0.	116.	431.
OECD PACIFIC	17.	0.	0.	63.	0.	4.	85.
USSR/E. EUR.	408.	0.	0.	612.	0.	160.	1179.
CHINA/ET.AL.	59.	0.	0.	356.	0.	2.	417.
MIDDLE EAST	717.	0.	0.	1.	0.	15.	733.
AFRICA	202.	0.	0.	52.	0.	5.	259.
LATIN AMER	182.	0.	0.	9.	0.	14.	205.
S.&E. ASIA	69.	0.	0.	64.	0.	10.	142.
ALL REGIONS	2125.	0.	0.	1792.	0.	590.	4507.

2000 CO2 EMISSIONS REPORT

CO2 EMISSIONS BY REGION AND PRIMARY ENERGY SOURCE
UNITS: 10**6 TONNES OF CARBON

REGION	CONV OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
USA	0.	0.	0.	0.	0.	51.	51.
W EUR + CAN	255.	0.	0.	0.	0.	89.	344.
OECD PACIFIC	0.	0.	0.	0.	0.	11.	11.
USSR/E. EUR.	434.	0.	17.	1461.	0.	394.	2307.
CHINA/ET.AL.	192.	0.	0.	1294.	0.	7.	1492.
MIDDLE EAST	804.	0.	0.	3.	0.	22.	829.
AFRICA	555.	0.	3.	223.	0.	6.	786.
LATIN AMER	459.	0.	0.	40.	0.	46.	547.
S.&E. ASIA	47.	0.	0.	260.	0.	29.	335.
ALL REGIONS	2745.	0.	20.	3281.	0.	654.	6701.

2025 CO2 EMISSIONS REPORT

CO2 EMISSIONS BY REGION AND PRIMARY ENERGY SOURCE
UNITS: 10**6 TONNES OF CARBON

REGION	CONV OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
USA	1.	1.	0.	0.	0.	143.	145.
W EUR + CAN	636.	1.	0.	0.	0.	212.	849.
OECD PACIFIC	1.	1.	0.	0.	0.	32.	34.
USSR/E. EUR.	1015.	1.	231.	2681.	3.	594.	4525.
CHINA/ET.AL.	177.	1.	162.	1857.	2.	27.	2226.
MIDDLE EAST	506.	1.	0.	0.	0.	124.	631.
AFRICA	555.	1.	20.	221.	0.	30.	828.
LATIN AMER	480.	1.	5.	52.	0.	239.	776.
S.&E. ASIA	121.	1.	0.	0.	0.	120.	242.
ALL REGIONS	3491.	9.	418.	4811.	5.	1521.	10255.

TABLE 7.10. CARBON DIOXIDE OUTPUT FOR PERIOD M (Continued) (2=NOPT(8)

2050 CO2 EMISSIONS REPORT
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CO2 EMISSIONS BY REGION AND PRIMARY ENERGY SOURCE
UNITS: 10**6 TONNES OF CARBON

REGION	CONV OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
USA	2.	4.	0.	0.	0.	375.	381.
W EUR + CAN	169.	3.	0.	0.	0.	188.	360.
OECD PACIFIC	2.	4.	0.	0.	0.	57.	62.
USSR/E. EUR.	479.	3.	1121.	4500.	64.	627.	6795.
CHINA/ET.AL.	168.	3.	564.	2233.	32.	97.	3098.
MIDDLE EAST	1839.	4.	0.	1.	0.	569.	2412.
AFRICA	487.	4.	100.	383.	5.	130.	1109.
LATIN AMER	401.	3.	18.	69.	1.	180.	672.
S.&E. ASIA	36.	3.	0.	1.	0.	30.	70.
ALL REGIONS	3583.	31.	1803.	7187.	103.	2253.	14958.

2075 CO2 EMISSIONS REPORT
****

CO2 EMISSIONS BY REGION AND PRIMARY ENERGY SOURCE
UNITS: 10**6 TONNES OF CARBON

REGION	CONV OIL	SHALE OIL	SYNOIL	COAL	SYNGAS	GAS	TOTAL
USA	3.	7.	0.	0.	0.	169.	179.
W EUR + CAN	117.	5.	0.	0.	0.	0.	122.
OECD PACIFIC	3.	6.	0.	0.	0.	0.	9.
USSR/E. EUR.	52.	6.	2833.	5789.	504.	0.	9184.
CHINA/ET.AL.	0.	7.	1563.	3146.	274.	163.	5152.
MIDDLE EAST	1703.	10.	1.	1.	0.	1091.	2806.
AFRICA	397.	10.	221.	433.	38.	395.	1494.
LATIN AMER	0.	8.	46.	92.	8.	0.	153.
S.&E. ASIA	87.	8.	1.	1.	0.	24.	121.
ALL REGIONS	2362.	67.	4663.	9462.	824.	1843.	19221.

TABLE 7.11. SUMMARY TABLES FOR ALL PERIODS (2=NOPT(9)

SUMMARY ENERGY PRODUCTION AND USAGE REPORT

PRIMARY ENERGY DEMAND, BY REGION AND PERIOD (UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	66.67	95.25	121.35	149.87	172.43	
CANADA & EUR	39.59	64.06	83.99	107.35	138.12	
OECD PACIFIC	20.49	32.00	42.72	52.86	66.23	
USSR/E. EUR.	59.45	87.10	106.56	107.23	97.92	
CHINA/ET.AL.	19.52	52.20	106.83	165.32	212.14	
MIDDLE EAST	3.78	12.32	34.32	64.13	105.14	
AFRICA	5.29	19.07	59.61	113.43	173.20	
LATIN AMER	11.21	37.18	97.55	170.23	220.23	
S.&E. ASIA	9.78	29.43	76.08	136.07	198.70	
ALL REGIONS	235.78	428.61	729.01	1066.49	1384.11	

PRIMARY ENERGY SUPPLY, BY REGION AND PERIOD (UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	63.15	18.28	37.19	62.57	64.12	
CANADA & EUR	31.26	39.83	79.56	59.83	61.21	
OECD PACIFIC	5.90	5.27	12.44	17.26	29.42	
USSR/E. EUR.	62.15	128.41	249.67	346.90	423.62	
CHINA/ET.AL.	19.12	72.71	119.34	176.53	285.28	
MIDDLE EAST	42.77	50.68	45.67	167.91	216.94	
AFRICA	13.34	45.08	65.26	96.71	141.15	
LATIN AMER	12.83	43.49	78.68	91.54	85.84	
S.&E. ASIA	7.84	24.80	40.99	47.25	75.33	
ALL REGIONS	258.37	428.55	728.80	1066.49	1383.91	

SECONDARY ENERGY DEMAND, BY REGION AND PERIOD (UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	48.92	59.63	71.59	81.07	85.79	
CANADA & EUR	26.83	39.90	48.11	54.34	53.47	
OECD PACIFIC	14.02	20.57	25.76	28.65	36.88	
USSR/E. EUR.	45.54	63.55	74.08	74.31	69.89	
CHINA/ET.AL.	17.76	43.54	83.12	110.76	127.83	
MIDDLE EAST	3.34	10.52	25.12	37.08	49.41	
AFRICA	4.03	13.36	39.11	62.47	79.48	
LATIN AMER	8.93	25.71	58.39	85.26	98.88	
S.&E. ASIA	7.35	20.18	45.85	68.94	82.19	
ALL REGIONS	176.72	296.96	471.13	602.90	683.83	

TABLE 7.11. SUMMARY TABLES FOR ALL PERIODS (Continued) (2=NOPT(9)

SUMMARY ENERGY PRODUCTION AND USAGE REPORT

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CONSERVATION AND NON-ELECTRIC SOLAR, BY REGION AND PERIOD (UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	.00	21.46	39.55	61.83	81.53	
CANADA & EUR	.00	2.38	9.01	17.52	27.41	
OECD PACIFIC	.00	1.01	4.66	8.66	12.79	
USSR/E. EUR.	.00	14.87	30.31	45.64	54.28	
CHINA/ET.AL.	.00	7.76	24.77	52.96	78.15	
MIDDLE EAST	.00	3.71	21.16	56.04	90.80	
AFRICA	.00	.06	.37	11.85	25.64	
LATIN AMER	.00	4.98	25.14	57.73	87.07	
S.&E. ASIA	.00	3.65	16.30	38.00	58.86	
ALL REGIONS	.00	59.88	171.26	350.24	516.53	

REFINABLE ENERGY DEMAND, BY REGION AND PERIOD (UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	66.67	95.05	120.63	145.90	166.52	
CANADA & EUR	39.59	63.97	82.33	101.39	122.62	
OECD PACIFIC	20.49	31.95	42.20	50.29	60.15	
USSR/E. EUR.	59.45	87.19	106.66	115.81	118.22	
CHINA/ET.AL.	19.52	52.20	106.97	165.96	209.72	
MIDDLE EAST	3.78	12.32	33.98	60.62	91.61	
AFRICA	5.29	19.00	58.63	107.44	151.81	
LATIN AMER	11.21	37.15	96.61	163.29	209.61	
S.&E. ASIA	9.78	29.43	74.11	124.61	164.57	
ALL REGIONS	235.78	428.27	722.11	1035.30	1294.82	

REFINABLE ENERGY SUPPLY, BY REGION AND PERIOD (UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	63.15	18.27	37.15	62.38	63.68	
CANADA & EUR	31.26	39.82	79.44	59.41	60.22	
OECD PACIFIC	5.90	5.27	12.41	17.17	20.20	
USSR/E. EUR.	62.15	128.15	246.13	329.06	383.74	
CHINA/ET.AL.	19.12	72.71	116.85	167.41	257.40	
MIDDLE EAST	42.77	50.68	45.67	167.90	216.64	
AFRICA	13.34	45.03	64.89	94.75	176.12	
LATIN AMER	12.83	43.48	78.50	90.69	83.47	
S.&E. ASIA	7.84	24.80	40.84	46.51	77.27	
ALL REGIONS	258.37	428.21	721.89	1035.30	1294.67	

TABLE 7.11. SUMMARY TABLES FOR ALL PERIODS (Continued) (2=NOPT(9)

SUMMARY ENERGY PRODUCTION AND USAGE REPORT

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REFINABLE OIL SUPPLY, BY REGION AND PERIOD (UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	20.41	.01	.17	.53	1.07	
CANADA & EUR	4.77	13.97	35.06	10.12	8.24	
OECD PACIFIC	.96	.00	.13	.34	.66	
USSR/E. EUR.	22.77	24.77	63.74	60.63	88.25	
CHINA/ET.AL.	3.23	10.47	14.61	26.61	47.92	
MIDDLE EAST	42.35	47.50	29.96	108.82	101.60	
AFRICA	10.59	29.12	29.82	29.34	29.76	
LATIN AMER	9.92	25.04	26.53	23.61	4.45	
S.&E. ASIA	3.79	2.58	7.02	3.52	8.74	
ALL REGIONS	118.79	153.46	207.04	263.52	290.67	

REFINABLE CONVENTIONAL OIL SUPPLY, BY REGION AND PERIOD (UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	20.41	.00	.04	.09	.15	
CANADA & EUR	4.77	13.94	34.78	9.23	6.38	
OECD PACIFIC	.96	.00	.04	.09	.15	
USSR/E. EUR.	22.77	24.25	56.70	26.74	2.88	
CHINA/ET.AL.	3.23	10.47	9.65	9.19	.00	
MIDDLE EAST	42.35	47.50	29.91	108.66	100.64	
AFRICA	10.59	29.03	29.04	25.50	20.79	
LATIN AMER	9.92	25.01	26.13	21.87	.00	
S.&E. ASIA	3.79	2.58	6.70	1.99	4.84	
ALL REGIONS	118.79	152.78	192.99	203.34	135.84	

REFINABLE UNCONVENTIONAL OIL SUPPLY, BY REGION AND PERIOD (UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	.00	.00	.04	.09	.15	
CANADA & EUR	.00	.00	.04	.09	.16	
OECD PACIFIC	.00	.00	.04	.09	.15	
USSR/E. EUR.	.00	.00	.04	.08	.14	
CHINA/ET.AL.	.00	.00	.04	.12	.28	
MIDDLE EAST	.00	.00	.04	.16	.45	
AFRICA	.00	.00	.04	.14	.38	
LATIN AMER	.00	.00	.04	.13	.32	
S.&E. ASIA	.00	.00	.04	.13	.32	
ALL REGIONS	.00	.00	.39	1.04	2.36	

TABLE 7.11. SUMMARY TABLES FOR ALL PERIODS (Continued)
(2=NOPT(9)

SUMMARY ENERGY PRODUCTION AND USAGE REPORT
****

REFINABLE SYNOIL SUPPLY, BY REGION AND PERIOD
(UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	.00	.01	.09	.35	.76	
CANADA & EUR	.00	.03	.24	.80	1.70	
OECD PACIFIC	.00	.00	.04	.17	.36	
USSR/E. EUR.	.00	.52	7.00	33.81	85.23	
CHINA/ET.AL.	.00	.00	4.92	17.29	47.64	
MIDDLE EAST	.00	.00	.00	.00	.51	
AFRICA	.00	.09	.73	3.70	8.59	
LATIN AMER	.00	.03	.36	1.61	4.12	
S.&E. ASIA	.00	.00	.28	1.40	3.57	
ALL REGIONS	.00	.68	13.66	59.14	152.47	

REFINABLE GAS SUPPLY, BY REGION AND PERIOD
(UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	19.59	3.79	10.59	27.80	12.69	
CANADA & EUR	8.35	6.58	15.73	13.99	.29	
OECD PACIFIC	.31	.82	2.43	4.23	.06	
USSR/E. EUR.	11.33	29.03	44.04	48.29	14.53	
CHINA/ET.AL.	.13	.48	2.05	8.16	20.16	
MIDDLE EAST	.33	1.53	9.16	42.09	80.86	
AFRICA	.10	.41	2.26	9.83	30.73	
LATIN AMER	.74	3.42	17.67	13.39	.70	
S.&E. ASIA	.49	2.11	8.87	2.26	2.38	
ALL REGIONS	41.36	48.16	112.80	170.05	162.41	

REFINABLE CONVENTIONAL GAS SUPPLY BY REGION AND PERIOD
(UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	19.59	3.79	10.59	27.78	12.56	
CANADA & EUR	8.35	6.58	15.72	13.95	.00	
OECD PACIFIC	.31	.82	2.43	4.22	.00	
USSR/E. EUR.	11.33	29.03	43.96	46.43	.00	
CHINA/ET.AL.	.13	.48	2.00	7.21	12.03	
MIDDLE EAST	.33	1.53	9.16	42.09	80.78	
AFRICA	.10	.40	2.26	9.62	29.27	
LATIN AMER	.74	3.42	17.67	13.31	.00	
S.&E. ASIA	.49	2.11	8.87	2.19	1.77	
ALL REGIONS	41.36	48.16	112.65	166.81	136.41	

TABLE 7.11. SUMMARY TABLES FOR ALL PERIODS (Continued)
(2=NOPT(9)

SUMMARY ENERGY PRODUCTION AND USAGE REPORT
****

REFINABLE UNCONVENTIONAL GAS SUPPLY BY REGION AND PERIOD
(UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	.00	.00	.00	.00	.00	
CANADA & EUR	.00	.00	.00	.00	.00	
OECD PACIFIC	.00	.00	.00	.00	.00	
USSR/E. EUR.	.00	.00	.00	.00	.00	
CHINA/ET.AL.	.00	.00	.00	.00	.00	
MIDDLE EAST	.00	.00	.00	.00	.00	
AFRICA	.00	.00	.00	.00	.00	
LATIN AMER	.00	.00	.00	.00	.00	
S.&E. ASIA	.00	.00	.00	.00	.00	
ALL REGIONS	.00	.00	.00	.00	.00	

REFINABLE SYNGAS SUPPLY, BY REGION AND PERIOD
(UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	.00	.00	.00	.02	.13	
CANADA & EUR	.00	.00	.00	.04	.29	
OECD PACIFIC	.00	.00	.00	.01	.06	
USSR/E. EUR.	.00	.00	.07	1.86	14.53	
CHINA/ET.AL.	.00	.00	.05	.95	8.12	
MIDDLE EAST	.00	.00	.00	.00	.09	
AFRICA	.00	.00	.01	.20	1.46	
LATIN AMER	.00	.00	.00	.09	.70	
S.&E. ASIA	.00	.00	.00	.08	.61	
ALL REGIONS	.00	.00	.15	3.25	26.00	

REFINABLE SOLIDS SUPPLY, BY REGION AND PERIOD
(UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	17.18	1.01	1.43	2.00	2.19	
CANADA & EUR	9.60	3.40	3.93	4.54	4.92	
OECD PACIFIC	2.67	.49	.70	.76	1.05	
USSR/E. EUR.	25.77	63.14	115.17	192.59	247.11	
CHINA/ET.AL.	15.01	56.09	80.93	98.49	138.12	
MIDDLE EAST	.03	.40	.60	1.31	1.47	
AFRICA	2.18	10.77	12.09	21.08	24.89	
LATIN AMER	.39	3.71	5.98	9.20	11.96	
S.&E. ASIA	2.68	13.53	4.66	7.98	10.36	
ALL REGIONS	75.51	152.52	225.38	338.13	442.07	

TABLE 7.11. SUMMARY TABLES FOR ALL PERIODS (Continued) (2=NOPT(9)

SUMMARY ENERGY PRODUCTION AND USAGE REPORT

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REFINABLE COAL SUPPLY, BY REGION AND PERIOD (UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	17.18	.00	.00	.00	.00	
CANADA & EUR	9.60	.00	.00	.00	.00	
OECD PACIFIC	2.67	.00	.00	.00	.00	
USSR/E. EUR.	25.77	61.56	112.97	189.63	243.93	
CHINA/ET.AL.	15.01	54.52	78.23	94.08	132.56	
MIDDLE EAST	.03	.14	.00	.03	.05	
AFRICA	2.18	9.39	9.32	16.15	18.24	
LATIN AMER	.39	1.71	2.20	2.91	3.86	
S.&E. ASIA	2.68	10.94	.00	.03	.06	

REFINABLE BIOMASS SUPPLY, BY REGION AND PERIOD (UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	.00	1.01	1.43	2.00	2.19	
CANADA & EUR	.00	3.40	3.93	4.54	4.92	
OECD PACIFIC	.00	.49	.70	.96	1.05	
USSR/E. EUR.	.00	1.57	2.20	2.97	3.17	
CHINA/ET.AL.	.00	1.57	2.69	4.41	5.56	
MIDDLE EAST	.00	.27	.60	1.28	1.42	
AFRICA	.00	1.38	2.77	4.93	6.65	
LATIN AMER	.00	2.00	3.68	6.28	8.10	
S.&E. ASIA	.00	2.59	4.66	7.95	10.31	
ALL REGIONS	.00	14.27	22.66	35.31	43.37	

SYNFUEL PRODUCTION, BY REGION AND PERIOD (UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	.00	.01	.09	.37	.88	
CANADA & EUR	.00	.03	.24	.84	1.98	
OECD PACIFIC	.00	.00	.04	.18	.42	
USSR/E. EUR.	.00	.52	7.07	35.67	99.76	
CHINA/ET.AL.	.00	.00	4.97	18.24	55.76	
MIDDLE EAST	.00	.00	.00	.01	.59	
AFRICA	.00	.09	.74	3.90	10.05	
LATIN AMER	.00	.03	.36	1.70	4.83	
S.&E. ASIA	.00	.00	.29	1.48	4.18	
ALL REGIONS	.00	.68	13.81	62.38	178.47	

TABLE 7.11. SUMMARY TABLES FOR ALL PERIODS (Continued) (2=NOPT(9)

SUMMARY ENERGY PRODUCTION AND USAGE REPORT
****

COAL CONSUMED IN SYNFUEL PRODUCTION, BY REGION AND PERIOD
(UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	.00	-.01	-.13	-.56	-1.33	
CANADA & EUR	.00	-.04	-.36	-1.26	-2.98	
OECD PACIFIC	.00	-.01	-.06	-.27	-.64	
USSR/E. EUR.	.00	-.78	-10.61	-53.50	-149.64	
CHINA/ET.AL.	.00	.00	-7.46	-27.36	-93.64	
MIDDLE EAST	.00	.00	.00	-.01	-.89	
AFRICA	.00	-.13	-1.11	-5.86	-15.07	
LATIN AMER	.00	-.05	-.54	-2.55	-7.24	
S.&E. ASIA	.00	.00	-.43	-2.22	-6.28	
ALL REGIONS	.00	-1.02	-20.71	-93.57	-267.70	

NET ENERGY IMPORTS, BY REGION AND PERIOD
(UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	3.52	76.77	83.48	83.52	102.85	
CANADA & EUR	8.33	24.15	2.88	41.99	62.40	
OECD PACIFIC	14.59	26.68	29.79	33.12	39.94	
USSR/E. EUR.	-2.70	-40.95	-139.47	-213.25	-265.53	
CHINA/ET.AL.	.40	-20.51	-9.88	-1.46	-47.68	
MIDDLE EAST	-38.99	-38.36	-11.69	-107.28	-125.04	
AFRICA	-8.05	-26.03	-6.26	12.68	15.68	
LATIN AMER	-1.63	-6.33	18.11	72.60	126.18	
S.&E. ASIA	1.94	4.63	33.27	78.09	91.33	
ALL REGIONS	65.84	143.27	215.74	367.39	484.90	

ELECTRICITY DEMAND, BY REGION AND PERIOD
(UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	24.98	50.36	69.12	91.25	112.50	
CANADA & EUR	17.95	33.97	48.05	66.23	90.54	
OECD PACIFIC	8.97	15.95	23.18	30.52	41.37	
USSR/E. EUR.	19.55	33.18	45.81	58.46	68.18	
CHINA/ET.AL.	2.50	12.22	33.58	77.76	115.54	
MIDDLE EAST	.60	2.49	12.44	33.27	59.79	
AFRICA	1.77	7.96	27.46	63.38	102.11	
LATIN AMER	3.15	15.95	53.74	109.92	156.24	
S.&E. ASIA	3.43	13.12	39.92	78.79	116.81	
ALL REGIONS	82.90	185.19	353.30	609.59	863.10	

TABLE 7.11. SUMMARY TABLES FOR ALL PERIODS (Continued)
(2=NOPT(9)

SUMMARY ENERGY PRODUCTION AND USAGE REPORT
****

ELECTRICITY SUPPLY, BY REGION AND PERIOD
(UNITS=EXAJOULES (J*10**18))

	1975	2000	2025	2050	2075	2100
USA	7.23	14.93	20.08	26.42	32.76	
CANADA & EUR	5.18,	9.91	13.83	19.18	26.39	
OECD PACIFIC	2.50	4.57	6.74	8.89	12.11	
USSR/E. EUR.	5.64	9.53	13.23	16.96	19.86	
CHINA/ET.AL.	.74	3.56	9.74	22.56	33.65	
MIDDLE EAST	.16	.69	3.58	9.73	17.60	
AFRICA	.52	2.33	7.94	18.42	29.79	
LATIN AMER	.87	4.51	15.52	31.89	45.51	
S.&E. ASIA	1.01	3.86	11.66	23.13	34.43	
ALL REGIONS	23.84	53.88	102.31	177.19	252.11	

ENERGY USE PER CAPITA, BY REGION AND PERIOD
EXAJOULES(J*10**18) PER CAPITA

	1975	2000	2025	2050	2075	2100
USA	311.55	375.00	430.31	520.38	590.52	
CANADA & EUR	97.76	134.59	159.06	194.11	245.76	
OECD PACIFIC	160.12	207.79	260.50	316.52	391.82	
USSR/E. EUR.	150.52	184.54	206.52	201.19	181.01	
CHINA/ET.AL.	21.43	41.83	71.27	102.55	128.80	
MIDDLE EAST	46.66	83.83	172.46	276.44	436.25	
AFRICA	13.25	27.36	63.22	103.02	150.61	
LATIN AMER	35.80	68.84	135.86	206.84	259.40	
S.&E. ASIA	8.65	15.45	30.25	47.12	66.35	
ALL REGIONS	59.30	72.74	99.00	130.11	163.88	

ENERGY USE PER DOLLAR GNP, BY REGION AND PERIOD
EXAJOULES(J*10**18) PER 1975 US DOLLAR GNP

	1975	2000	2025	2050	2075	2100
USA	43.87	29.52	21.12	15.77	11.99	
CANADA & EUR	21.78	17.21	12.75	9.83	8.11	
OECD PACIFIC	34.95	27.02	19.87	15.38	12.65	
USSR/E. EUR.	61.52	44.31	31.47	20.47	12.94	
CHINA/ET.AL.	60.32	52.82	40.75	27.76	17.73	
MIDDLE EAST	27.31	20.68	15.05	9.71	6.35	
AFRICA	34.17	33.62	29.57	20.91	13.95	
LATIN AMER	35.52	31.64	25.18	17.76	10.96	
S.&E. ASIA	41.86	36.70	29.36	21.23	14.62	
ALL REGIONS	38.93	30.12	23.33	16.91	11.65	

TABLE 7.11. SUMMARY TABLES FOR ALL PERIODS (Continued)
(2=NOPT(9)

SUMMARY ENERGY PRODUCTION AND USAGE REPORT
****

CARBON EMISSIONS, BY REGION AND PERIOD
UNITS=10**6 TONS OF CARBON

	1975	2000	2025	2050	2075	2100
USA	1056.26	51.19	144.81	380.58	179.39	
CANADA & EUR	431.02	343.77	849.16	359.86	121.50	
OECD PACIFIC	84.69	10.99	34.40	61.89	9.16	
USSR/E. EUR.	1179.17	2306.82	4525.05	6795.12	9183.96	
CHINA/ET.AL.	417.29	1492.12	2225.58	3098.04	5152.97	
MIDDLE EAST	732.72	828.81	630.77	2411.59	2806.29	
AFRICA	259.05	786.05	827.65	1109.18	1494.29	
LATIN AMER	205.21	546.53	776.29	672.19	153.09	
S.&E. ASIA	141.76	334.89	241.79	69.60	121.49	
ALL REGIONS	4507.16	6701.17	10255.49	14958.05	19221.25	

AN INTRODUCTION TO THE USE OF THE IEA/ORAU, LONG-TERM, GLOBAL, ENERGY MODEL

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AN INTRODUCTION TO THE USE OF THE IEA/ORAU, LONG-TERM, GLOBAL, ENERGY MODEL

INTRODUCTION

The IEA/ORAU,[1] long-term, global, energy model was developed by Jae Edmonds and John Reilly at the Institute for Energy Analysis to provide a consistent, conditional representation of economic, demographic, technical, and policy factors as they affect energy use and production. It is a powerful and flexible assessment tool in policy analysis.

The global model is dissaggregated into nine regions (see Figure 1).[2] It is long-term, based to 1975, with benchmark years, 2000, 2025, 2050.[3] Nine types of primary energy are currently considered (see Table 1), as well as biomass and coal conversions to liquids and gases, conservation and nonelectric solar energy substitution. In addition to the supply and demand for energy by region, and forecast period, the model also estimates world and regional energy prices consistent with overall global energy balance. The model is extensively documented in its structure, the development of its data base, its output, and in its usage[4]; this documentation is available through IEA/ORAU.[5]

History of the Model

Model development began in the fall of 1980 for the U.S. Department of Energy, Office of Energy Research.[6] During the development phase the modeling and critical elements of the concurrently developed data base were submitted to external review. On July 27 and 28, 1981, Lester Lave, Bob Kuenne, and David Pumphrey met with the model developers to review both the technical details and

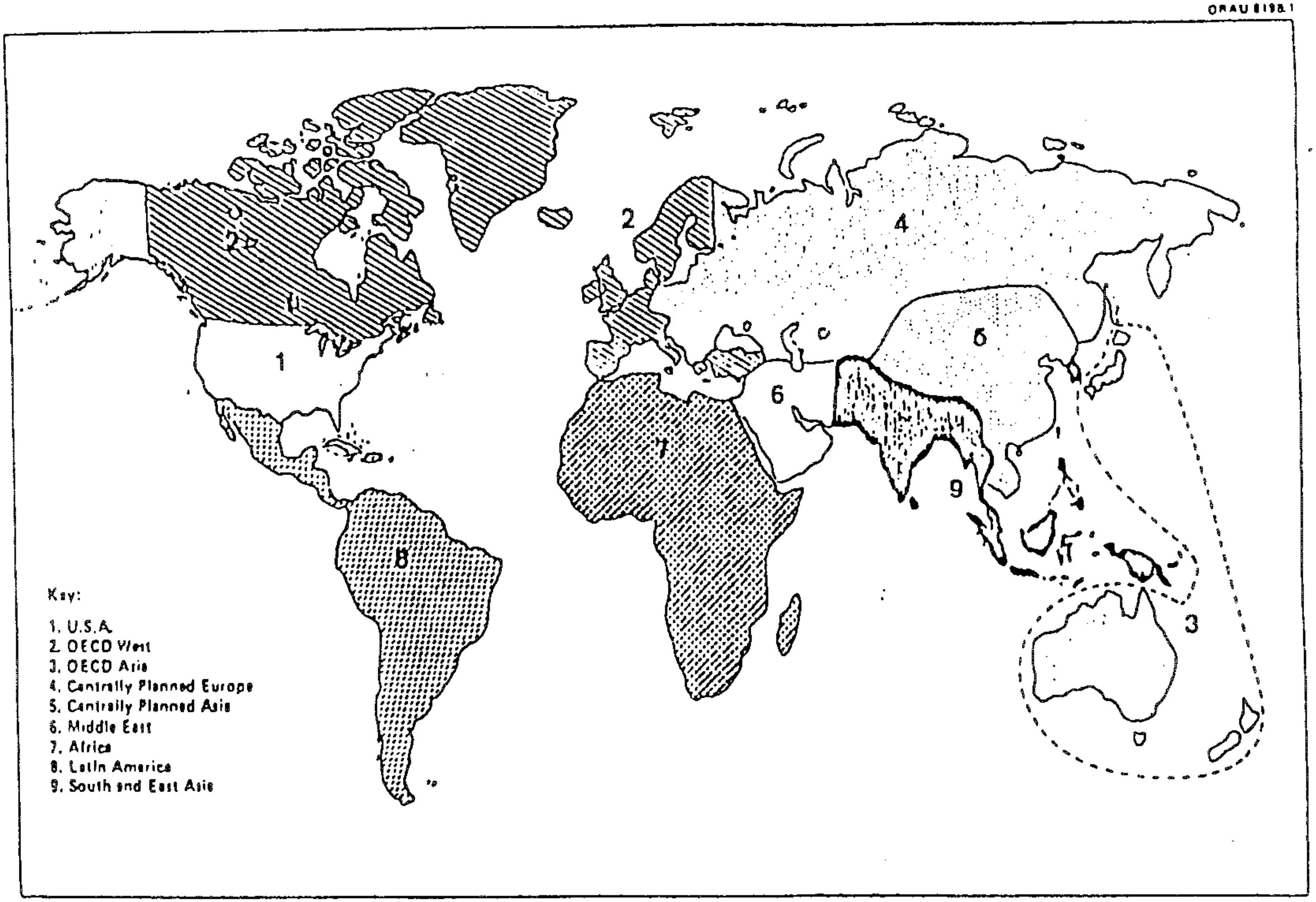

Figure 1. Geopolitical Divisions

TABLE 1. PRIMARY FUEL TYPES IN THE IEA/ORAU MODEL

1.0 Oil
  1.1 Conventional Oil
  1.2 Enhanced Recovery, Shale Oil, and Tar Sands

2.0 Gas
  2.1 Conventional Gas
  2.2 Nonconventional Gas

3.0 Solids
  3.1 Coal
  3.2 Biomass

4.0 Resource Constrained Renewables
  4.1 Hydro, Geothermal

5.0 Nuclear

6.0 Solar
  6.1 Solar Electric (other solar is associated with conservation), Wind Power, and Tidal Power, OTEC, Fusion, and other Advanced Renewable Technologies.

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the overall methodological underpinnings of the model.[7] The long-term demographic and labor force estimates developed by Nathan Keyfitz of Harvard University were later reviewed by Philander Claxton. Each stage of the modeling effort was subjected to a process of review and revision in light of any recommended changes before moving on to the next stage.

The initial purpose of the model was to assist in addressing what has come to be called the "CO_2 question." Carbon dioxide (CO_2) is released as a by-product of the combustion of fossil fuels. While not generally considered a pollutant, atmospheric CO_2 produces a "greenhouse" effect allowing incoming sunlight to penetrate to the earth's surface, but trapping escaping heat radiation. Thus an increasing atmospheric concentration of CO_2 has the effect of warming the earth. By its association with fossil fuel combustion, the CO_2 question becomes an energy question.

Examination of the CO_2 question required a minimum disaggregation of energy into fuel categories with different CO_2 emitting characteristics. The resulting model is relatively simple and inexpensive to operate but provides an interesting level of detail for many long-term energy questions. The detail includes coal transformation to liquids and gases, an electricity sector, and important new technologies (e.g., shale oil and solar).

The initial testing of the model was conducted during January of 1982, and a base case was accepted by April 1, 1982. Documentation of the energy results soon followed. "Global Energy Production and Use to the Year 2050" was in draft on May 1, 1982, and "Global Energy and CO_2 to the Year 2050" was in draft by June 1, 1982.

The model has been used by the U.S. Environmental Protection Agency, to forecast CO_2 emissions to the year 2100 under alternative scenarios. In addition results are being shared with researchers at both the U.S. National Academy of Sciences (NAS) and the International Institute for Applied Systems Analysis (IIASA).

MODEL APPLICATIONS

The model is a powerful and flexible tool for the analysis of long-term, international energy questions. The model has numerous applications, some of which are discussed below. While the discussion in no way exhausts the potential applications of the model, these examples are indicative of the breadth and scope of the model's usefulness.

Energy and the Macro Setting

GNP. One of the fundamental driving variables of the model is GNP. The GNP is an important determinant of energy demand. For each region in each forecast year, assumptions about the level of GNP that would emerge if energy prices remained at 1975 levels are entered into the model. However, energy prices and GNP are recognized as interdependent. As energy resources are depleted, more economic resources are needed in the energy sector, simply to keep energy production from falling. This shift of resources away from other uses and toward energy leaves less available for the rest of the economy, thus slowing economic growth. The model allows for this two-way interaction between energy and the economy. A base line GNP (the GNP that would obtain if energy prices remained constant) enters the model as an input, but the realized GNP, the GNP which is consistent with actual energy prices in any forecast year, is a model output. This more sophisticated treatment of the energy-economy interaction allows one to see the full GNP costs to the economy of energy scarcity by comparing the base line and realized GNPs.

Because the GNP enters as a regionally independent input variable, differential growth rates are possible between, for example, developing, developed, and centrally planned economies. It is therefore possible to explore the energy consequences of faster or slower economic growth rates in any or all regions. It should be noted, however, that because the regional GNPs are determined independently of one another, the user is responsible for maintaining a reasonable relationship between the GNP growth assumptions in the nine regions and between population growth and GNP in each region (see the following discussion on population).

Population. The level of population is another important determinant of energy demand. Like GNP the population is an exogenously specified input variable. Each region's population is specified independently. There is no feedback from GNP. On the other hand population and GNP are related because the GNP depends on the size of the labor force (a demographic variable) as well as the level of labor productivity. Thus base case GNP assumptions were developed in conjunction with demographic assumptions. The model takes no formal account of any effects GNP may have on population growth. While a large literature exists relating a demographic transition to economic advance, the details of this relationship were judged to be poorly understood for a formal treatment of this interaction. Under extreme GNP growth scenarios a user may want to alter population growth assumptions. For example, very rapid GNP growth might be postulated as leading to a more rapid reduction in the birth rate, thereby slowing population growth; alternatively very slow GNP growth (negative GNP per capita growth) might be postulated as resulting in starvation and deteriorating health status of the population thereby increasing the death rate and slowing population growth.

Energy and the International Setting

One of the most useful features of this model is that it sets energy questions in an international framework. It recognizes that energy questions are not just national or regional, but also international. The importance of OPEC decisions on U.S. energy policy or Soviet decisions on West European energy planning is explicitly taken into account.

Mideast oil supply. The largest single oil exporting region of the world is the Middle East (Region 6). Production decisions by Mideast producers can have a profound impact on the price and composition of energy products throughout the world. A major model input assumption is the level of production of Region 6. We have not attempted to incorporate a formal political decision model. A compelling model of the international and domestic political considerations of the OPEC nations as they interact with economic factors to determine the actual supply of oil from this region have eluded analysts to date. Rather than impose a particular structure on Mideast oil production we have merely represented production as a fixed level of production in each forecast period, with cumulative production consistent with resource constraints. The impacts of any given scenario of Middle East oil production can be explored.

International trade and tariffs. The model allows the trade of three aggregate energy carriers: liquids, gases, and solids. Liquids include conventional crude oil, unconventional crude oil (shale oil, tar sands, or tertiary recovery), and synoil from solids (coal or biomass). Similarly, gases include conventional, unconventional (deep gas or geopressured gas), and syngas from solids. Solids include coal and biomass. Electricity is excluded from interregional trade. Each region can either import or export these fuels. In the absence of taxes the cost of a fuel which is exported is simply the world price. Imported fuels are subject to a transportation charge and possibly a tariff charge. Tariffs can be used to represent import reduction policies or subsidies of domestic energy production. Tariffs are fuel, time period, and region specific.

International trade and isolationism. Tariffs form one kind of barrier to international trade. Another, more absolute barrier is a policy of isolationsm. A region, China for example, might decide to become energy self-sufficient and refrain from international commerce in energy for one or several periods. The model can easily be modified to handle this case.

A more difficult case, but one which the model has also been designed to handle is the case in which an individual region, chooses to be self-sufficient in one fuel but not all fuels. For example, the U.S. might decide to prohibit coal exports if carbon dioxide emissions were deemed a serious global problem. The model can be modified to deal with such a problem, and in fact such a case has already been run.

Energy and Resources

One of the major issues in long-term energy analysis is the magnitude of energy supply. The model has two classes of energy supply technologies. The first class, which includes conventional oil, conventional gas, and hydro-electricity, is resource constrained. That is, the amount of the resource available is small enough, relative to the potential demand for the resource, that the level of production is constrained by available resources. The second class, which includes unconventional oil, unconventional gas, coal, nuclear, and solar energy, is considered resource unconstrained. That is, the amount of the resource, relative to potential demand is sufficiently large that for practical purposes, resource size alone does not constrain the rate of production.

Conventional Oil and Gas. While the amount of conventional resources are considered small relative to unconventional resources, such as oil shale and coal, there remains considerable disagreement over the total resource available for exploitation. High and low estimates of the global oil resources vary by a factor of about two, while gas resource estimates vary by a factor of almost three. The model allows the user to specify the conventional resource available in each region and in addition, the model contains a parameter which specifies the rate at which the resource is exploited.

Deep gas and geopressured gas. In addition to conventional gas, there are unconventional gas resources which are vastly more abundant but are also more difficult to produce; geopressured gas is an example. Both cost and resource estimates are uncertain, but the model can be used to explore the consequences of both alternative costs and the rates of production. Similarly, Marchetti and Gold have contended that abiogenic gas is in abundant supply at great depths, and the model can be used to explore the consequences of such discoveries.

Shale oil and tar sands. As with gas, there are unconventional sources of oil. There is far less controversy surrounding resource estimates for shale oil and tar sands. These sources are known to be in massive global supply. Still the price at which these resources become economically recoverable is a matter of great debate. Shale oil has always seemed to be elusively beyond reach; the model can provide a general solution to the question of how much shale oil will be produced and when, under a given set of assumptions, because it incorporates all possible fuel substitutes (e.g., other liquids technologies, electricity, and liquids imports) in a full accounting of energy demand.

Energy and Technology

The issues surrounding energy and technology are numerous and multi-faceted. Technology affects both energy demand and energy supply. While the model can shed no light on technological questions per se, it can be used to explore the consequences of alternative technological "solutions."

Energy productivity. A great deal has been made of the slow-down and recent decline in labor productivity in the developed economies, especially in the United States. As a consequence of this the role of tehnological change has come into focus in this arena. Much less prominent has been the trends in energy productivity. Energy productivity, the amount of activity possible per unit of energy, has been improving for a long period of time both in the presence and absence of price incentives. The continuance of a 1 percent growth in energy productivity would reduce energy demand to about one-fourth of the level it could otherwise have achieved by the year 2100. The model explicitly considers energy productivity and the effects of simple technological improvement as an issue separate from price induced conservation.

Electric cars. Energy is not consumed for its own sake, but rather for the services which it provides--space heating, transportation, refrigeration, and direct electric services, for example. As a consequence, the model has been structured so as to follow the transformation process from primary energy source to energy service. The long-term nature of the model makes it impossible to credibly project energy services in detail. Instead three energy services: residential/commercial, industrial, and transport, have been designated in each of the three developed regions (1. U.S., 2. Western Europe and Canada, and 3. Japan, Australia and New Zealand), with one aggregate energy service elsewhere. Each energy service can currently be provided by one of four alternative modes: liquids, gases, solids, or electricity. The technology for transforming these four secondary energy aggregates into energy services is an input into the model. As a consequence, one could simulate the introduction of an inexpensive electric car by altering the technological specification by which electricity provides transportation services.

Nuclear and solar electricity. The model contains three nonfossil sources of electricity: hydro (a resource constrained technology) and solar and nuclear (resource unconstrained technologies). Wind energy is included as a solar technology. Because solar and nuclear are not resource constrained technologies, their production depends critically on the price at which these modes can produce electricity relative to each other and relative to the fossil alternatives. The model contains sufficient flexibility so that the user can not only specify a supply price for these modes, but also can either escalate or reduce costs over time, for a period of any duration.

Nonelectric solar and conservation. Both nonelectric solar energy and energy conservation are included in the model as reductions in the demand for marketed fuels. Both respond to the price of energy. The two are not disaggregated at present, though the model was built in such a way as to allow for nonelectric solar energy to be directly included, separately from conservation as an end-use alternative to conventional fuels.

The responsiveness of conservation and nonelectric solar to the price of alternative energy can also be controlled. As a consequence different values for price elasticities can be included without great difficulty.

Synfuel conversions. Both liquids and gases can be obtained by conversion from solids (coal and biomass). The supply of synfuels depends both on the price of producing synthetic liquids and gases and on the price of the conventional alternatives. The cost of producing synthetics in turn depends both on the conversion technology chosen and on the price of solids. While the price of solids is determined within the model structure itself, the conversion technology is an exogenous input to the model. Alternative technologies may thus be specified and the resulting penetration of synfuels may be examined as well as the effects of these technologies on oil and coal trade on or energy prices.

Hydrogen. As presently specified, no hydrogen production is included in the model. Its exclusion was based on the grounds of economics. Yet the model was constructed with a place for the production of this advanced technology fuel and the investigation of its penetration is possible.

Energy Policy

To this point little has been said about exploring the impacts of government intervention on energy production and consumption. Many policy levers are already in place in the model and can be used to simulate individual regions' policies as well as joint regional policies.

Energy use taxes. Energy-use taxes can be set on the end-use of any secondary fuel. Thus a gas or oil tax can be placed separately or jointly. Similarly a subsidy or negative tax can also levied.

Energy tariffs. Tariffs may be placed on any traded fuel.

Supply subsidies. While the taxes we have just discussed affect energy demands, financial considerations on the supply side may also be considered. Such subsidies on the production of energy may advance the date when unconventional technologies become available or expand the level of production in a declining industry.

Moratoria and forced-draft expansions. Some energy policy may be set without regard to economic considerations. There are some for example who feel that nuclear power generation is so undesirable that it should be halted. The model can rather easily be modified to curtail the use of any energy supply technology. Similarly, there are advocates of technologies that feel that expansion should continue without regard for economic consideration. For some fuels forced-draft expansions can easily be accommodated, while in others the model must be modified slightly to reflect such assumptions.

Measuring policy costs and benefits. As was stated earlier, the model calculates both market clearing prices and GNPs as outputs. The overall costs or benefits in terms of GNP and energy prices, of instituting a given policy can be measured by comparing equilibrium GNP results to a base case. Thus one could calculate the foregone GNP asociated with an energy tax strategy or the imposition of higher capital costs on energy users related to environmental concerns.

Energy and the Environment

Shale and coal production. The interactions between energy and the environment are many and varied. They flow from the fact that the production and consumption of energy is associated with negative externalities. The production of coal, for example has long been associted with occupational health and safety problems, environmental disruption, wastes disposal problems, subsidence and acid mine drainage. Similarly, a significant shale oil industry is likely to produce considerable environmental problems, including water pollution, land reclamation, interbasin transfers of water, and groundwater pollution.

The IEA/ORAU model can provide base projections of production of energy from a given source (e.g., shale) consistent with expectations of the international energy future and technology specifications. Such projections provide the base for a projection of future pollution levels in a business-as-usual case. The model can provide these types of analyses as a background to technical analyses establishing rates of pollutant production per amount of energy production activity. One can then propose pollution abatement plans and examine their effectiveness and their effects on energy markets and the economy.

Acid rain. In addition to pollution surrounding energy production, pollution is also associated with energy consumption. Acid rain is a source of concern in many parts of the world. Sulfur and nitrogen oxides, byproducts of oil and coal combustion, are believed to be responsible. The model can indicate the magnitudes of energy and, particularly, coal use under alternative scenarios. While the acid rain question is generally thought of as a short or medium term problem, long-term projections can provide insights into how regulations may have to be strengthened over time to maintain emissions rates below a given level.

Carbon dioxide. While not generally considered a pollutant, carbon dioxide (CO_2) is an important element in the earth's atmosphere. By allowing incoming sunlight to pass through to the earth's surface, but trapping reflected heat, CO_2 exerts a "greenhouse" effect and helps to keep the earth warm. CO_2 is also a byproduct of fossil fuel combustion, and scientists fear that the continued combustion of fossil fuels will increase the atmospheric concentration of CO_2 and consequently the earth's average temperature, with possible major changes in climate. This model contains a CO_2 emissions module option capable of assessing likely rates of carbon release under alternative scenarios.

MODEL LIMITATIONS

While modelers often suggest that their particular model can do anything and everything, all models are based on a set of simplified representatives of reality which make them more or less applicable to a given problem. This section briefly notes the major limitations of the IEA/ORAU long-term energy model.

Sectoral Boundaries

To begin with the model is an energy model. It looks only at energy markets. Nonenergy markets play no explicit role in the model. The only feedback between energy and the rest of the economy is through the GNP. The model is a partial equilibrium and not a general equilibrium model. As a consequence, the model is not designed to project such things as the international balance of payments, global availability of capital, interest rates, political events, international terms of trade, international capital flows or deal formally with the relationship between regional economic growth rates or the relationship between economic and population growth. The effects of such events on energy markets can be assessed by the model if the intermediate effects of such events are specified in terms of parameter inputs; the model itself gives no projections of future trends in these variables or an indication of how energy markets affect these events.

Disaggregation

The model is global and the geographic unit of analysis in the model is the global region. There is only one single-country region: the United States. And while the nine regions selected for inclusion in the model could be changed, there is little that could be done within the context of the model to disaggregate to significantly smaller units. For example, an assessment of state level energy supply and demand would be meaningless in the context of this model. The expected forecast error would greatly exceed the forecast itself.

Similarly, we feel that disaggregation of energy services much beyond the current level would result in spurious precision. The model is not suited for tracking the global demand for refrigeration or airconditioning serivces by the residential sector. This limitation stems not so much from conceptual difficulties surrounding the creation of such detailed models but rather from the nature of man's knowledge of long-term evolution in energy and economic systems.

Time Horizon

This is a long-term, global, energy model. It was designed to look into the relatively distant future. As a consequence of that design criterion, the model's effectiveness is maximized when used for long-term analysis. It is not a very helpful model if one is attempting to forecast the next quarter, next year, next five years, or even next decade. Underlying the parameters of the model is an explicit assumption that capital stocks are malleable, which however justified in the long-term, is clearly not justified in the short- or mid-term.

A frequently asked question, for almost all energy models, is, could your model have predicted the 1973 energy disruption and its immediate consequences? The answer to this question is, of course not. And the reasons are obvious. First, as stated earlier, the model is not a political model. It does not attempt to forecast politial disruptions, the formation and dissolution of cartels, or the pricing and production allocation system developed by cartels. Such is not the province of this model, and there is no model of which we are aware that could in fact have predicted the events of 1973. Second, the model is not a short-term model. It cannot, and is not intended to be able to forecast the short-term consequences of energy supply disruptions. The model is designed to answer the very different class of questions surrounding the long-term interaction of energy, population, economic development, technology, and energy policy.

END NOTE

While IEA/ORAU long-term, global energy model is a useful and powerful tool for handling an important class of problems. Further information on the model's capacities and limitations is available from IEA/ORAU.

NOTES

1. Institute for Energy Analysis, Oak Ridge Associated Universities.

2. The nine region global disaggregation can be modified either by aggregating regions, or by creating new regions, though such modifications require the redevelopment of data.

3. The model has been modified to run as far out as 2100. Tentative projections have not been carefully examined for the reasonableness of the parameters and model structure beyond 2050. The model can also be modified to accommodate other benchmark years.

4. The model and parameter values are developed in three volumes:

   I. The Framework and Methodology for ORAU/IEA's Long-Term, Global, CO_2 Energy Assessment Framework,
   II. Determinants of Global Energy Demand to 2050,
   III. Determinants of Global Energy Supply to 2050.

   Two reports of model usage are: "Global Energy Production and Use to the Year 2050," submitted for publication in Studies in Management Science and Systems, B. V. Dean, ed., North Holland (forthcoming), and "Global Energy and CO_2 to the Year 2050." In addition a user's guide is in preparation.

5. Address requests for documentation to Jae Edmonds or John Reilly, Institute for Energy Analysis, 1346 Connecticut Avenue, NW., Suite 530, Washington, DC 20036. Or phone (202) 653-8205.

6. In the Carbon Dioxide Research Division under Contract No. DE-AC05-76OR00033.

7. Their favorable findings were recorded in the committee's formal report, Report on the ORAU/IEA Long-Term, Global CO_2 Energy Policy Assessment Methodology. In this report they concluded, "We see this effort as a solid professional job in the face of a difficult task."

A long-term global energy–economic model of carbon dioxide release from fossil fuel use

Jae Edmonds and John Reilly

In this paper the authors develop a long-term global energy–economic model which is capable of assessing alternative energy evolutions over periods of up to 100 years. The authors have sought to construct the model so that it can perform its assigned task with as simple a modelling system as possible. The model structure is fully documented and a brief summary of results is given.

Keywords: Carbon dioxide; Global model; Energy–economics

Energy, economics, and the environment have long been recognized to be closely intertwined. Nowhere have they been more closely connected than in what has come to be called the 'carbon dioxide question'. Carbon dioxide (CO_2) is a non-toxic gas in the Earth's atmosphere. It exerts a 'greenhouse' effect by allowing incoming sunlight to pass through to the Earth, but traps outgoing heat. CO_2 is a by-product of decaying plants, animal respiration, cement production, some mining, and fossil fuel combustion. At higher levels of atmospheric CO_2 the greenhouse effect is intensified; global temperatures would tend to be higher, causing associated climatic changes. If the present atmospheric concentration of 339 ppm increased to 600 ppm it is generally felt that the mean global temperature would increase by 1.5–4.5 deg C, with an accompanying change in global climate patterns.[1]

The burning of fossil fuels represents the major anthropogenic source of CO_2. As such, fossil fuel use projections are critical to any analysis of atmospheric CO_2 buildup and are essential in determining the likelihood and timing of significant climate change.

The CO_2 question can be broken up into three parts:

(1) Will CO_2 emissions continue to grow at rates which will cause atmospheric concentrations to reach 'critical' levels?
(2) What are the consequences of CO_2 concentrations in the critical range? and
(3) What can or should be done about this problem?

Points 2 and 3 of a CO_2 research programme would seem to hinge on the outcome of point 1. Ironically, the bulk of the research effort has been conducted in the support of points 2 and 3

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A number of individuals have provided us with advice and assistance during the course of this work. On 27 and 28 July 1981 Robert Keohane from Princeton University, Lester Lave of the Brookings Institution, and David Pumphrey of the US Department of Energy met as a formal review committee. Their extensive review of our methodology which is embodied in their final report, *Review Committee Report of the ORAU/IEA Long-Term, Global, CO_2 Energy Policy Assessment Methodology*, was particularly helpful. In addition, we are indebted to Derriel Cato of the Energy Information Administration, US Department of Energy, Peter C. Roberts, UK Department of the Environment, William Van Gool of Rijksuniversiteit, The Netherlands, and two Institute staff members, David Reister and Ralph Rotty for their advice and comments. While we have benefitted greatly from their inputs, all remaining errors are the sole responsibility of the authors. Finally, we wish to acknowledge Fay Kidd for her patience and perseverance in typing the various drafts of this manuscript.

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The lack of attention to the economic–energy aspects of CO_2 buildup stems from an early identification of the issue as largely an area of natural science interest. Early emissions forecasts were based on simple time trend analysis of CO_2 release. Based on such forecasts, CO_2 was moved from an issue of basic research and academic interest to one where a large body of scientific evidence indicated potentially large and disruptive effects on society in the not too distant future. The most recent trends in energy consumption have cast doubt on simple time trend analysis of fossil fuel use as a basis for CO_2 emission forecasts.

Economists have similarly focused on the consequence rather than the existence question.[2,3,4,5] However, the existence question has been studied. Nordhaus[6] and Hafele[7] both address the question. Hafele and his fellow researchers at the International Institute for Applied Systems Analysis (IIASA) used a set of detailed process, linear programming, and input–output models linked together by judgment in the development of two reference energy cases. While the reference scenarios have been lauded, the modelling process has been criticized. Meadows[8] contends that the model system is cumbersome to use (taking months to run successfully) and that its outputs have not been independently reproduced. The Nordhaus model is a linear programming model of the world, used to explore optimal energy–CO_2 strategies.

There was obviously a need for a behavioural, long-term, global energy model, which was flexible enough to explore alternative economic, demographic, technical, and policy interactions with energy and CO_2, but which was also simple enough to provide this analysis quickly and inexpensively. The US Department of Energy, Office of Energy Research, Carbon Dioxide Division began funding the development of such a model at the Institute for Energy Analysis, Oak Ridge Associated Universities (IEA/ORAU) in autumn 1980.

The major thrust of this paper is in the systematic development of the formal model used to assess the long-term, global energy–CO_2 interaction. We develop this energy–economic model as an example of a modelling effort which was designed around a specific energy–economic problem. We discuss the criteria which were used to develop model structures as well as the model structures themselves. Finally, we present some results from model runs, although the detailed discussions of model results are presented elsewhere.[9,10]

Minimum modelling

We have sought to develop the modelling framework with some appreciation for the limitations imposed by the nature of the task and the state of the seer's art. There are uncertainties at every turn. Key exogenous variables such as population and levels of economic activity have proved to be extremely illusive forecast targets in the past, and we have no reason to believe that they are any easier to foretell now. Similarly, such model parameters as the price and income elasticities of demand for energy have proved a rich source of disagreement.

In short, the future, and particularly the distant future, is impossible to predict. What is hoped for is that conditional scenarios can be constructed to explore alternatives in a logical, orderly, consistent, and reproducible mann[er]. The model is not a crystal ball in which future events are unfolded with certainty, but rather an energy–CO_2 assessment tool, of specific applicability, which can shed insight into the long-term interactions of the economy, energy use, energy policy and CO_2 emissions.

Recognition of the limits of modelling the long term led to adoption of a single overriding design criterion. We have coined the term 'minimum modelling' to refer to this criterion. It is nothing more than a modelling effort aimed at developing the simplest possible framework for analysis given the research question. As such, the model we have developed is task oriented, with much of the levels of detail and disaggregation dictated by the needs of the user community.

We have also sought to make this model as open as possible. Reproducibility of results was viewed as a key reason for developing a formal model. In addition, we have sought to make the model as understandable and transparent as possible. The 'black box' concept of modelling is less useful to the assessment of CO_2 emissions than what Martin Greenberger has termed the 'open box' concept.[11] Needless to say, the construction of a global model requires attention to some detail and the box, while open, may be more or less understandable to observers. We have felt it useful to discuss both overall model design in the context of the design criteria, and the actual model equations.

Minimum requirements

Despite the desire for simplicity, there are several levels of detail which are nonetheless required if reasonable energy–CO_2 scenarios are to be constructed. These form the set of minimum requirements that a CO_2 assessment must meet:

- disaggregation by fuel type;
- very long-term applicability;
- global scale;
- regional detail;
- energy balance;
- CO_2 energy flow accounting.

Disaggregation by fuel type

Energy is unalike in its emission of CO_2. Nuclear, solar and hydroelectric power generation contribute no carbon directly to the atmosphere, while coal and western US shale oil (oil in carbonate rock) are major sources of carbon release. Oil and gas also release carbon in combustion, but are not as important contributors as coal and shale oil (see Table 1).

In light of the wide disparity among carbon release coefficients of various fuel types, an important element in any carbon release assessment is the composition of fuels consumed over the period.

While there are four CO_2 release coefficients there are in fact nine types of primary energy technologies.

Table 1. Carbon release in the production and combustion of fossil fuels.

Fuel	Carbon, g/MJ
Oil	19.2
Gas	13.7
Coal	23.8
Shale oil mining[a]	27.9
Solar	0.0
Nuclear	0.0
Hydro	0.0

[a] Western US shale oil from carbonate rock.
Source: G. Marland, 'The impact of synthetic fuels on global carbon dioxide emissions', W. C. Clark, ed, *Carbon Dioxide Review*, Oxford University Press, New York, 1982.

conventional oil, conventional gas, unconventional oil, unconventional gas, coal, biomass, solar electricity, nuclear electricity, and hydroelectricity. These in turn are aggregated into six primary energy categories: oils, gases, solids (biomass and coal), hydroelectricity, nuclear electricity, and solar electricity. In addition primary solids may be converted into either secondary liquids or secondary gases, while non-electric solar and conservation enter as a reduction in the demands for marketed fuels.

Very long-term applicability

The CO_2 problem is long term. It is unlikely that fossil fuel combustion will culminate in dangerous levels of global warming before 2030, although the policy initiatives necessary to avoid critical accumulations of CO_2 may have to be implemented at much earlier dates. The current terminal analysis date of the IEA/ORAU framework is 2050. The long-term nature of the enterprise argues for simple model specifications. The elegant and powerful advances in economic theory, which have proved so useful in mid-term energy analysis, have been focused on such areas as duality theory, flexible functional forms, *ex ante/ex post* production structures and input–output analysis. The explicit treatment of capital stocks by vintage, endogenous and embodied technological change and other factors of production would seem to give the illusion of a far greater understanding of the long-term future than can possibly be justified. As a consequence, we have chosen to use simple, well behaved functional forms to represent energy, economic, technical, and policy interactions.

Global scale

While some forms of environmental pollution result primarily in local effects, the expected climatic changes associated with major CO_2 accumulations do not. The severity and geographical distribution of climatic changes resulting from carbon accumulation depends on the total amount of fossil fuels combusted by all global energy users. No major energy consumer can be ignored in the process of CO_2 assessment. Thus, an assessment of both the centrally planned economies and developing nations must be included.

Regional detail

From both a scenario building and assessment perspective, it is necessary to identify individually the major CO_2 actors. Some regions are significant because they are important sources of a major global energy source for example the Middle East. On the other hand some regions, such as the European centrally planned economies, are major sources of fossil fuel combustion with uniquely important characteristics. Still other regions, such as North America or the European OECD nations are important potential sources of energy policy initiatives which would affect carbon emissions. Nine distinct regions have been specified (Figure 1).

Energy balance

Despite the fact that carbon release calculations depend directly on the level and composition of global energy combustion, not all energy forecast models can be modified to suit this purpose. For example much early work in the field of international energy analysis can be categorized as 'gap studies'. Gap studies forecast supply and demand for energy based on an exogenously specified world oil price path. The general conclusion reached by such studies was that under the price scenarios investigated, there were likely to be deficiencies of global energy supplies. These conclusions provided useful insights into the energy problem. But neither these studies nor their methodologies were ever intended to address CO_2 issues, as a consequence they are of marginal value in that regard. Such model designs fail to equilibrate global energy supplies and demands across energy use regions. As a result, the global oil market may not be in balance and it is impossible to tell how much carbon is released by fossil fuel combustion if production forecasts fall below consumption forecasts. At the very least, an assessment tool must provide global energy balance to enable consistent CO_2 release scenarios to be generated.

An iterative process of price adjustment combined with a price sensitive formulation of supply and demand insures global energy demand in each fuel market (see Figure 2). It begins with an arbitrary set of international prices for the traded fuel aggregates, liquids, gas and solids. These prices are used to generate a set of supplies and demands by fuel type. In addition to prices, the demand model uses exogenous inputs of regional populations, regional GNPs, regional energy productivity (technological changes) and regional taxes and tariffs. The supply module uses inputs of regional resource bases for resource constrained technologies and production descriptions for backstop technologies. Prices are adjusted in successive iterations until global supplies and demands for each fuel balance within a prespecified bound. The result is regional production and consumption, estimates of international trade flows and world prices consistent with the global equilibrium. It then becomes a relatively straightforward process of applying CO_2 coefficients to energy consumption and production to arrive at global CO_2 emissions.

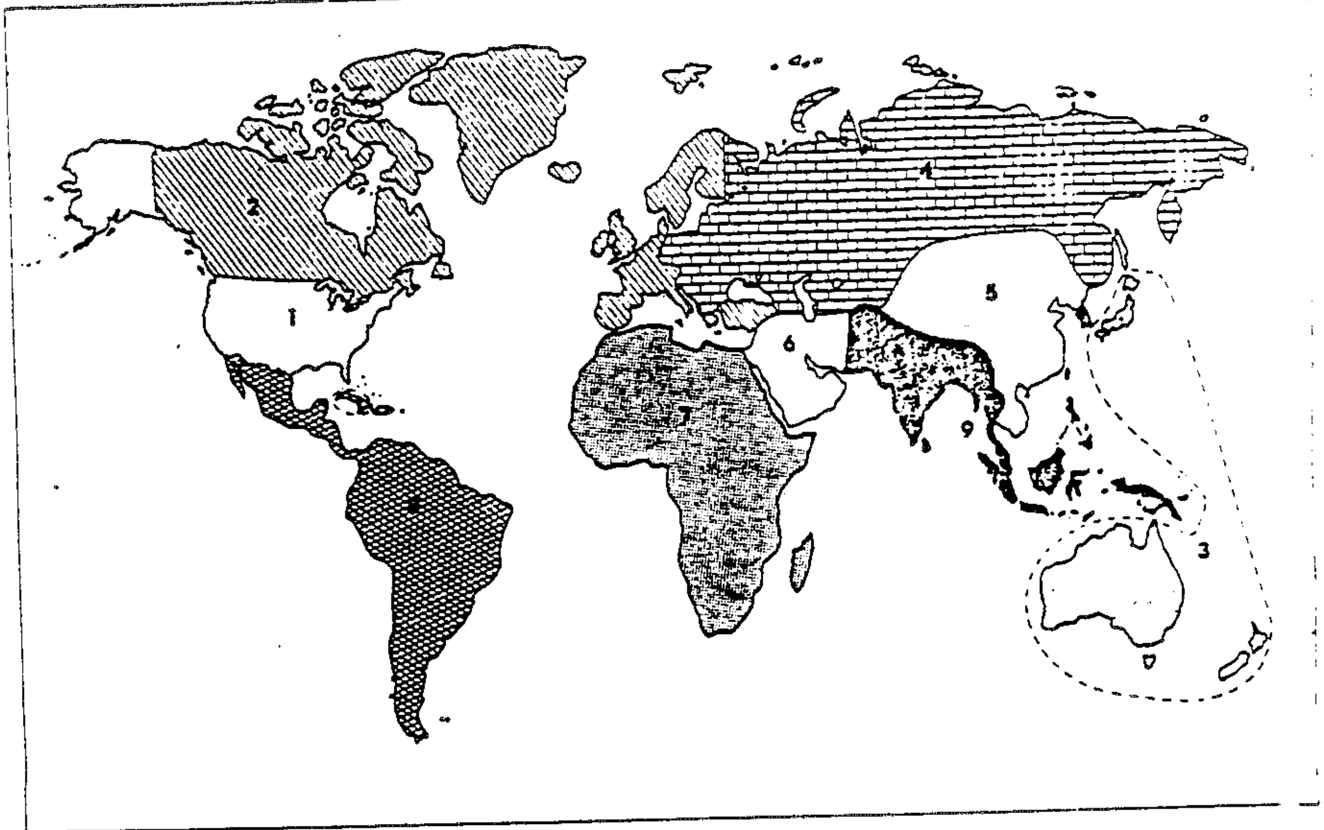

Figure 1. Geopolitical divisions in the IEA/ORAU assessment framework.
Key: 1. USA; 2. OECD West; 3. OECD Asia; 4. Centrally planned Europe; 5. Centrally planned Asia; 6. Middle East; 7. Africa; 8. Latin America; 9. South and East Asia.

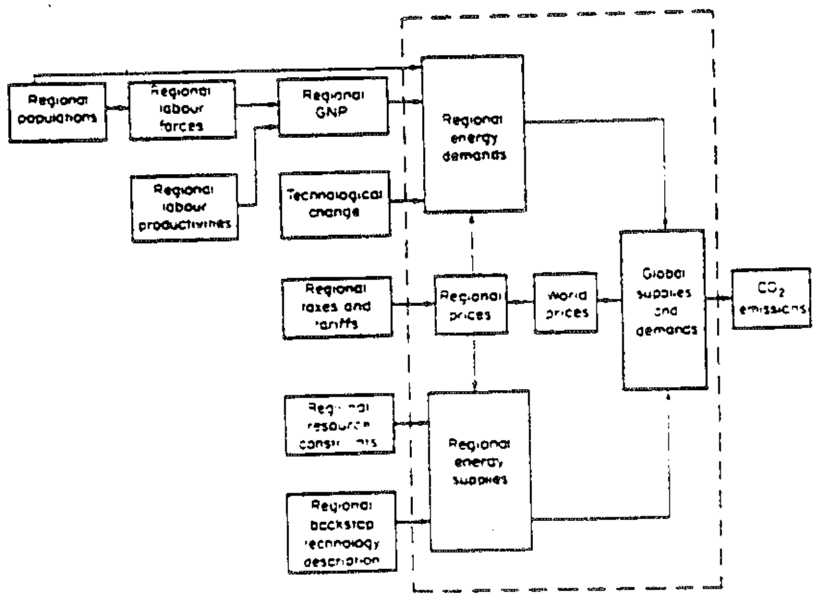

Figure 2. The IEA/ORAU CO_2 emission model.

Energy flow accounting

Carbon is released at the point of energy combustion, which makes it important to distinguish between primary, secondary and tertiary forms of energy and to be able to distinguish non-combustion uses (for example petrochemical feedstocks and asphalt) and flaring. For example, the distinction between primary and secondary energy forms would prove important across scenarios if the role of electricity varied between them, and in addition the CO_2 intensity of power plants was either much higher or lower than the economy in general (eg due to either heavy dependence on coal – implying high CO_2 intensity in power generation, or heavy dependence on solar and nuclear – implying low CO_2 intensity in power generation). Similarly, it has proved important to be capable of distinguishing coal which is consumed directly as opposed to coal used for liquefaction and gasification.

The demand for secondary energy types is a derived demand springing from the demand for energy services, tertiary energy. As a consequence, the demand for secondary energy depends not only on the overall demand for energy and the relative cost of that particular energy fuel, but also on the non-energy costs of transforming that fuel into a useful energy form. Thus, coal's low relative cost is frequently more than offset by its associated high capital, labour and material costs, which often make it a more expensive provider of energy services.

The model

Each of the four sections which follows corresponds to a major computational component of the assessment framework: supply, demand, energy balance, and CO_2 emissions. These sections document the actual equations used to calculate regional energy supplies and demands, the techniques used to insure energy market equilibrium, and the computations needed to develop projected CO_2 emissions.

Supply

The supply module forecasts supplies and prices of the six major primary energy categories for a given region in a given period. Its inputs are the prices of the three major traded fuels (oil, gas, and coal), and the energy–GNP demand ratio for the two major renewable resources (nuclear and solar). Prices and outputs for the final primary energy category, hydroelectric generation, are introduced exogenously. There are three generically different technologies considered in the module: 'resource constrained exhaustible energy technologies', 'resource constrained renewable technologies', and unconstrained energy resources or 'backstop' technologies.

The assignment of primary energy technologies to these three categories is given in Table 2.

Table 2. Distribution of supply technologies across supply categories.

	Supply categories		
	Resource constrained conventional energy	Resource constrained renewable energy	Unconstrained energy resources
Energy technologies	Conventional oil Conventional gas	Hydro	Unconventional oil Unconventional gas Solids Solar Nuclear

Primary and unrefined energy

Each of the three fossil fuels – oil, gases, and solids – forms a primary energy category. A distinction is made between primary energy and a category which, for accounting purposes, has been termed refinable energy. The two categories differ in that the latter includes coal derivative synfuels while the former excludes them.

The primary energy category includes energy at the extraction stage before any processing of the form has occurred. Thus primary oil and gas consist of conventional and unconventional components. Coal used for conversion to liquids and gases is counted as primary coal. In contrast, there are three related categories: refinable liquids, refinable gases and refinable solids. Refinable liquids and gases include both primary energy and the energy content of coal liquids and gases input before the final refining process. Refinable solids include only that coal which is eventually used in the form of solid fuels. It excludes coal production for synfuel conversion. Biomass enters with coal as a solid primary fuel with the potential to be converted to refinable liquids, solids or gases.

Resource constrained exhaustible technologies

Oil and gas resources are disaggregated into two grades of resource, conventional and unconventional. The conventional components of oil and gas supply are resource constrained. By definition all conventional resources are profitable to produce at current price levels. There are, however, real-world constraints which prevent this grade of resource from being consumed immediately. The resource must first be found. This requires search procedures and drilling operations. In the short term, drilling equipment is fixed and the ultimate intensity of its use is limited physically. In the longer term, there are costs of building equipment which are minimized by using the equipment over time rather than in one massive search. Even where the oil resources are well known, resource owners have incentives to disburse their product over time so as to maximize profits.

Conventional oil and gas models can be classified into three categories: extrapolation models, econometric models and discovery process models. The first of these classes is simplest. A curve is fitted between production and time or reserve additions and drilling. Such models mete out a fixed resource mechanically over time. They contain no price effects although they are easy to use and have had success as forecasting tools.* Econometric

*See for example Deffeyes and MacGregor,[12] p 70, and Cherniavskey.[13]

models incorporate prices, but typically leave ultimate total production unconstrained. This is a distinct disadvantage in a long-term framework. Discovery process models are the most sophisticated representations of conventional oil and gas supply. They model individually the process of exploration additions to reserves and production from reserves. While these models have performed well as explanatory and forecast models,[14] they are clearly not simple models. Not only must prices, resources and discovery constraints be incorporated, but so also must expected future prices. The latter input is especially important in the formulation of cartel supply models.

Process discovery models are clearly the most intellectually satisfying of the three modelling categories. They yield both insights into the process by which supply is created and are reasonable forecasting tools. They are especially appealing in an economic context since price plays an important endogenous role in the analysis. This is not to say that they are without difficulties. To some extent, the discovery process model pushes all of the interesting questions surrounding production into discovery rate parameters. Thus, 'the discovery process model relies on curve fitting just as heavily as any of the curve fitting extrapolation models'.[15]

In this model, supply is determined by a simple extrapolation model. The theoretical difficulties with such models are well recognized. Such models lack any behavioural insights. They are non-economic in orientation, and the particular function chosen to represent the production time path cannot be justified on physical grounds. Nonetheless, as noted earlier, such models have been successful as forecasting tools. They are simple and sufficiently flexible to accommodate alternative resources-remaining scenarios. Finally, it is worth noting that the alternative real world supply considerations may be implemented exogenously through the various resource and production rate parameters of the supply schedule.

Production of the constrained resource is handled conventionally via a logistics function. The logistics function relates the cumulative fraction of the total resource base which has been exploited, $f(t)$, to time. The relationship is given by

$$\frac{f(t)}{1 - f(t)} = \exp(a + bt) \quad (1)$$

where a and b are parameters, and t denotes time elapsed from an initial period.

This implies that the fraction of the resource exploited by the period t is given by

$$f(t) = \frac{e^{a+bt}}{(1 + e^{a+bt})} \quad (2)$$

The initial resource base to be exploited over all time is denoted by R. The total amount of the resource exploited by time, t, is given by $Rf(t)$. This is different from the rate at which the resource is being produced at a given point in time. The rate of production, Q_s, is given by

$$Q_s(t) = f(t)\,[1 - f(t)]bR \quad (3)$$

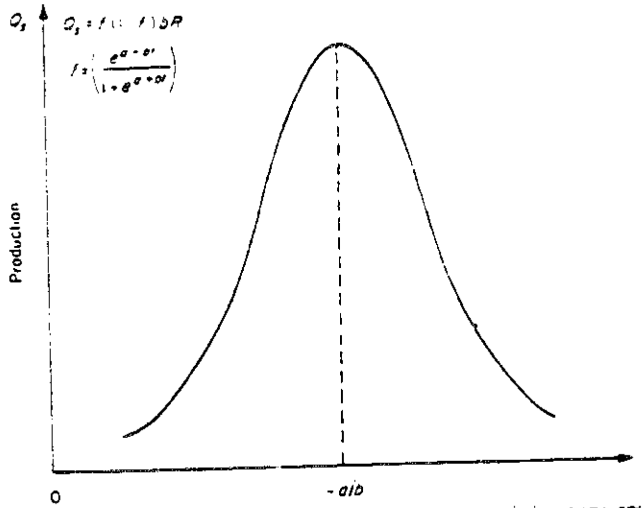

Figure 3. Production over time of an exhaustible resource using a logistics function.

The time path of production is shown in Figure 3. The initial fraction of resources that were used up in the initial period, $t = 0$, is simply

$$f(0) = \frac{e^a}{1 + e^a} \quad (4)$$

while initial production is

$$Q_s(0) = \frac{e^a}{(1 + e^a)^2}bR \quad (5)$$

The maximum production rate occurs where $f(t) = 1/2$, and $t = -a/b$.

For regions other than the Middle East the logistics equation is used to forecast the production of conventional oil and gas. The level of Middle East output is assumed to be determined by OPEC policy, and that policy is an exogenous input to the supply module as is the time profile of the rate of natural gas flaring. For example, a constant level of output is frequently cited as a likely production scenario for this region. Other supply scenarios are also possible.

It is important to point out that while each of the individual regional production time paths may be described by Figure 3, the global production time paths may not be. In fact, the regional pattern of resource distribution is likely to skew the global production time path to the right with a 'fatter' tail and earlier peak than would be obtained from a global logistics representation of production.

For resource constrained technologies, supply does not respond to price. Production rates are assumed to follow the logistics path, and the total supply is offered without regard to market conditions. The same is not true of backstop oil and gas supplies.

which are offered to the market on the basis of market prices and overall rate of economic activity.

The one exceptional resource constrained technology is hydroelectric generation. Here the level of resource exploitation is given exogenously along with production costs. Both the price and quantity of this resource are passed on to the electric utility components of the demand module.

Natural gas flaring

Natural gas is a premium fuel frequently found in association with petroleum. Despite its end-use attractiveness, the market for natural gas was slow in developing, due to problems with transport and storage of the fuel. As a consequence, associated natural gas was often flared or vented. As the natural gas market has developed, the fraction of gas flared or vented has diminished. In OECD countries the market has developed to the point where most gas is introduced into a natural gas pipeline system for distribution, flaring and reinjection are not important considerations. Some gas is now liquefied, in a more costly process, and transported by sea. However, natural gas markets remain underdeveloped in LDCs.

Economic considerations have been important to the development of gas markets. Prices now offer sufficient incentive to market gas which once would have been flared. As a consequence, the fraction of gas flared, capped, and reinjected is expected to continue to diminish. This has been modelled in the framework as follows: the amount of gas that is flared, f, is expected to continue to decline from a present rate of b, to an ultimate rate of a over a period of T years. The transformation is modelled as an exponential interpolation

$$f(t) = a^s b^{(1-s)}, \ (s = t/T) \qquad (6)$$

where t is the number of years of adjustment already experienced. Note that this equation structure diminished flaring more rapidly in early periods than later periods. If a and b are equal, as they are in the OECD, the flaring fraction is constant. It is also important to point out that while price is the driving motivation for reduced flaring of gas, it is not included specifically, as the magnitude of the gas resource at issue is insufficient to warrant attention to second-order effects which would either hasten or dampen the primary trend.

Backstop technologies

Backstop technologies are, by definition, capable of producing inexhaustible supplies of energy. The term inexhaustible applies strictly to the context of the analysis. Backstop technologies include unconventional oil, unconventional gas, coal, solar, and nuclear energy.

The traditional use of the term 'backstop' implies a resource which can be supplied with an infinitely elastic supply schedule.[16] A backstop technology then is an industrial analogue to the perfectly competitive firm in economic theory. That is, the industry is so small relative to the economy as a whole that its production cannot affect the price of its resources or the long-term price of output.

The methodology chosen for use here is somewhat more sophisticated than that used to model the simple backstop concept, but contains that simplification as a special case. The specification used here departs from the simple backstop concept in that it introduces the concept of a normal rate of growth. For a pure product with no special input requirements this norm might be the growth rate of the economy as a whole. For breeder reactors, this norm might be derived from the breeding ratio. For shale oil it might be some other reference rate. If the backstop energy sector attempts to grow more rapidly than its 'normal' rate, costs are bid up in the short term. If the sector then returns to its normal or base growth rate of expansion, costs of production fall back toward the long-term backstop price, P^*. Backstop supply prices can remain significantly above or below this price only if the sector continues to expand at a rate different from the normal rate.

A relatively simple equation structure is used to relate three parameters: a breakthrough price, a, below which no output will be forthcoming; a 'normal' backstop price, P^*, which is determined by the parameter b, and a short-term price elasticity control parameter, c. The supply equation is specified in terms of production costs, P, and the ratio of output, Q_t, to a base Q^*, $g = Q_t/Q^*$.

$$P = ae^{(g/b)^c} \qquad (7)$$

This equation is depicted graphically in Figure 4. If the long-term rate of expansion of supply matches the normal rate of expansion, then the backstop technology supply schedule, $S(g)$ long term, is infinitely elastic. An infinite amount of supply is available at the price P^*. Over the short run the industry may expand either more rapidly or more slowly than this base rate. If production exceeds the base level, then short-term costs rise, forcing prices up. If on the other hand the industry fails to attain its base production normal rate, prices tend to fall and the industry moves back along its short-

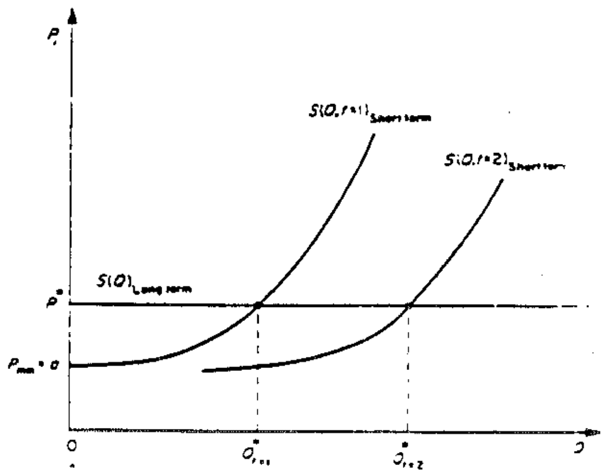

Figure 4. Short-term and long-term supply schedules for backstop technologies.

term supply schedule. There is a limit, however, to how low prices can fall. There is a shutdown price, P_{min} which is given by a.

Note that the short-term supply schedule shifts over time with the base supply level, Q^* (see Figure 4). Note also that the *marginal* cost, P, of producing a given supply depends only on the rate of growth of output in that period, and that the shut-down price, a, is independent of output and growth rates.

The short-term price elasticity of supply, E, is obtained by logarithmically differentiating Equation (7) which yields

$$E = \frac{\partial \ln Q_i}{\partial \ln P_i} = \frac{(g/b)^{-c}}{c}$$

Note that the elasticity becomes infinite at the shut-down price, $g = 0$, and completely inelastic as g becomes large.

It is also worth pointing out that in the limiting case, where c approaches infinity, the distinction between the short-run and long-run elasticity vanishes, and the two curves merge.

There are three key parameters to be determined, a, b, and c. The first, a, is simply the short-run, shut-down price of the industry. To determine b and c first note that at the reference price, P^*, realized and base production are equal, so that

$$\ln (P^*/a) = b^{-c}$$

The parameter c may then be expressed in terms of the shut-down price, a, the reference backstop price, P^*, and the short-term price elasticity of supply, E, via

$$c = [E \ln (P^*/a)]^{-1}$$

The parameter b then is found by simple substitution:

$$b = [\ln (P^*/a)]^{(-1/c)}$$

It is finally worth pointing out that the supply schedule can be expressed as a function of price, a, Q^*, and supply elasticity at the base price, E^*, by

$$Q_t = Q^* [\ln (P/a)/\ln (P^*/a)]^{E^* \ln (P^*/a)}$$

Another important characteristic of backstop technologies is technological change. This is less important for a fuel such as coal, and extremely important for a technology such as photovoltaic cells. With technological change the entire supply schedule shifts downwards and to the right. There are a number of ways in which this can be represented. In this framework technological change is treated as if it lowered the entry price. Technological change is 'phased in' over a period of length T. This is described as a decrease in the minimum cost of the technology, a, from an initial value of a_1 to an ultimate minimum of a_2. The transition is carried out in T periods using the formula

$$a = a_1^{\left(1 - \frac{t}{T}\right)} a_2^{\left(\frac{t}{T}\right)}$$

Thus in the initial period ($t = 0$) $a = a_1$ and in the final period ($t = T$) $a = a_2$. (Note that the period of transition can begin and end at any chronological time period and that $t = 0$ is used only for expository convenience.)

Resource constrained renewable technologies

Electricity generated from hydropower, geothermal power and wind can best be represented in the period of analysis as a category of primary energy characterized by a permanent flow of energy with an ultimately limited contribution to global supplies. Hydroelectricity is, by far, the dominant technology in the category. The resource has an ultimate limit determined by physical constraint. While economic considerations could elicit a marginal supply response, the overwhelming share of the resource could be available at prices below existing electricity prices. Exploitation of the full resource will be gradually phased in over the period of analysis. The resource, while an important contributor because of the low cost and desirable characteristics, faces an ultimate constraint that is relatively low in terms of future global energy requirements. The resource is modelled as being phased in over time as determined by a logistics curve, described in Equations (1) and (2). Because the resource is renewable, production in period t is simply given by

$$Q_s(t) = \frac{e^{a+bt}}{(1 + e^{a+bt})} R$$

where R is the total resource.

This is not to say that the size of the resource and the rate of exploitation are not dependent on price and profitability. Rather, the sizes of the resources in question are small by world standards, and the quantitative descriptions of price responsiveness are not well-known. Because these economic considerations cannot be expected to add significantly to the degree of accuracy in the estimates of global CO_2 emissions, a first-order approximation of resource constrained renewable supply was adopted.

The path of exploitation described by the logistics curve is shown in Figure 5. The logistics curve describes a path where the share exploited approaches 100% of the total resource.

Unrefined liquids and gases production

While coal, nuclear, and solar are treated as pure backstop technologies and hydro is treated as a pure resource constrained technology, oil and gas are hybrids having elements of both. In addition, unrefined liquids and gases are each made up of three constituents: conventional or resource constrained supplies, unconventional supplies and synfuel derivatives of coal. Synfuel derivatives are an intermediate energy good, representing a transformation from one energy type, coal, to another, oil or gas using energy and resources in the process. Total unrefined supply is the sum of these three elements.

All primary fuels are eventually refined into secondary fuels. Primary oil is refined into the secondary fuel liquids, while all gas is refined into secondary gases. Coal is unique. Some coal is refined into the secondary

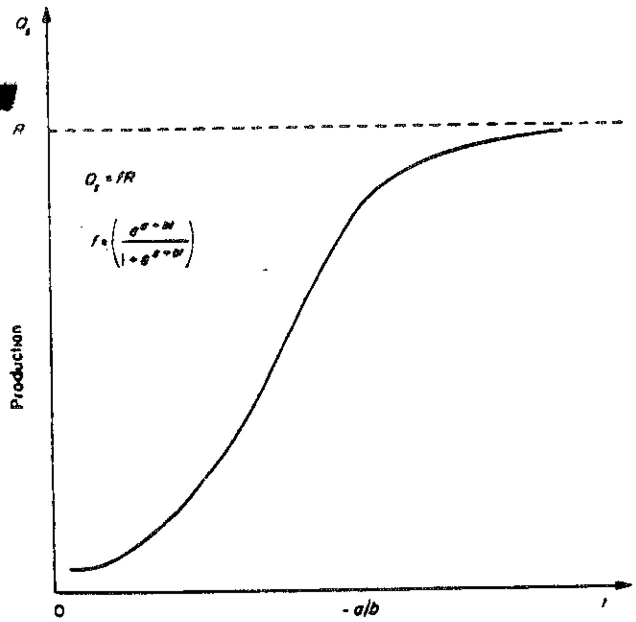

Figure 5. Production over time of a renewable resource using a logistics function.

product, solids, but some is treated as if it were pre-refined into a primary oil or gas equivalent. All three types of oil and gas inputs (conventional, unconventional, and synfuels), are then aggregated and jointly refined into the secondary liquids and gases. While a specific coal conversion process may not be decomposable into these two steps, from an accounting standpoint it is treated as if it were.

The conventional component of oil and gas production is obtained from Equation (3) from the logistics model or via exogenous assumption. The unconventional supply of the resource is obtained from Equation (7). This is accomplished by writing the expression with the energy output ratio as a function of the supply price.

The total supply of coal is determined by Equation (7), but as the previous discussion implies, this supply is trisected. One part is converted into primary oil equivalents, one part into primary gas equivalents and the third part remaining as primary coal. The size of the first two components depends upon the prices of oil, gas, and coal and on the transformation technology.

The cost of producing one unit of synfuel as a substitute for oil or gas depends on the price of coal, the technology, and non-energy costs. That is

$$P_{ic} = g_{ic}P_c + h_{ic} \qquad i = \text{oil, gas} \tag{8}$$

where P_{ic} is the price of a coal substitute for primary fuel i, g_{ic} is the amount of coal required per unit of synfuel production and h_{ic} is the non-energy cost per unit of output.

The share of coal allocated to the production of fuel substitute i, S_{ic}, is given by the logit share equation,

$$S_{ic} = \frac{(P_{ic}/P_i)^{r_i}}{1 + \sum_{j=1,2} (P_{jc}/P_j)^{r_j}} \tag{9}$$

The supply of refinable fuel i derived from coal, Q_{ci}, thus equals

$$Q_{ci} = \begin{cases} S_{ic}Q_{coal}/g_{ic} & i = \text{oil, gas} \\ (1 - S_{1c} - S_{2c})Q_{coal} & i = \text{coal} \end{cases} \tag{10}$$

Biomass

As described in Reilly *et al*[17] biomass and coal have much in common. Both can be consumed as solids, or converted to either liquids or gases. The demand for coal and biomass are derived from the same sources, and the price of coal is assumed to govern the price of biomass feedstocks. The supply of biomass depends on the price of biomass and a resource base. Agricultural residue and urban waste are aggregated into a single base which in turn is assumed proportional to the level of economic activity. The share of that base which is exploited is a function of price. The share, S, is given by

$$S = \begin{cases} 0.1 + 0.2{*}P & 0 \leq P \leq 1 \\ 0.2 + 0.1{*}P & 1 < P \leq 4 \\ 0.8 & P > 4 \end{cases}$$

where P is the price of biomass in 1979 constant dollars/million Btu. Note that while biomass waste resource base varies by region and GNP, the rate of exploitation varies only with the price.

In contrast, the biomass resource base from biomass farms is invariant with respect to GNP and varies only by region. Again the exploitation rate is assumed to depend only on the price of biomass feedstocks, via

$$S = \begin{cases} 0.0 & 0 \leq P \leq 1.5 \\ -0.6 + 0.4{*}P & 1.5 < P \leq 2 \\ -0.4 + 0.3{*}P & 2 < P \leq 4 \\ 0.8 & P > 4 \end{cases}$$

where S is the share of the resource base exploited, and P is the price of biomass feedstocks in 1979 constant dollars/million Btu.

The total amount of biomass supplied is the sum of biomass from waste plus biomass from biomass farms. Since biomass is assumed to compete directly with coal in the solids market, biomass is subtracted from total solids to obtain total coal production.

Demand

The demand module calculates the primary fuel requirements by type for a given region in a given period. The key inputs to the determination of demand are the level of population, level of economic activity (GNP), and prices of primary energy types. (Though prices are exogenous to the demand module, they are endogenous to the analysis framework, a point to be discussed in greater detail in connection with market equilibrium.) The demand for primary energy is established in a two step process which first traces energy from world market prices for primary energy, through transport and refining, to the costs of providing energy services. The demand for primary energy is then derived by tracing the effects of energy prices back through its influence on GNP, end-use energy demands (residential/commercial, industrial and transport), secondary fuel demands (liquids, gases, solids and electricity), through refinery demands for primary-equivalent fuels (oil, gas, coal, nuclear, solar and hydro), and, finally, through the derived demand for synfuels to total primary energy demands.

Prices are a key determinant of both the level and composition of demand. The first step is to develop regional primary, secondary and end-use prices for energy. This first step is carried out by the price preprocessor submodule.

The price preprocessor

The price preprocessor submodule determines the regional price for each of the three primary fossil fuels (oil, gas and coal) from the world market prices for each. Next, it calculates regional prices for the four secondary fuels, using the regional prices of all six primary energy types as inputs. Secondary fuel prices are handled in a two step process. First the costs of refined fossil fuels (liquids, gases and solids) are computed. Next the cost of electricity generation is computed using refined (secondary) fossil fuel prices and production costs for nuclear, solar, and hydroelectric facilities as inputs.

The price of traded fuels i in region m, P_{im}, depends on the world market price, P_i, the transport costs associated with that fuel, TR_i, and taxes or subsidies applied to fuels, TX_{im}, in that region. Taxes and subsidies are assumed to be applied proportionately to the landed price of energy so that

$$P_{im} = (P_i + TR_i)TX_{im} \tag{11}$$

Only fossil fuels are assumed to be traded across the regional boundaries. Interregional trade in secondary electricity is almost nonexistent. The cost of producing secondary fossil fuel type j using the associated refinable energy input is given by

$$P_{rj} = P_j g_j + h_j, \qquad j = \text{liquids, gases, solids} \tag{12}$$

where g_j is the unrefined input necessary to produce one unit of secondary fuel j, and h_j is the non-energy refining costs associated with a unit of secondary fuel j.

Electricity is handled separately. Electricity is generated using the three refined fossil fuels and the three primary electricity sources, nuclear, solar and hydro as energy inputs. The cost of producing a unit of electricity using one of these six fuels is denoted, P_{ej}, and is calculated in a manner analogous to that used in Equation (12),

$$P_{ej} = BP_j P_j g_{ej} + h_{ej} \qquad j = 1, \ldots, 6 \tag{13}$$

where j is either refined fossil fuels or primary electricity, g_{ej} is the fuel requirement for a unit of electricity, h_{ej} is the associated non-energy cost of generation, and BP_j is a scale factor relating the average cost of refined fuel j to the price paid by electric utilities.

Five fuels compete via cost for a share of the electricity generating market: secondary liquids, gases, solids, nuclear and solar. Hydroelectricity supply is determined exogenously as is its cost. The market share of the five fuel types is determined by a logit framework. The share of the market captured by the jth supply technology is determined by expected cost and associated probability density function, via

$$S^*_{ej} = \frac{b_{ej}P_{ej}^{r_{ej}}}{Z} \qquad j = 1, \ldots, 5 \tag{14}$$

where

$$Z = \sum_j b_{ej}P_{ej}^{r_{ej}}$$

and the parameter b_{ej} is the base market share of fuel j, and r_{ej} is a measure of the variance of the cost function distribution. The market share for fuel j is related to the market share associated with hydro, S_{eh}, via

$$S_{ej} = (1 - S_{eh})S^*_{ej} \qquad j = 1, \ldots, 5 \tag{15}$$

The cost of generating a unit of electricity depends on the mix of modes used. Denote the electricity cost as P_e, then the relationship between P_e and modal prices is

$$P_e = \sum_{j=1} S_{ej}P_{ej} \tag{16}$$

Equations (12) and (13) define the derivation of prices, while Equations (14) and (15) determine the market shares.

The final function performed by the price preprocessor is the computation of energy service prices. There is one energy service price for each end use sector, and an overall aggregate energy service price. There are two classes of detail considered in the model. OECD regions distinguish three separate end-use sectors: residential/commercial, industrial, and transport. For these regions there are three separate energy service prices. Non-OECD regions are not disaggregated and contain only one end-use sector. The cost of energy services in a sector is given by

$$P_k = \sum_j S_{jk}P_{jk}PK_{jk} \tag{17}$$

where P_{jk} is the cost of providing energy services to end-use sector k using secondary fuel type j (the secondary fuel types are liquids, solids, gases and electricity). P_{jk} is the sum of direct energy and non-energy costs divided by a base price, BP_{jk}:

$$P_{jk} = (P_j g_{jk} + h_{jk})/BP_{jk} \tag{18}$$

and PK_{jk} is the relative cost of services provided by fuel j to the overall service price. Again the use of price indices necessitates common units of measure.

The overall aggregate energy service cost, PS, is a weighted sum of individual energy service prices, or

$$PS = \sum_k S_k P_k / BPS \tag{19}$$

where BPS is the base price of aggregate energy services

Having completed the computation of all secondary and tertiary (energy service) prices, the demand module proceeds to use these in the determination of secondary and tertiary energy demands.

Determining secondary energy demands

The GNP is one of the principal determinants of energy demands, but energy can conversely have an effect on the GNP. To reflect this, the base case GNP is adjusted for the overall level of energy service price to allow for this two-way interaction. This is accomplished through a simple elasticity relationship,

$$Y = \text{GNP} \cdot PS^{r_y} \qquad (20)$$

where r_y is the percentage change in the GNP resulting from a 1% increase in the cost of providing energy services, and Y is the adjusted GNP level.

This formulation yields a first-order approximation to the impact of energy on GNP. These effects would be likely to change with both the levels of energy prices and GNP, and these changes in turn would be likely to go on at a non-constant rate. Unfortunately, there are neither clear empirical nor theoretical grounds upon which to determine either the direction or magnitude of second- and third-order GNP feedback effects. Even the magnitude of first-order effects are in question, though for most values of expected energy prices, magnitudes of r_y are expected to be relatively small.† As a consequence, the representation of the energy price feedback given in Equation (20) was deemed to be as accurate as current empirical research can reasonably support.

The total demand for energy services is determined using income and energy service price elasticities, r_{pk} and r_{yk}. The demand for energy services for the residential/commercial and transport sectors in OECD economies is given by

$$E_{sk} = P_k^{r_{pk}} \cdot X^{r_{yk}} \cdot \text{POP} \qquad (21)$$

where E_{sk} is the total demand for energy services. X is a per capita GNP index and POP is the population size index. Non-OECD regions and the OECD industrial sector are indexed to the total level of economic activity, Y, so the computation becomes

$$E_{sk} = P_k^{r_{pk}} \cdot X^{r_{yk}} \cdot Y \qquad (22)$$

The fraction of energy services provided by each fuel type depends on the relative cost of providing those services, and the level of income. Both income and price effects are considered. These are derived from the logit share structure so that the service share for fuel j in sector S_{jk}, is given by

$$S_{jk} = b_{jk} \cdot P_{jk}^{r_{pjk}} \cdot X^{r_{yjk}} / Z_k \qquad (23)$$

$$Z_k = \sum_j b_{jk} \cdot P_{jk}^{r_{pjk}} \cdot X^{r_{yjb}}$$

and where price and income elasticities are determined by the power terms r_{pjk}, and r_{yjk}, and b_{jk} is the base service share captured by the fuel j.

The demand for each secondary fuel in a sector is identically equal to the product of total service demand with the fuel service share and this value is multiplied by the fuel requirement per unit service, divided by the level of technological improvement or

$$F_{jk} = g_{jk} \cdot S_{jk} \cdot E_{sk} / \text{TECH}_{jk} \qquad (24)$$

The level of technological progress is added to account for the fact that technological progress has acted to conserve energy even when energy prices fell. Needless to say, this factor may or may not be an important source of energy conservation in the future. This specification allows for both continued progress and stagnation to be explicitly considered.

The region's total demand for the secondary fuel type j is found by simply summing over the sectors

$$F_j = \sum_k F_{jk} \qquad (25)$$

The share of total energy services produced in the region by the kth sector is found by computing

$$S_k = b_{sk} \cdot E_{sk} / Z \qquad (26)$$

where

$$Z = \sum_k b_{sk} \cdot E_{sk}$$

and b_{sk} is the base case energy service weight.

The determination of primary energy demand

Primary energy demands may be inferred from the demands for secondary energy sources, and the information on fuel transformations. Fossil fuel demands for primary energy depend on the demands from end-use sectors, the electric utilities and synfuel conversions from coal. The demand for fossil fuels for electric utility generation, in turn, depends on the demand for electricity.

Primary energy demands are calculated in three steps. First the electric utility demand for refinable fossil fuels is calculated by

$$E_{uj} = g_{je} S_{je} F_e g_j \qquad j = 1, \ldots, 6 \qquad (27)$$

where E_{uj} is the electric utility demand for secondary fuel j, e denotes the secondary fuel, electricity, g, S, and F having their conventional meanings. This demand in turn must be adjusted for synfuel conversions. There are several alternative accounting procedures that could be adopted to distribute the demand for refinable oil between conventional oil (or gas) and synfuels from coal alternatives. The convention adopted here assumes that all synfuels from coal are consumed domestically, and that all imports of oil (or gas) are of conventional oil (or gas). Refinable energy demand must be adjusted by the share of total demand that cannot be met by domestic synfuel production coal.

†See Hitch.[16] The focus of energy—economy studies has been the USA. The relationship is less well understood elsewhere in the world.

$$\left(1 - \frac{ES_{coal} \cdot S_{i,c}/g_{ic}}{F_i + E_{ui}}\right) = 1 - S_i$$

Thus, sectoral primary energy demands are given by

$$E_i = (F_{ik} + E_{uik}) \cdot (1 - S_i) \qquad i = \text{oil, gas} \qquad (28)$$

where k is the sectoral index.

Coal demand, of course, is the sum of direct plus indirect demands, the indirect demands coming from both the demand for electricity and the demand for synthetic liquids and gases from coal.

$$E_{coal} = F_{coal,k} + E_{u,coal,k} \qquad \text{(direct)}$$
$$+ \sum_{j = \text{oil, gas}} S_j \cdot (F_{jk} + E_{ujk}) \cdot g_{ic} \qquad \text{(indirect)} \qquad (29)$$

The total demand for primary fossil fuels is found by aggregating the primary energy demands for end-use sectors and electric utilities. That is,

$$E_i = E_{ui} + \sum_k E_{ki} \qquad i = 1, 2, 3 \qquad (30)$$

It remains only to compute the fossil fuel equivalent value for primary electricity. This is done by multiplying each of the three benign forms of electric power generation, nuclear, solar, and hydro, by the average primary energy used by fossil fuels to produce energy, C. That is,

$$E_i = C \cdot F_{ei} \qquad i = 4, 5, 6 \qquad (31)$$

The average primary fossil fuel requirement is computed by first summing all fossil fuel inputs to electric power generation, and then dividing it by the total power generated:

$$C = \left(\sum_{i=1}^{3} E_{ui}\right) \Big/ \left(\sum_{i=1} S_{je} \cdot F_e\right) \qquad (32)$$

Energy balance

It is an identity that the quantity consumed must equal production. The framework must accommodate this reality. So-called 'gap studies' take a price as exogenously given and then calculate the resulting supply and demand. These are generally not equal, but there is no mechanism by which equality can be achieved other than by allowing a residual fuel to provide a backstop.

The approach taken here is different. Markets for oil, gas, and coal are international and, as a consequence, there is an interdependency between price and the resulting supply and demand in that market. By assumption, nuclear, solar, and hydro do not trade and are available as specified in the supply and demand modules. There is no problem with markets clearing for these three fuels. They are clear as identities.

The oil, gas, and coal markets are different. They must be cleared by a more complicated mechanism. A set of market prices for these three fuels must be found which brings production and disbursements into agreement. The methodology employed to derive these prices is relatively simple, and involves a search procedure begun at an arbitrary set of prices.

The market equilibrium search procedure

At the initial prices, world supplies and demands for the three fossil fuels are calculated. A measure of the disparity between supply and demand is calculated by the difference between the natural logs of both sides.

$$X_i = \ln Q_i^D - \ln Q_i^S \qquad i = \text{oil, gas, coal} \qquad (33)$$

If the gap between supply, Q^S, and demand, Q^D, is sufficiently small, then the market is assumed to clear. If the initial prices were not sufficiently close to equilibrium, then an estimate of the new equilibrium prices is made, based on price elasticities.

Denote the price elasticity of demand by U_{ij}, and the price elasticity of supply by V_{ij}, where

$$U_{ij} = \frac{d \ln Q_i^D}{d \ln P_j} \qquad (34)$$

$$V_{ij} = \frac{d \ln Q_i^S}{d \ln P_j}$$

Now for each fuel

$$dX_i = \sum_j (U_{ij} - V_{ij}) d \ln P_j \qquad j = \text{oil, gas, coal} \qquad (35)$$

An estimate of equilibrium prices can be obtained by calculating exactly how much prices need to change to reduce excess demand to zero. The necessary change in prices is given by setting dx_i equal to $(-x_i)$, and calculating

$$\begin{bmatrix} d \ln P_{oil} \\ d \ln P_{gas} \\ d \ln P_{coal} \end{bmatrix} = \begin{bmatrix} W_{oil,oil} & W_{oil,gas} & W_{oil,coal} \\ W_{gas,oil} & W_{gas,gas} & W_{gas,coal} \\ W_{coal,oil} & W_{coal,gas} & W_{coal,coal} \end{bmatrix}^{-1} \times \begin{bmatrix} -X_{oil} \\ -X_{gas} \\ -X_{coal} \end{bmatrix} \qquad (36)$$

where $W_{ij} = U_{ij} - V_{ij}$.

New prices are calculated by $P_{new,i} = P_{old,i}(1 - d \ln P_i)$. These new prices are in turn used to compute a new gap measure, which is tested for closeness to equilibrium.

Calculation of elasticities

The calculation of elasticities can be made either on the basis of numerical or analytical procedures. The latter have the advantage of being faster to calculate once derivatives have been obtained, but possess the disadvantage that calculating the derivative may be a lengthy, intricate, and tedious procedure. Furthermore, derivative procedures make model modifications more difficult since not only must supply or demand changes be instituted in the model core, but in addition the effects of these changes in model structure must be traced through the model derivatives. This makes model transport more difficult as well. As a consequence, model run time has been sacrificed in order to obtain malleability.

The procedure used is a simple one. The computer model has been encoded in double precision Fortran. Derivatives are obtained by sequentially varying each price by a small amount, and noting the resulting difference from the unperturbed run.

CO_2 emissions

Given the solution from the energy balance component of the model, the calculation of CO_2 emission rates is conceptually straightforward. The problem merely requires the application of appropriate carbon coefficients (carbon release per unit of energy) at the points in the energy flow where carbon is released. Carbon release is associated with the consumption of oil, gas, and coal. Significant carbon release is also associated with production of shale oil from carbonate rock. A zero carbon release coefficient is implicitly assigned to nuclear, hydro, solar, and conservation.‡ Actual calculation of CO_2 emissions is made somewhat more complex than indicated by the conceptual simplicity, but primarily because of the need to account appropriately amounts of fossil fuels which are subtracted out before final consumption (see Figure 6).

A considerable literature exists concerning appropriate values for CO_2 coefficients. The coefficients in Table 1 are representative of average global fuel of a given type and are consistent with the model's CO_2 accounting conventions as indicated by Figure 6.

In order to grasp the underlying rationale for the flow diagram in Figure 6, it is necessary to note a few points concerning CO_2 release. Generally CO_2 is not released from fossil fuels used as feedstock (asphalt, lubricants, road tars, and waxes). However, a group of petroleum products are rapidly oxidized (eg paints and solvents). This latter group is not included as part of the feedstock in Figure 6 and, therefore, CO_2 released from oxidation is included as part of calculated emissions.

While non- or very slowly oxidizing feedstock uses are excluded, all energy arriving at the 'refinery gate' is included. In terms of the model's accounts, both

‡ Only direct emissions of carbon from energy consumption are calculated. Indirect emissions are implicitly included. For example, the CO_2 released in the production of steel for solar and nuclear and in the transportation of fossil fuels is accounted for in the industrial and transport sectors respectively.

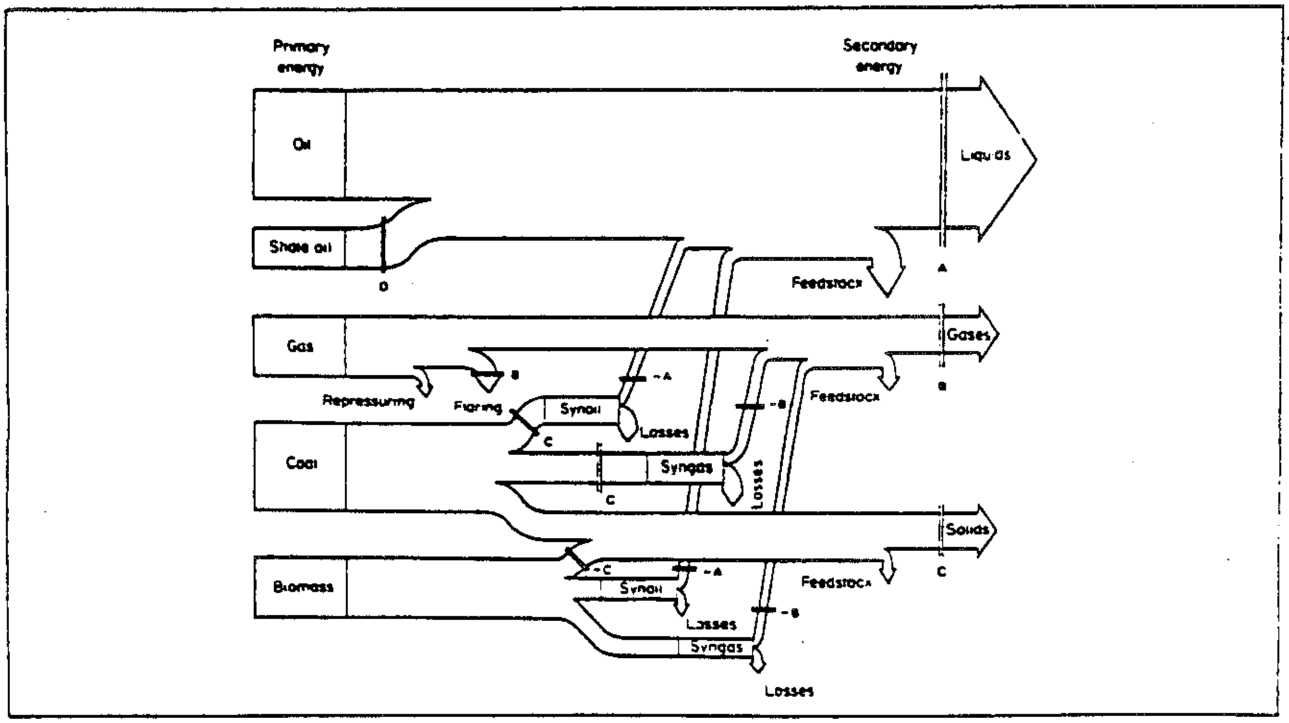

Figure 6. Energy–CO_2 accounting diagram for the IEA/ORAU long-term global energy–CO_2 model.

Application of CO_2 coefficients

A = CO_2 (liquids)
B = CO_2 (gases)
C = CO_2 (solids)
D = CO_2 (shale)
═ indicates point of application
— indicates application of a negative value

conventional and unconventional oil and gas are included as are liquids and gases derived from the production of synfuels (using both coal and biomass as bases). For solids, secondary energy consists of the portions of coal and biomass which were not allocated to the production of synfuels and non-oxidizing feedstocks. This accounting method yields an appropriate estimate of CO_2 releases associated with consumption for any given region.

To get total regional release of CO_2 it is necessary to add releases associated with energy production. These include synfuel production, biomass production and shale oil production. Production of shale oil from carbonate rock has relatively high CO_2 release because the retorting process releases the carbon in the carbonate rock. The total CO_2 release from shale oil includes the carbonate rock mining plus liquids consumption coefficients or 47.6 TG/EJ. Production of synfuels (from coal or biomass) tends to release high amounts of CO_2 because of the tremendous amounts of the energy input consumed in the process. To account for this energy use, the full coal coefficient is applied to the coal going into the synfuel plant; the CO_2 remaining in the liquid or gas as it leaves the plant is then subtracted to avoid counting the amount at the production and consumption point. Negative liquid, gas, and solids coefficients are applied to amounts of end-use fuels derived from biomass. Since biomass fuels, at the point of consumption, are implicitly assumed to have carbon release equal to the average of the fuel type, this accounting methodology implies zero net contribution to carbon emissions from biomass.§

Finally, the production of conventional gas from associated wells gives rise to another source of CO_2 release in energy production. Portions of the associated gas which are not marketed are either flared or reinjected in the well to maintain well pressure and aid in the extraction of oil. Flared gas is counted at the end use CO_2 emissions rate; reinjected gas is counted at a zero emissions rate.

Results in brief

The model has been used to develop a long-term global base case for CO_2 emissions. This work is more extensively documented in Edmonds and Reilly.[19] The results of this first stage of work are rather striking, however, and a brief summary is indicative of the model's potential.

We begin by establishing a reference level of CO_2 concentration in the atmosphere at 600 ppm.♦ The doubling date depends on the initial CO_2 concentration, the rate of release, and the fraction of that release which remains in the atmosphere (the airborne fraction, f). We have developed a concept called the 'doubling window'. The doubling window is defined by looking at the date at which the CO_2 concentration reaches 600 ppm under a given scenario assuming that f goes no higher than 0.7 nor lower than 0.4.

Simple time trend extrapolations of the post-war rate of growth of CO_2 release yield a doubling window between 2021 and 2035. Our base case, no surprises scenario yields a doubling window period of 2049–20[illegible]. This finding indicates a doubling date as much as three decades later than scientists had originally used as a reference point.

On the other hand, our findings indicate considerable difficulty in postponing the doubling window through the use of CO_2 taxes. Unilateral action by the USA would have little effect on the doubling date. For example, a 100% tax on coal use combined with taxes on oil and gas in proportion to their relative carbon release rates with an export ban on coal moved the doubling window back about five years. Even under a cooperative scenario, where the entire world joins the USA in such a CO_2 tax scheme, the doubling window would be moved back only about a decade.

Among the CO_2 results, was the finding that the globe appears to be heading towards a period in which coal and shale oil become economic ways of providing secondary liquids and gases while coal continues to compete with nuclear to supply electricity. Renewable technologies, particularly biomass and non-electric solar and conservation, will provide a very significant contribution to energy needs by 2050, but continued growth in energy demand spurred by population and economic growth put heavy demands on all fuels. The next 75 years are likely to evolve with a mixture of energy types fuelling the world rather than a transition to a 'sustainable future' based on nuclear, solar, fusion or some combination of these sources. Fuel mode shares will probably change over the next three-quarters of a century, with an initial shift towards primary electric and natural gas, slowing the rate of CO_2 emissions from a historic rate of 4.5% per year to 1.5% per year for the remainder of this century before increasing to over 3% per year by 2050. The pattern emerging from the modelling effort, continued slowing of CO_2 growth in this century followed by a jump in the rate of increase, should caution policy makers and researchers from being lulled into believing the CO_2 problem will 'go away' on the basis of present trends and short-term forecasts.

§ Stock effects of growing or shrinking biomass resources are not computed, though such effects could make biomass either a net source or sink for carbon.

♦ A level of 600 ppm, approximately a doubling of the pre-industrial atmospheric concentration, has become a common benchmark. It is likely to cause a temperature rise of 3 ± 1.5 deg C (see Perry et al[20]). Climatic and, in turn, societal impacts of atmospheric CO_2 are not subject in any simple way to a threshold level; the number of different events, continuous temperature change, and uncertainty about specific relationships make it impossible to identify a single critical CO_2 level. Our adoption of 600 ppm as a reference level is based on this understanding.

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