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# The Integrating Model of the Project Independence Evaluation System

*Volume 1 — Executive Summary*

April 1979

Prepared for:
**U.S. Department of Energy**
Energy Information Administration
Assistant Administrator for Applied Analysis

Under Contract No. EC-77C-01-8558

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## *Volume 1 — Executive Summary*

April 1979

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Prepared for:
**U.S. Department of Energy**
Energy Information Administration
Assistant Administrator for Applied Analysis
Office of Integrative Analysis
Mid-Term Analysis Division
Washington, D.C. 20461

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Released for printing: October 3, 1979

## EIA Perspective

This contractor report was prepared by Logistics Management Institute and provides documentation of the version of the Project Independence Evaluation System (PIES) as it existed on January 1, 1978. Since that date, PIES has evolved into what is now called the Mid Range Energy Market Model (MEMM), a major component of the Mid Range Energy Forecasting System (MEFS). Major structural changes that have occurred between January 1, 1978 and January 1, 1979, are documented in the supplemental volume entitled, "Revisions to the Midterm Energy Market Model Relating to Natural Gas Regulation, Advanced Technologies, Coal Demand and Dynamics." Together, the six volume set of documentation, plus the supplemental volume on revisions, form the most comprehensive and up-to-date version of MEMM documentation currently available, documentation which significantly surpasses in both form and content the single volume published in January, 1977.

Although this documentation has not gone through the appropriate review process and clearance procedures to be published as an EIA endorsed report, it is currently being made available in its present form as an interim measure to satisfy many outstanding requests for MEMM documentation. As this report has not been submitted to comprehensive review, EIA does not endorse any information contained herein. The documentation is presently being subjected to comprehensive review both inside and outside the Department of Energy. A contract is currently in process to update it to the version used for the 1978 Annual Report to Congress (published in July 1979). This new version of the documentation report is intended to bring the MEMM documentation into conformity with EIA's documentation standards and to respond to any issues raised as a result of the review process. The results of the latter effort will result in a set of MEMM documentation fully cleared and endorsed by EIA, available in 1980.

## PREFACE

This documentation describes the Project Independence Evaluation System (PIES) Integrating Model as it existed on January 1, 1978. The complete documentation consists of six volumes describing the various aspects of the Integrating Model as follows:

- Volume I is an executive summary, providing a simple, nontechnical overview of PIES.
- Volume II is a primer, describing and illustrating the basic inputs to the PIES algorithm.
- Volume III is a user's guide, describing scenario specification and the operational procedures for running the Integrating Model.
- Volume IV is the main model documentation, describing the theoretical basis of the Integrating Model and each of the supply submodels.
- Volume V is code documentation, describing the data processing aspects of PIES: the data flow through the PIES programs, the functions performed by each program, the data inputs and outputs, and the PIES naming conventions.
- Volume VI is data documentation, containing the standard table data used for the Administrator's Report at the beginnin of 1978, along with primary data sources and the office responsible. It also contains a copy of a PIES Integrating Model Report with a description of its contents.

The data and scenarios used in these volumes are those used in the 1977 Annual Report to Congress, (actually published in 1978), prepared by the Energy Information Administration. In all volumes, we refer to this report as the Administrator's Annual Report (AAR).

This report is Volume I of a six-volume series documenting the Integrating Model of the Project Independence Evaluation System (PIES). It offers a review of entire PIES system, including the basic components of the Integrating Model, which are described in detail in Volume IV of this series. In particular, this volume addressed the problem that PIES solves, and the major features and applications of PIES.

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## DEFINITION OF THE PIES PROBLEM

PIES is a national energy forecasting system used by the Department of Energy's Energy Information Administration to provide alternative forecasts of energy prices, supplies, demands and conversion activities. It is also an analytical tool that can be used to examine the potential impact of changes in Federal policies, by the specification of alternate scenarios.

In a broad sense, PIES addresses the following questions:

- What will U.S. energy requirements be in the next 5 to 20 years?
- What mix of fuels will satisfy these requirements and what will be their market prices?
- In which geographic regions will these fuels be extracted (or imported), and where and how will they be converted from raw fuels to refined petroleum products or electricity?
- How will they be distributed throughout the country?
- What types and capacities of new energy-related facilities (e.g., mines, refineries, electric generating plants) will be required to satisfy energy demands?

Thus, PIES provides, for selected years (currently 1985, 1990 and 1995) forecasts of both national and regional market equilibrium levels and prices for major fuels and thereby predicts fuel import levels and patterns of activity in each of the major energy industries including electric utilities, oil and gas producers and the refining industry.

Underlying PIES' national or regional forecasts, there is considerable information about the ways in which energy will be supplied. For example, aggregate coal supply in the PIES system is composed of 11 different types of coal,[1] mined in up to 102 different types of mines in 12 different geographic regions.

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[1] Differentiated by Btu and sulfur content.

PIES can be used to examine both differing resource and technological option assumptions (e.g., high versus low discovery rates for oil and gas), and the comparative impacts of differing political, tax, and regulatory environments. To do this, scenarios are specified, which reflect the appropriate world oil price and tax and regulatory conditions, as well as other parameters. Thus, PIES contains both a data base and a modeling structure that offers a wide range of assumptions; these assumptions can be analyzed and compared for their policy indications through the selection of scenario variables.

The PIES framework consists of three major components: a Demand Model; a supply network; and an equilibrating mechanism, which balances supply and demand to achieve a multiproduct, multiregion equilibrium. The relationship between these components is depicted in Figure 1.

The Demand Model is an econometric representation of the U.S. economy, which estimates consumer demands for fuels and energy as functions of prices. Demand is governed by the general level of economic activity value added in manufacturing, demographic trends, the nature and extent of conservation programs, and by other demand-related scenario assumptions. Demands are calculated in PIES for refined petroleum products, natural gas, coal, and electricity in each of the 10 DOE regions, and in the major consuming sectors - residential, commercial, industrial, transportation, and raw material.

The PIES supply network is a detailed, representation of the U.S. Energy Resource System, composed of production, conversion, and transportation activities. This integrated supply network can be viewed as a set of energy sources that are called upon to satisfy demands. A simplified flow of fuels from production (or input) through conversion (refineries or electric utilities) to points of demand is depicted in Figure 2.

In establishing the supply representation, a set of satellite models is used to represent the supply (either production or import) of each of the major raw materials, i.e.,

FIGURE I

SCHEMATIC OF THE PIES INTEGRATING FRAMEWORK

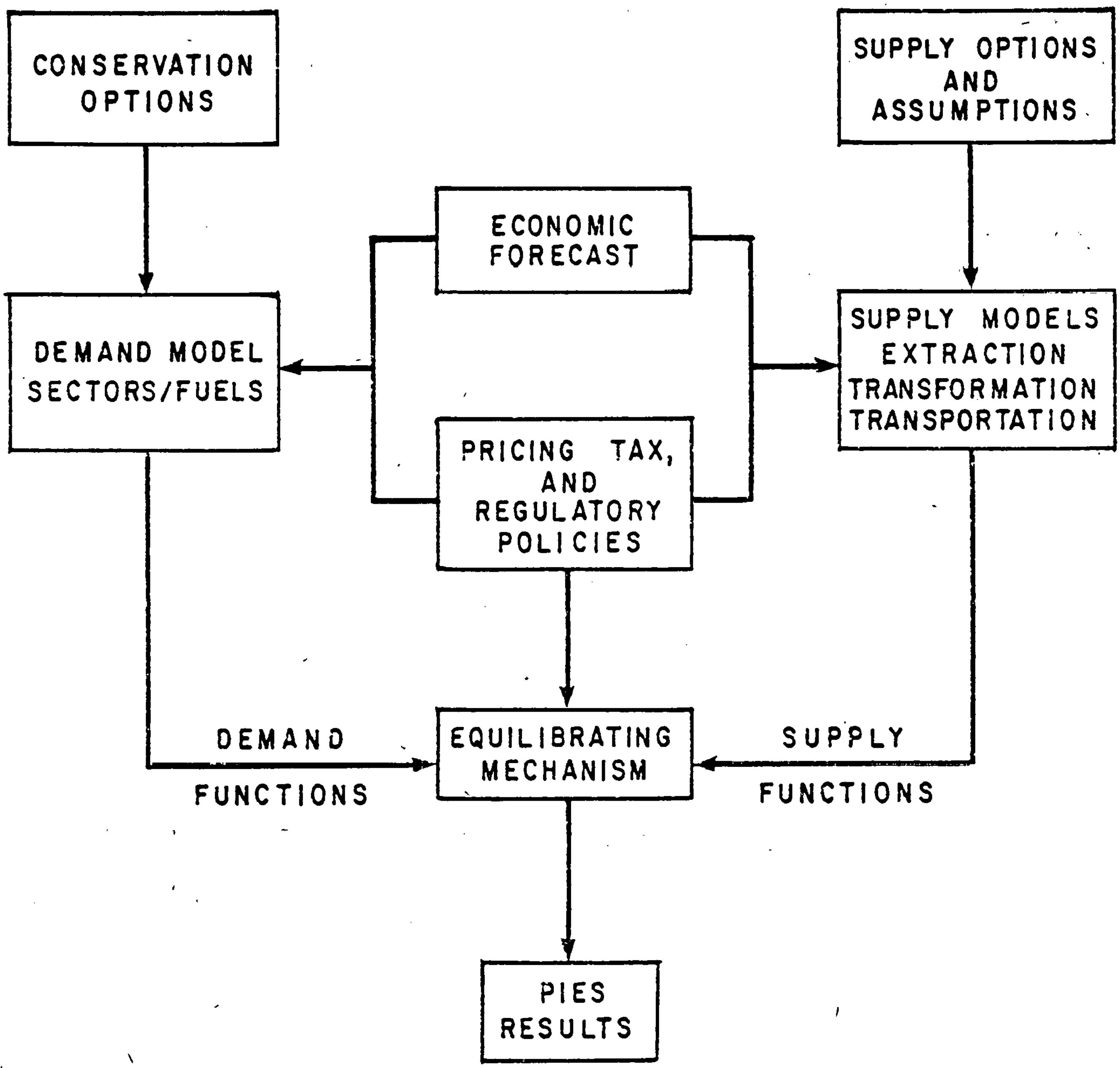
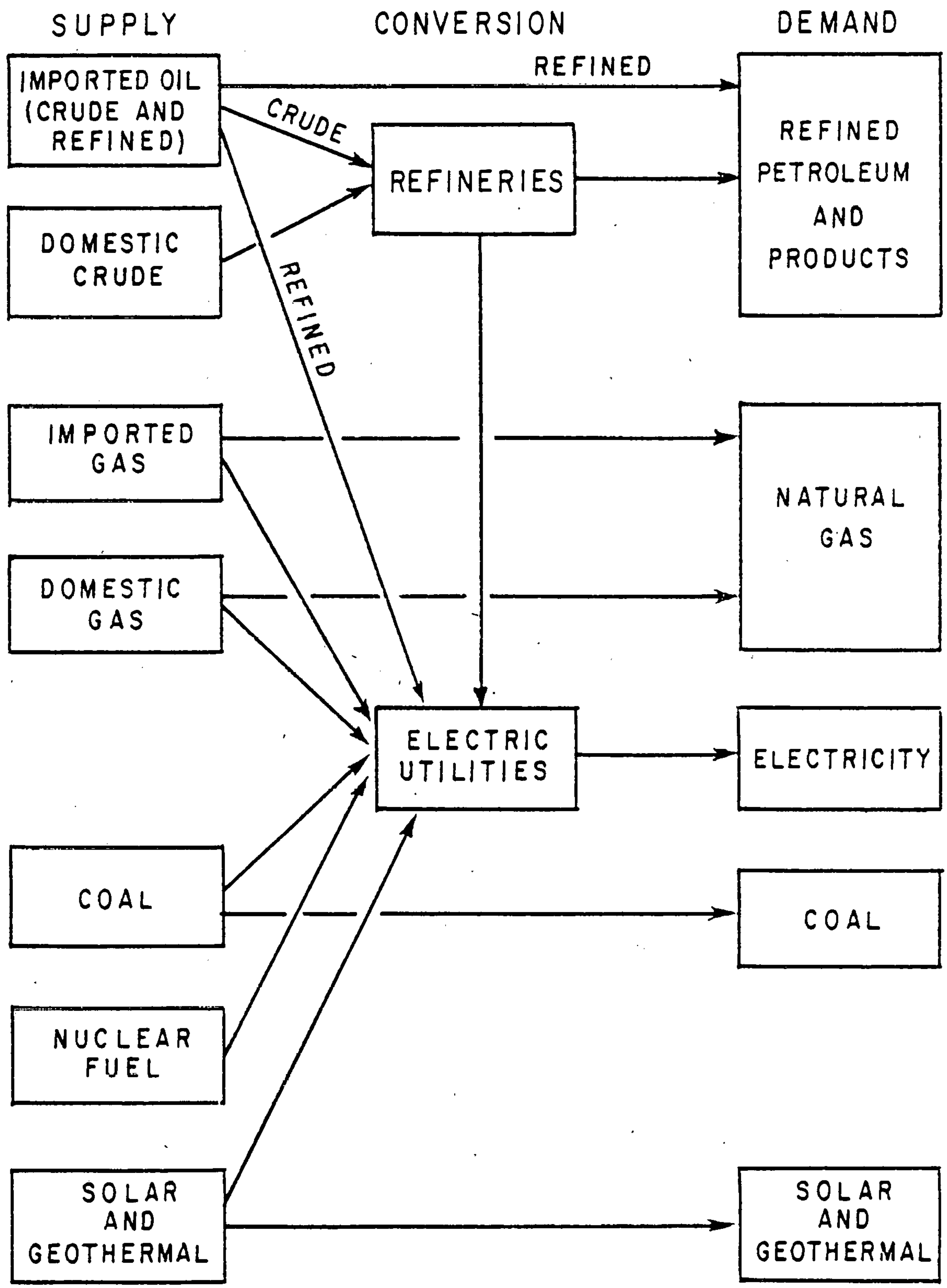


FIGURE 2

## SIMPLIFIED FLOW OF MATERIALS IN THE PIES INTEGRATING MODEL



coal, oil, natural gas, nuclear fuel, shale oil, synthetics, etc. The satellite models are built to simulate the response of the specific industries to price changes. The supply representation also includes process models to represent U.S. refineries, electric utilities, and synthetic fuel plants, all of which convert raw materials into consumable forms of energy, i.e., refined fuel products or electricity. The satellite models are depicted in Figure 3.

The various sectors of PIES are linked by means of a distribution network that represents the movement of raw materials or products from the points of production, import, or conversion to where they are converted or consumed. The levels of consumption are derived from the Demand Model.

The method by which the equilibrating mechanism integrates these supply and demand components is discussed under the heading 'Solution Procedure', below.

## ECONOMIC ASSUMPTIONS

The major economic assumptions implicit in the PIES model structure are:

- Market equilibrium conditions govern the purchase prices and quantities of fuels in such a way that the sum of consumers' and producers' surplus is maximized across all regions and all energy industry sectors, subject to the constrained market condition introduced by government regulation, etc.

- Consumers are prepared to substitute fuels for each other based on their relative prices.

- Suppliers regard the marginal cost of supply as a minimum acceptable sellers price.

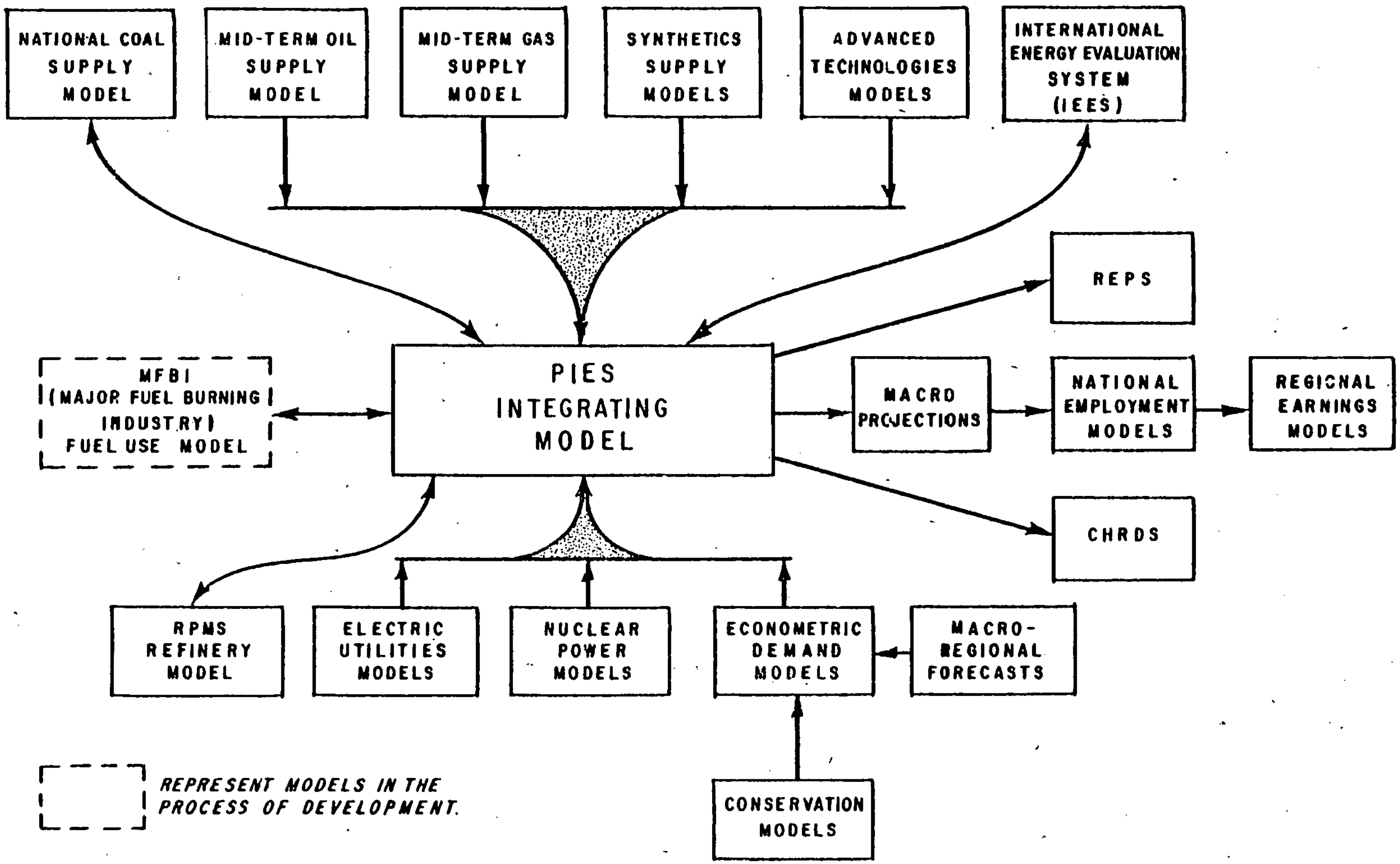
- The rate of construction of new facilities between the present and the PIES target years is linear.

- No resource constraints exist other than those for fuels (i.e., no restrictions exist on the availability of capital, manpower, cooling water, steel, concrete, etc.).

- Products are purchased and investments made on the basis of the marginal prices of the products, except for electricity, which is sold at an average cost price, natural gas which is priced on a rolled in basis and oil which is subject to entitlements.

FIGURE 3

## PIES SATELLITE MODELS

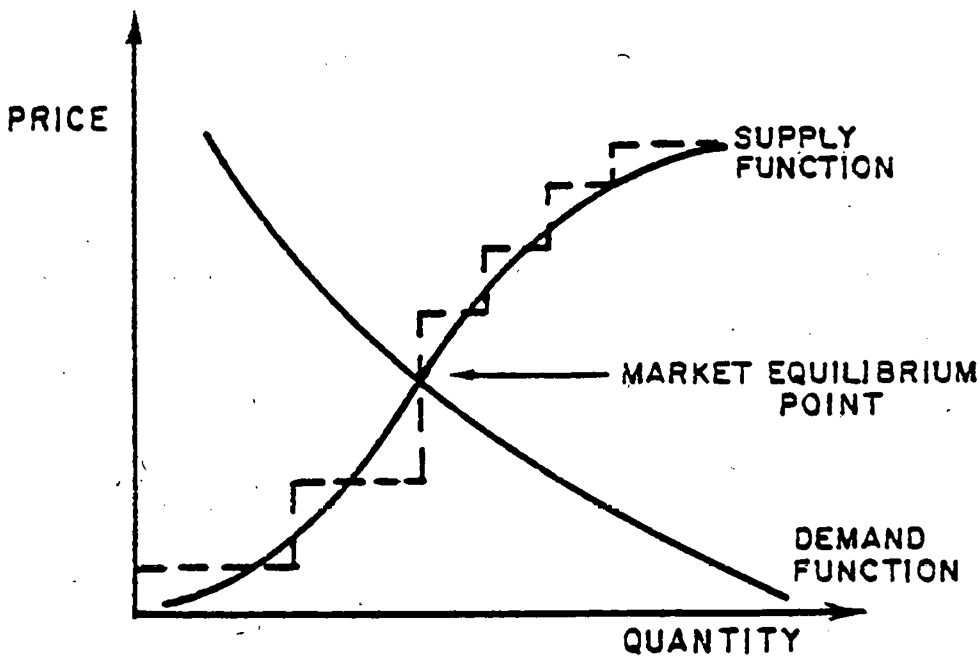


## SOLUTION PROCEDURE

Underlying PIES is the assumption that, subject to the constraints imposed by Government policies, participants in the economy (i.e., consumers and suppliers) act in their own self-interest. It is assumed that consumers are rational and maximize their benefits, and that producers acting in this fashion maximize profits. With this assumption, demand will be greater with decreasing price, and supply will be greater with increasing price. Thus, the supply and demand functions are of the general form depicted in Figure 4.

FIGURE 4

TYPICAL SUPPLY AND DEMAND CURVES




Consequently, the market equilibrium for fuels occurs where the supply and demand functions intersect. This occurs (in PIES) when fuels are purchased in a cost-conscious fashion by consumers, who, over time, substitute fuels for each other on the basis of their relative price changes and when industry operates so as to maximize its return across the entire national energy sectors. Because perfect market conditions do not exist in the real world, this clearly is an approximation to real world conditions. Thus, an equilibrium determined by PIES represents a solution to the overall problem of energy supply and demand in a partially regulated market.

Although the Demand Models provide estimates of consumer responses to prices for the forecast years, these quantities have not been matched to the quantities suppliers will produce when acting in their own self-interest. In order to obtain a market equilibrium point, supply must equal demand. PIES does this by using an equilibrating algorithm which matches an optimal supply set with demands.

In order to represent the supply set using a linear program, step-like approximations to the supply and demand curves are generated, as is indicated for supply in Figure 4. The step-function approximation to the demand curve is obtained by using estimates derived from the Demand Model; while supply models provide the supply approximations. Incorporating these step-function approximations to the supply and demand curves and the initial demand estimates into the linear program and solving, a set of prices, demands, and activity levels are obtained, which serve as a candidate for an equilibrium.

The solution to the linear program is not automatically an equilibrium, since the linear program cannot provide directly for fuel substitution effects, except in the case of electric utilities. To handle this problem, several iterations of the linear program are performed using a revised set of demand estimates on each iteration. These demand estimates are calculated using a continuous demand curve, which is a function of price and is based on the initial prices, quantities, and own-and cross-elasticities of demand obtained from the Demand Model.

If, on a particular solution of the linear program, the prices and associated quantities are within set tolerance limits of the previous prices and quantities, an equilibrium has been achieved. If not, new levels of product demand in each region are calculated from the previous solution, taking into account cross-elasticity effects for fuels. The linear program is revised to reflect these new levels of product demand. The linear program is again solved. This iterative process continues until the equilibrium solution is obtained.

An approximate equilibrium is reached when the absolute value of either the change in price or the change in quantity between two successive iterations is less than, or equal to, 2 percent of the price or quantity, respectively, at the first of these iterations.

## THE USE OF SCENARIOS

Scenarios permit evaluation and analysis of alternative issues. They are essentially sets of data that either select specific modeling structures, such as implementation of a tax program or regulation of natural gas, or change the value of model parameters to examine the sensitivity of results to specific data elements. Usually, a scenario, which contains the data and assumptions thought most likely to exist in the future, is developed and used as a reference for analyzing alternative scenarios. These alternative scenarios permit the model to be used comparatively to determine the impact of changing the scenario assumptions on the solution.

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# II. COMPONENTS OF PIES

## REGIONAL STRUCTURE

Production, distribution, conversion and consumption of energy material each have a regional structure in PIES. The primary purpose of the regional detail is not to provide results for regional analyses, but rather more representative national figures. Throughout PIES, the choice of regional structure is governed largely by the availability of data for that segment of the energy system. Specific regional details are included in the following descriptions of each PIES submodel.

## DEMAND MODELS

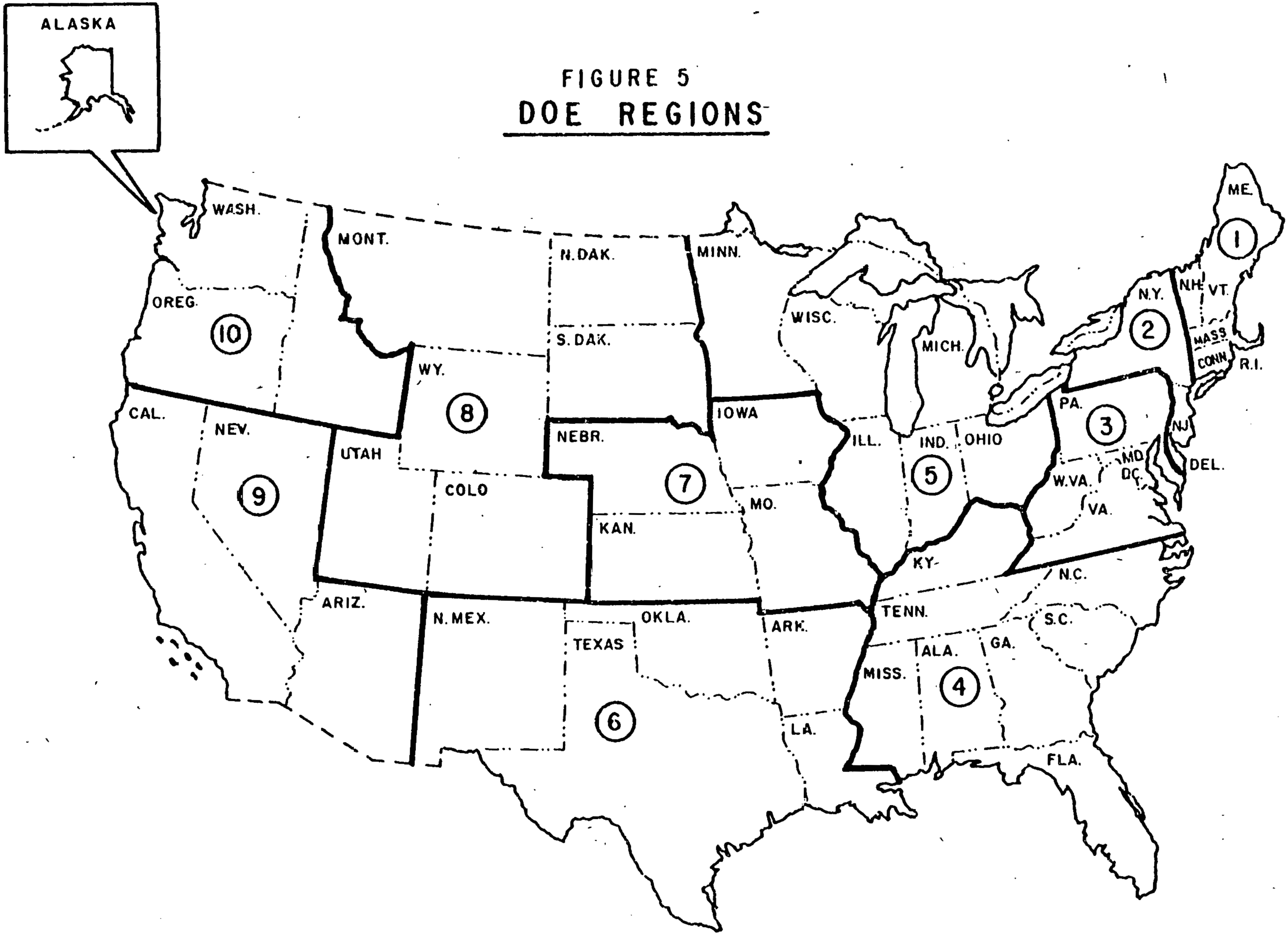
The Demand Models are satellites of the PIES Integrating Model and are depicted as such in Figure 3. The output from the Demand Models, which consist of price elasticities (own and cross) for 30 sector-specific products in each of ten regions for the target year, are input to the Integrating Model. Demand regions are the ten DOE regions depicted in Figure 5.

## THE SUPPLY AND CONVERSION SUB-MODELS

Traditionally, economists have estimated output as a function of capital and labor, without giving serious attention to the resource base. This is inappropriate in energy supply modeling, because the most important factor affecting the level of output is the character and extent of the resource base.

Rather than using the extrapolation of historical time series data and statistical techniques to predict future raw material and product availability, production models within PIES are built to simulate the actual production capabilities, given the resource base of the energy sector considered and the presumption that producers seek individually to maximize their profits. Each of the supply submodels is formulated using a microeconomic perspective based on investment planning using operations research techniques.

## FIGURE 5
## DOE REGIONS



Coal

The National Coal Model is used to provide supply functions for 11 different categories of coal in the 12 PIES coal supply regions. These regions, depicted in Figure 6, were chosen to correspond to the traditional mining regions defined by the Bureau of Mines. Each is relatively compact and contains only a few categories of steam coal. A number of the regions also contain metallurgical coal. Within PIES, coal is differentiated by its sulfur and Btu content.

Costs of transportation constitute a substantial part of the total costs of using coal. Consequently, within PIES, the more compact the coal region, the better the estimate of transportation costs from the coal region to the utility or demand regions, where the coal is consumed. Thus, even though some regions, such as Central and Southern Appalachia, produce the same categories of coal, they are modeled as two separate regions to provide better estimates of transportation costs.

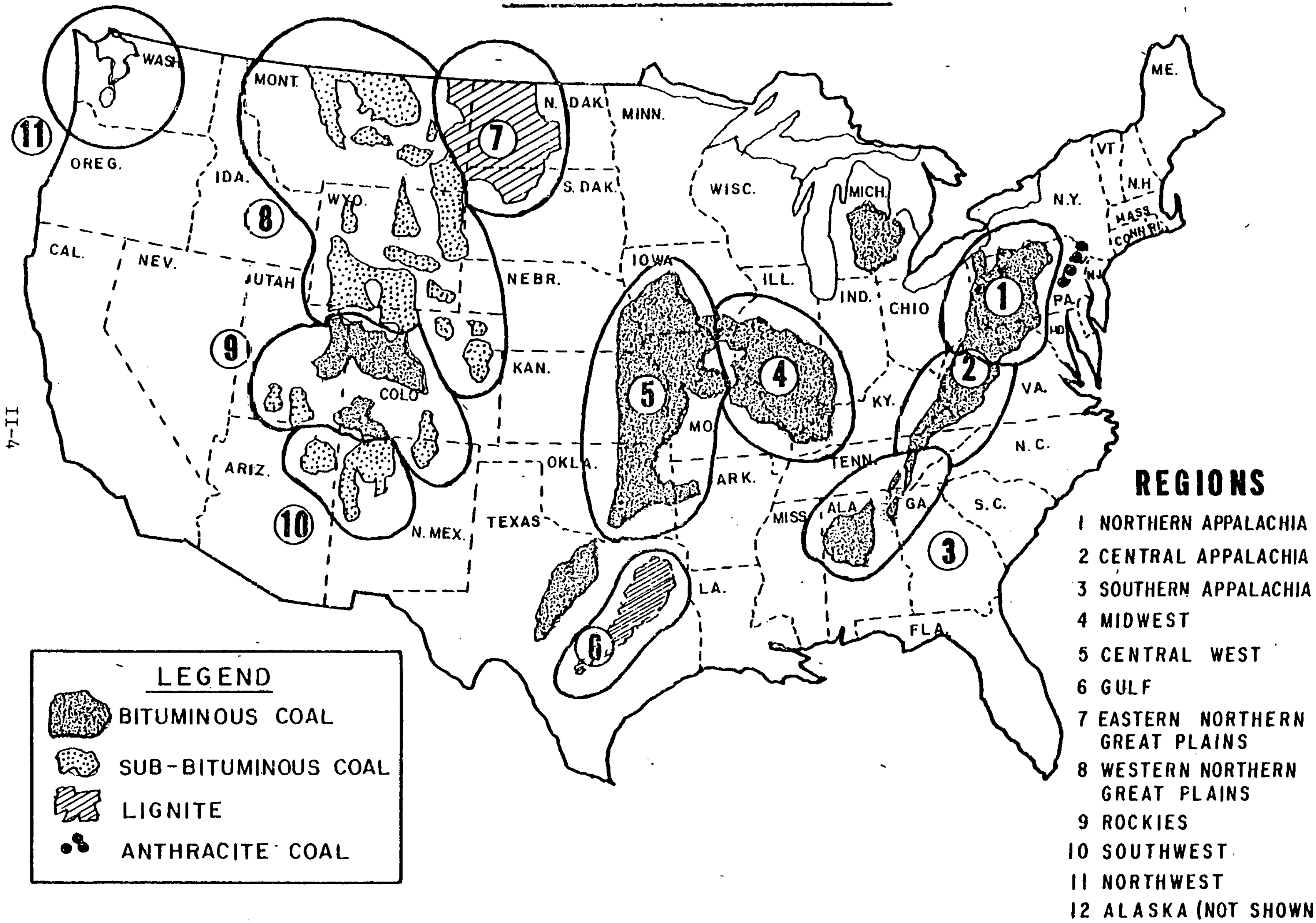
As for all supply functions in PIES, step functions are used to approximate individual coal supply curves. For each type of coal, the steps of the coal supply curve represent the development of a specific mine type.[1] The lowest cost steps on the coal supply curves generally correspond to existing mines, or mines that are about to be opened. In such instances, capital costs are sunk, or mostly sunk, and the mines will be operated as long as the marginal revenue is at least equal to the operating cost. The higher cost steps reflect the capital recovery necessary for opening new mines.

The production capacity for new mines is estimated as the maximum annual production that the former Bureau of Mines-estimated reserve base could sustain for 20 years, with the effect of mine closings included. Reserves not committed to existing mines are allocated to categories of new mines, reflecting different costs for different

[1]Differentiated by depth, seam thickness and annual capacity for deep mines and overburden ratio and annual capacity for surface mines.

FIGURE - 6

## PIES COAL REGIONS



categories of surface and deep mines. The amount of coal in each cost category is estimated by means of statistical distributions appropriate for the region and coal type. The cost of coal is determined through an income-statement simulation in which there are four major determinants of cost: capital, labor cost and productivity, power and supplies, and rate of return. Preparation costs, reclamation costs and state severance taxes are additional factors that effect the cost of the coal.

Oil and Gas

Oil production is modeled 13 regions, consisting of 8 regions onshore in the lower 48 states, 3 regions on the Outer Continental Shelf (OCS), the Alaskan North Slope, and South Alaska. These regions are based on the National Petroleum Council (NPC) classification, with Alaska being split into two regions and NPC regions 8, 9 and 10 being aggregated. They are depicted in Figure 7.

Fourteen natural gas regions are modeled. They are identical to the oil regions, except the NPC regions 8, 9 and 10 form two natural gas regions: one composed of NPC regions 8 and 9, and the other composed of NPC region 10. The natural gas regions are shown in Figure 8.

A satellite oil supply model provides supply functions for approximately 20 different domestic crude oils in the appropriate oil production regions, plus associated gas and coproducts. The crude oils are differentiate by sulfur content and API gravity. A satellite gas supply model provides supply functions for natural gas and coproducts in each of the gas production regions. In deriving these supply functions, the oil and gas submodels use approximately the same methodology. For each NPC region, the estimate used for the resource base is obtained from United States Geological Survey (USGS) circular 725.

A barrel of oil-in-place discovered in a region is partitioned into primary, secondary, and tertiary reserves, based on historical regional recovery factors. (No enhanced recovery is considered for gas.) An exponentially declining curve is used to represent

FIGURE 7

# OIL REGIONS

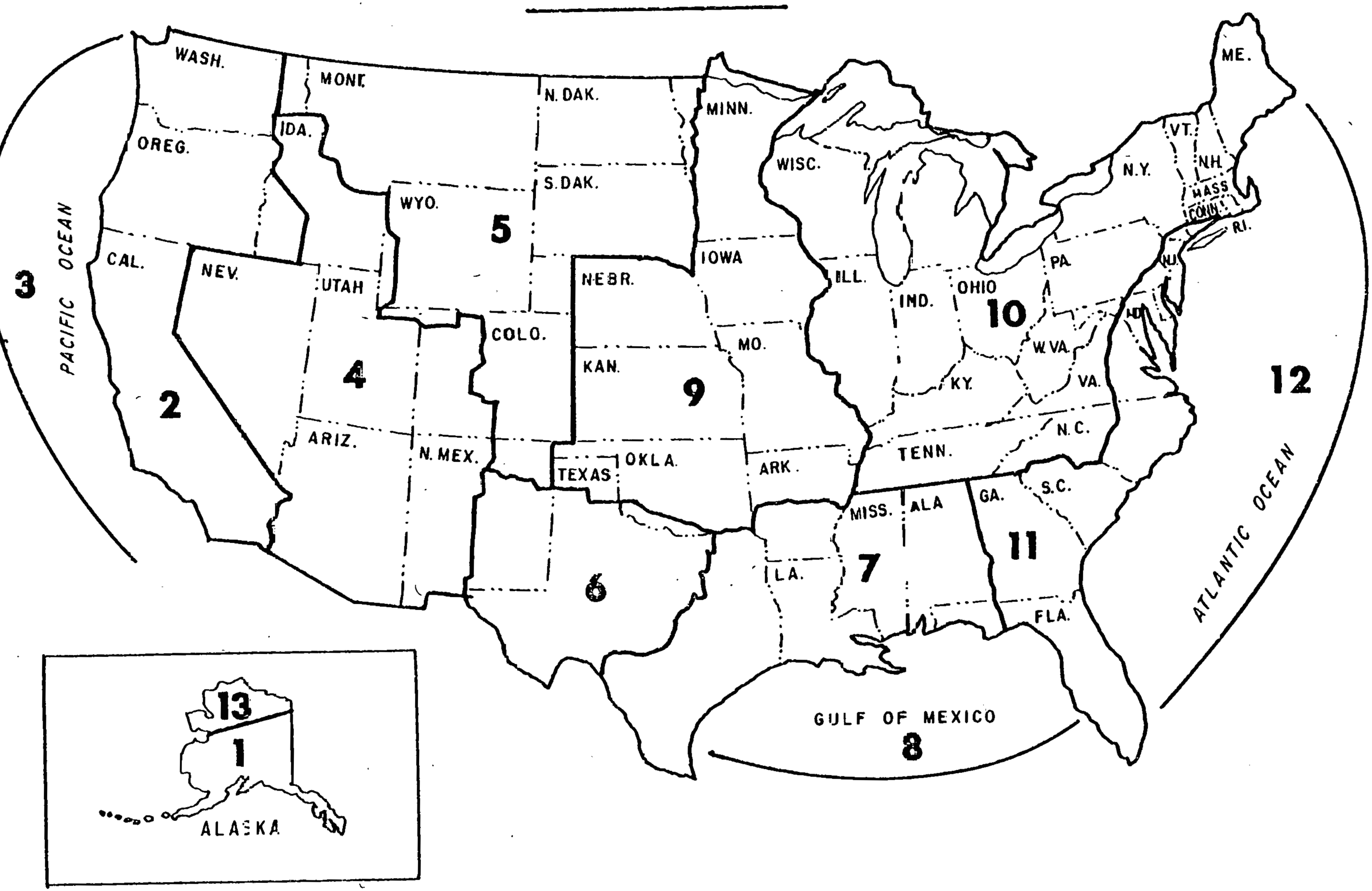
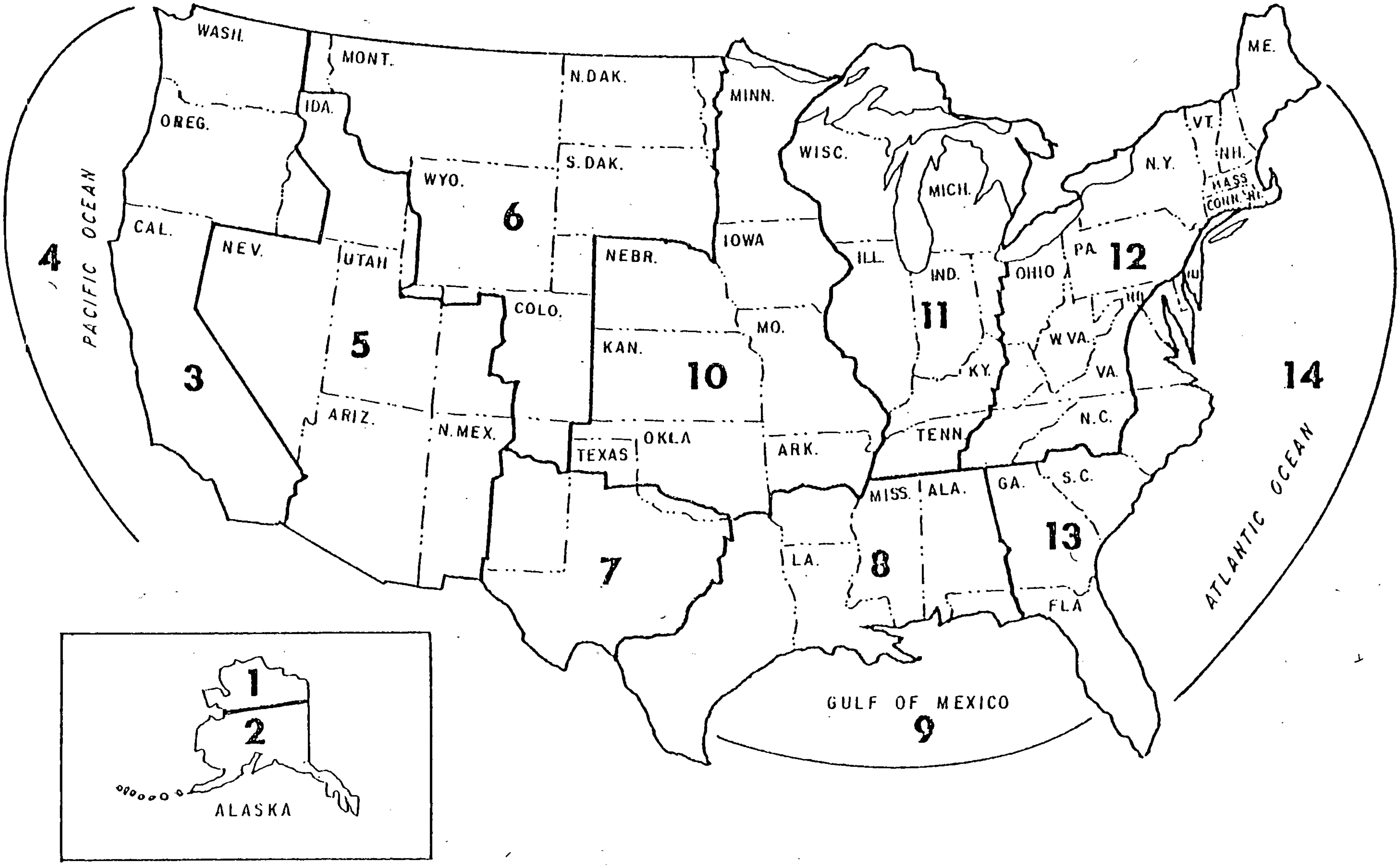


FIGURE 8

## NATURAL GAS REGIONS



production over time. Secondary production starts several years after the oil is added to reserves; tertiary even later. For each oil (gas) price on the supply curve, the discounted cash flow from a barrel (thousand cubic feet) of reserves is calculated. An initial finding rate per foot is established by examining the recent history of barrels of oil (thousand cubic feet of gas) added to reserves per foot drilled (all wells for gas, exploratory only for oil).

Once the value of a unit of reserves added and the cost of discovering the reserves are known, the cumulative feet worth drilling for each price level is determined. Starting from the current rate of activity, drilling effort is increased, and then decreased, to reflect the growth and the decline of activity. The initial surge of activity becomes greater as the price rises and does not occur if there is a price decline. As the yield per foot drilled declines, the rate of increase in activity declines; eventually, the rate of drilling decreases to zero when profitable opportunities disappear. As the drilling occurs and as reserves are added over time, production occurs from the reserves added in every year. To determine the amount of supply in any given year, for any given price, the production from reserves is added first.

Electric Utilities

The electric utilities submodel simulates operation and planning behavior to represent electricity generation. It chooses the capacity and mix of generating plant types required to meet load demands which vary daily and seasonally. In so doing, it models the consumption of fuels (coal, residual oil, distillate oil, natural gas and uranium) that are transported from domestic producing and importing regions to utilities. It models conversion of fuels to electricity taking account of energy losses; and then models the transmission of that energy through the transmission and distribution network to satisfy sectoral demands for electricity in the coincident demand regions.

PIES utility regions correspond to the ten DOE regions depicted in Figure 5. The model allows electricity demand to be satisfied by generation only in its coincident utility region. This implies that the electricity distribution model cannot explicitly include power imported one region to another.

The key to modeling dispatching behavior by electric utilities is that they cannot store electricity and must produce it on demand. This means that utilities must own some equipment that operates most of the time and some that runs during peak demand periods only. The demand levels for electricity during a year are represented by regional, annual load duration curves of the form shown in Figure 9.

PIES models base, cycling, daily peak and seasonal peak modes of operation. Base load is characterized by a constant level of customer demand. Cycling load provides electricity for which demand varies seasonally or by time of day. Daily peak and seasonal peak meet demands for electricity during a few peak hours of the day and during extremely hot or cold weather, respectively.

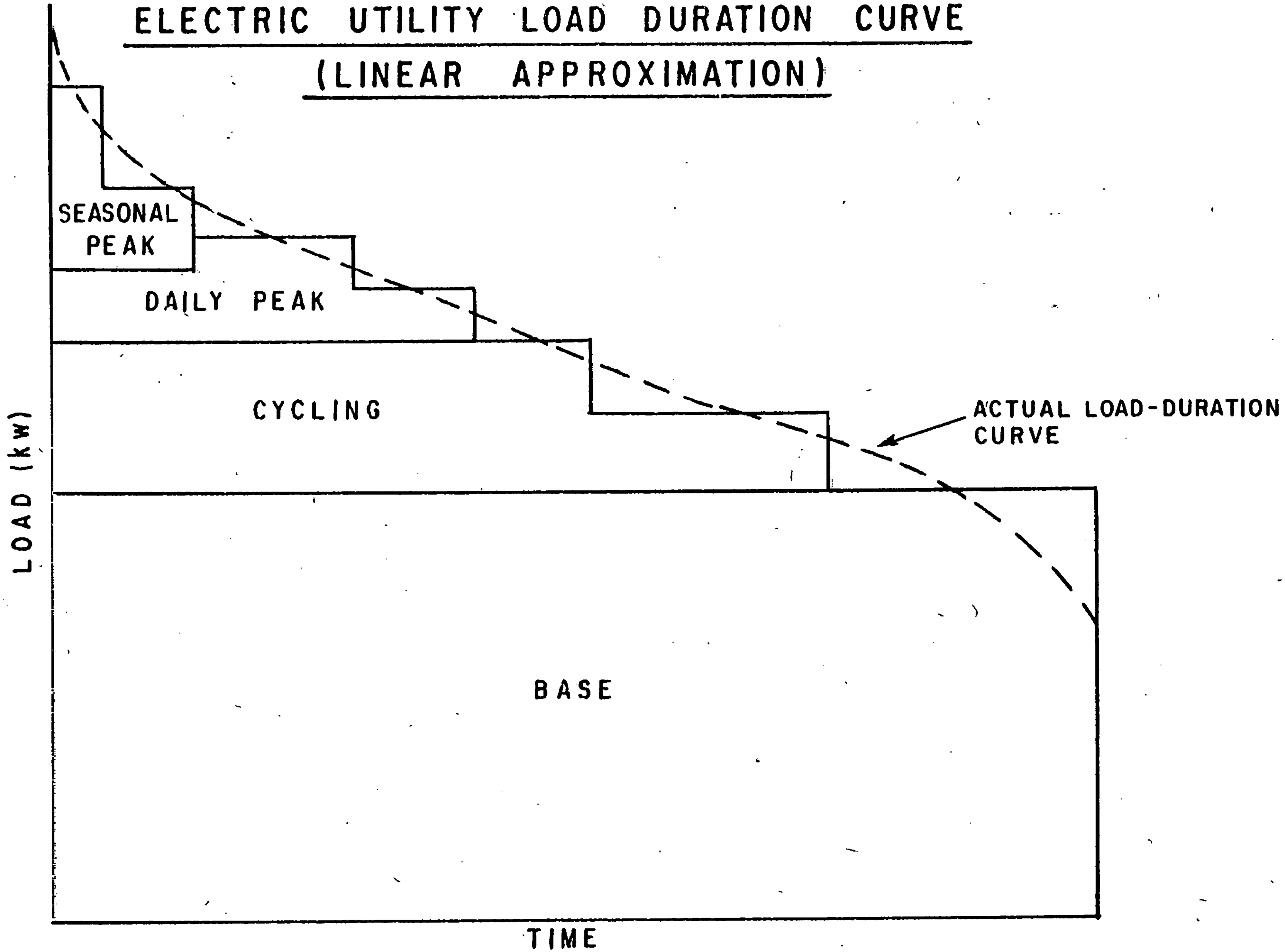
The types of generation equipment that can be used include nuclear power, coal-fired steam (with or without scrubbers), residual-fired steam, gas-fired steam, simple-cycle turbines, combined-cycle distillate turbines, and hydroelectric power. Each type of generation plant has its own cost and load factor characteristics.

In most cases, base load is powered by either hydro, nuclear or coal plants; cycling load is provided by hydro, coal, residual-fired steam, gas-fired steam, or combined-cycle plants; and peak load is produced by hydro or turbines. That is, equipment with high capital costs and lower operating costs is best suited for base load demand, whereas equipment with low capital costs, but relatively high operating costs, is better for satisfying peak load.

It is important to understand one more aspect of the utilities submodel. The rates utilities can charge are regulated, so that a customer is charged the average cost of

FIGURE - 9

## ELECTRIC UTILITY LOAD DURATION CURVE
## (LINEAR APPROXIMATION)



electricity (based on actual costs of equipment rather than replacement costs). Thus, in PIES, consumers respond on the basis of average cost prices, while utility investment decisions are made on the basis of marginal production costs.

Refineries

The refineries submodel is a simplified aggregate planning model, which represents the conversion of crude oils (both domestic and imported) to 7 major refined products demanded by consumers (naphtha, gasoline, jet fuel, distillate, residual, liquefied petroleum gases, and other). Crude oils processed by refineries differ in physical and chemical characteristics, and consequently each crude type must be processed slightly differently, with processing costs varying slightly from crude to crude, and each operating mode producing a different mix of products. The PIES refineries submodel has the capability to differentiate crude oils by characteristics such as specific gravity and sulfur content and can distinguish approximately 45 different domestic and imported crude types.

It is important, of course, that the refineries submodel capture the characteristics of existing refinery capacity; this is done off-line by calibrating and adjusting the model, so that it simulates recent performance of the industry.

Provision must be made for modeling the expansion of the refinery industry; this is done by providing a spectrum of choices for construction of new capacity. As with utilities, the inclusion of new capacity implies that capital expenditures must be made. These costs are annualized capital charges for operating new refinery modes.

Thus, in being consistent with the overall PIES approach, the refineries submodel selects and transports specific crude types to refinery regions, chooses specific operating modes, specifies necessary types of capacity for expansion, and produces and transports refined products to the consumers, all in a way that minimizes the refiner's costs.

The refinery regions are the five Petroleum Administration for Defense Districts (PADDs), with PADDs 1 and 2 each being divided into two regions as depicted in Figure 10. These regions were originally defined for the administration of refineries by the Navy during a national emergency. Within PIES, crude oil is transported into refinery regions from the oil production or import regions, and refined products are transported from the refinery regions to either the utility or demand regions by pipeline, barge, or tanker.

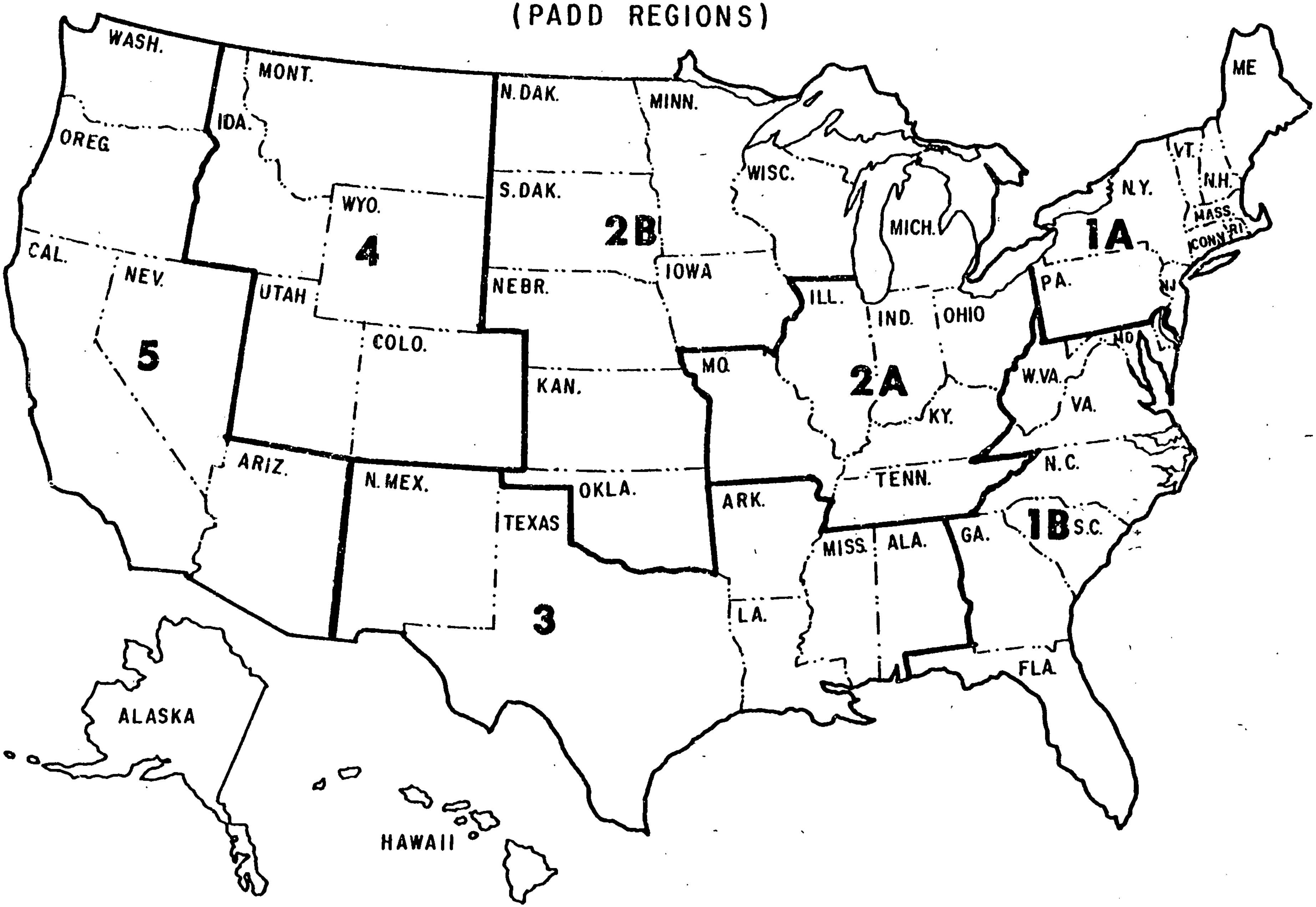
Transportation

All production, conversion, and consumption activities within PIES are linked by a transportation network. The transportation submodel provides interregional links to model coal transportation by barge and rail, gas by pipeline, and oil and refined products by tanker, barge and pipeline. It also calculates the costs for shipping each material by the potential transportation modes for each link. In most cases, there is no capacity constraint on the quantities that may flow through a link. The exceptions are oil pipeline constraints for transportation from Alaska.

FIGURE 10

# PIES REFINERY REGIONS

(PADD REGIONS)



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# III. PRINCIPAL USES OF PIES

## INTRODUCTION

Since its initial development in 1974, PIES has been used extensively to forecast the impacts of many different Government energy policy proposals. In 1974, it was the basis of the analyses behind the Project Independence Report published in November of that year. The successor to that publication was the 1976 National Energy Outlook published in April 1976, and PIES was again fundamental to the analyses performed. PIES was also used to assess the impacts of the proposed legislation implementing President Carter's National Energy Plan and to study the counter-proposals put forward by the House, Senate, and House-Senate conferees.

Since then, PIES has been used for a variety of analyses including:

- a study of Electric Utility Load Management for the General Accounting Office (GAO)
- an analysis of the impacts on fuel shares of divestiture of coal companies
- a study of the marketability of Alaskan natural gas for the Federal Energy Regulatory Commission (FERC)
- analyses for the Council on Environmental Quality (CEQ) and DOE's Policy Office

Most recently PIES has been used to provide the mid-range forecasts contained in Volume II of EIA's 1977 Administrator's Annual Report to Congress (published April 1978).

## EXAMPLES OF POLICY USES

One way PIES has been used was to analyze a number of alternative routes for the Trans-Alaskan natural gas pipeline system. Three distinct routes were proposed, one paralleling the Trans-Alaskan oil pipeline; one following the path of the MacKenzie River through Canada's Northwest Territory, linking up with the U.S. gas pipeline network east of the Rockies; and a third route through Alaska to a proposed liquefaction facility from which LNG would be transported to California in tankers. PIES result were used in the examination of the merits of each of these routes.

PIES was used recently in response to a request from the Energy Modeling Forum (EMF)[1] to analyze the use of coal from 1980 to 2000. The purpose of the exercise was to compare the results of several models using a common set of assumptions and scenarios developed by EMF. The comparisons were to uncover differences and similarities in the way major forces affecting the coal transition (for example, the effects of different air pollution standards) were treated in the models; and not to compare forecasts of coal production and utilization. Specifically, the models were intended to:

- calculate the rate of production by type and location of coal
- display how regional coal production patterns respond to environmental regulations on sulfur emissions or changes in the relative costs of mining, transporting, and using coal
- examine the economic competitiveness of alternative coal supply sources and types, and in comparison with other fuels in the generation of electricity or other uses
- provide information on the coal transport flows, the requirements for plants and equipment, and the use of scrubbers.

A detailed account of this application of PIES is documented in "Coal in Transition," Analysis Memorandum #AM 78-09, EIA, February 15, 1978.

At the request of Senator Jackson, PIES was recently used to analyze the impacts of major proposals being considered in the debate over the National Energy Act. Specifically, it was used to determine the estimates of revenue that will accrue to producers of natural gas between now and 1985 under four different proposals;

1. the present system of regulation of natural gas prices
2. the natural gas pricing provisions of H.R. 8444 as passed by the House

[1]The EMF is funded by the Electric Power Research Institute to improve the use of energy models in policy analysis. It operates through a series of working groups of energy model developers and users and is administered by the Stanford University Institute for Energy Studies.

3. the natural gas pricing legislation which passed the Senate

4. the tentative agreement announced by the caucus of House-Senate conferees on April 21, 1978

The PIES structure extended was to model each of these proposals. Energy projections for 1985 were determined, and revenue estimates from 1978 through 1985 were developed in an off-line analysis. The results are documented in "An Evaluation of Natural Gas Pricing Proposals," Analysis Memorandum No. AM/IA-7802, EIA, June 14, 1978.

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## APPENDIX A. THE PIES INTEGRATING MODEL REPORT

### INTRODUCTION

After each execution of PIES, a customized solution report known formally as the "PIES Integrating Model Report," and informally as "WONDERCOOKIE" or "COOKIE" is produced. Included in this appendix are four of the most widely used tables, with descriptions, from the PIES Integrating Model Report for the 1985 mid-range/TRENDLONG scenario, which assumes a normal rate of growth for the economy, natural gas regulation and an oil import price of $15.32/barrel.

### TABLE 1: Executive Data Summary (Standard Physical Units)

TABLE 1 of the PIES Report summarizes energy production, consumption and import projections for 1985. The columns are fuel types, and the rows show distribution of energy fuel among imports, domestic consumption and domestic supply. The units are standard physical units per year, as listed in Table A-1. Physical units for coal are million short tons (MMST) where a short ton is 2,000 pounds. The volume of oil imports in millions of barrels per calendar day (MMB/CD) is given in a footnote.

The first column summarizes coal data. Indigeneous coal supply is given as 1,033.98 MMST/YR, and coal imports are noted as -74.00 MMST/YR. Negatively signed imports represent exports; thus, 74.00 MMST/YR of coal are exported, reducing the amount of coal available for domestic uses to 959.98 MMST/YR, as given in the total supply row.

Oil supply derives from several different sources; 3262.15 MMB/YR of crude is produced within the U.S. Co-products associated with crude oil production account for 456.11 MMB/YR and shale oil for 17.15 MMB/YR of indigenous OIL supply. Total imports for OIL amount to 4021.28 MMB/YR, of which 2828.99 MMB/YR are crude imports, and

TABLE A-1. PHYSICAL UNITS IN THE PIES REPORT

| | |
|---|---|
| B | Barrel |
| BCF | Billion cubic feet |
| BCF/YR | Billion cubic feet per year |
| M | Thousand |
| MB/CD | Thousand barrels per calendar day |
| MCF | Thousand cubic feet |
| M.E. Ton | Material equivalent ton of 22.5 million Btu |
| MKWH | Thousand kilowatt hours |
| MM | Million (Thousand thousand) |
| MMB | Million barrels |
| MMB/CD | Million barrels per calendar day |
| MMB/YR | Million barrels per year |
| MMCF/CD | Million cubic feet per calendar day |
| MMMKWH/YR | Billion kilowatt hours per year |
| MMST | Million short tons (a short ton is 2000 pounds) |
| MMST/YR | Million short tons per year |
| MM$/YR | Million dollars per year |
| ST | Short ton |
| T | Ton |
| TBTU | Trillion Btu |
| $/BBL | (1978) Dollars per barrel |
| $/MCF | (1978) Dollars per thousand cubic feet |
| $/M.E. Ton | (1978) Dollars per material equivalent ton |
| MILS/KWH | (1978) MILS per kilowatt hour |

1192.28 MMB/YR are refined petroleum product imports. Total oil supply is thus 7756.69 MMB/YR, which is total indigenous supply plus total imports. The 203.61 MMB/YR volumetric gain indicated in TABLE 1 occurs because the volume of petroleum products produced is greater than the volume of crude entering the refinery.

Indigenous gas supply is derived from gas wells that produce no oil (non-associated gas) and from oil wells that produce both liquid hydrocarbons and gas. The non-associated gas production entry, 13,504.54 BCF/YR is in the COAL, GAS, ELEC. row. The entry for associated and dissolved gas is found in the CO-PRODUCTS/ASSOC. GAS row. Total associated gas production is given as 3,221.32 BCF/YR.

There are two columns with solar and geothermal references. The column labeled HYDRO, SOLAR, GEOTHERMAL relates to the generation of electrical power by utilities from these sources, which amounts to 395.67 MMMKWH/YR. The 14.35 entry in the DIRECT SOLAR/GEO row represents the reduction of electricity demand resulting from the substitution of solar and geothermal resources for electricity. For example, the use of solar heating in a residence to reduce the use of electricity would be represented in this category. The standard transmission line loss of electricity supply from the 410.02 MMMKWH/YR of electricity from HYDRO, SOLAR, GEOTHERMAL sources is 35.70 MMMKWH/YR. There is no loss associated with direct substitution of solar and geothermal sources for electricity. The SOLAR/GEO FOSSIL SUBST column similarly reflects the reduction fossil fuel demand resulting from direct solar and geothermal substitution. A sectoral breakout of these numbers appears in the consumption portion of the table.

Fuel consumption by sector is shown in the lower portion of TABLE 1. These consumption, or demand, sectors include residential, commercial, industrial, transportation, synthetics and electrical generation. To find the amount of coal consumed in the residential sector, we find the entry corresponding to the fuel type column, COAL, and the sector row, RESIDENTIAL; thus 1.03 MMST/YR of coal are consumed in the residential sector. Similarly, .56 MMST/YR of coal are consumed in the commercial sector, and 745.50 MMST/YR are consumed in the generation of electricity. Sectoral consumption amounts for the other fuel types are also obtained by looking down the fuel type column and across the sector row.

Total supply should equal total domestic consumption for each fuel type. A note at the bottom of TABLE 1 explains that any imbalance between net supply and demand is due to the convergence criteria used in the equilibration process.

TABLE 2: Executive Data Summary (Trillion Btu)

TABLE 2 is basically a repetition of TABLE 1 in which each entry is reported by BTU value, thus allowing direct comparisons between fuel types. A number of summation columns have also been incorporated to aggregate across fuel types.

TABLE A-2. CONVERSION FACTORS

| Item | Millions of Btus per Indicated Unit |
|---|---|
| Crude Oil (all) (B) | 5.800 |
| Gas Liquids (B) | 5.248 |
| Butane (B) | 4.010 |
| Coal - High Btu, Medium Sulfur (ST) | 23.800 |
| Coal - Medium Btu, Medium Sulfur (ST) | 21.800 |
| Coal - High Btu, High Sulfur (ST) | 23.800 |
| Coal - Medium Btu, High Sulfur (ST) | 21.800 |
| Coal - Low Btu, Low Sulfur (ST) | 18.330 |
| Coal - Very Low Btu, Low Sulfur (ST) | 13.000 |
| Coal - High Btu, Low Sulfur (ST) | 23.800 |
| Coal - Very Low Btu, Medium Sulfur (ST) | 13.000 |
| Coal - Low Btu, Medium Sulfur (ST) | 18.330 |
| Coal - Medium Btu, Low Sulfur (ST) | 21.800 |
| Coal - Metallurgical (ST) | 27.000 |
| Electricity (MKWH) | 3.412 |
| Gasoline (B) | 5.248 |
| Distillate (B) | 5.825 |
| Residual (B) | 6.287 |
| Other Refined Petroleum (B) | 5.000 |
| Natural Gas (MCF) | 1.032 |
| Liquid Petroleum Gases (B) | 4.010 |
| Jet Fuel (B) | 5.318 |

The SOLAR/GEO FOSSIL SUBST. column of TABLE 1 is not given as a separate column in TABLE 2 because of space limitations. It has been combined with the hydro, solar and geothermal entries, and a footnote gives the fossil fuel substitution amount as 119.86 TBTU. The amount of solar and geothermal substitution is given as 143.50 TBTU.

The fossil fuels (oil, gas and coal) and electricity represent the actual Btu contents of the fuels (see Table A-2 for conversion factors). Entries for the HYDRO, SOLAR, GEO columns do not represent the actual BTU content but estimate the BTU consumption of an equivalent fossil fuel plant with a heat rate of 10,000 BTU/KWH. This conversion factor is not used for the entries in the DIRECT SOLAR/GEOTHERMAL row. Nuclear entries assume heat rates of 11,000 BTU/KWH.

GROSS ELECT. INPUTS represents a distribution of the electrical generation (31563 TBTU/YR) and the synthetics fuel (196 TBTU/YR) consumption volumes among the remaining four sectors on the basis of end-use proportions. For example, if the residential sector is assumed to use 60 percent of the electricity generated, the entry under this column and across the RESIDENTIAL row would represent 60 percent of the total inputs consumed in electrical generation and synthetic fuel production (31,759 TBTU/YR). The first four sectors are chosen because they are end-use consumption sectors. The electrical generation and synthetics sectors provide energy to the remaining four consumption sectors and the GROSS ELECT. INPUTS column shows the distribution of the fuel consumed in generating this energy to the four sectors based on sectoral consumption of electricity.

TOTAL FOUR SECTOR INPUTS in the consumption portion of the table represents both direct fuel consumption and consumption of fuel for the purpose of producing electricity and synthetic fuels and is thus the sum of TOTAL 6 SECTOR INPUTS and GROSS ELEC. INPUTS for the first four sectors. NET 4 SECTOR INPUTS represent both direct fuel consumption and the direct consumption of electricity and thus is the sum of UTILITY ELECTRIC DISTRIB. and TOTAL 6 SECTOR INPUTS for the first four sectors only.

TABLE 3: Price Summary in 1978 $/Standard Physical Unit

TABLE 3 contains the retail prices of the energy products. These prices are given by sector (residential, commercial, raw material, industrial and transportation) and by region (the ten DOE regions). Retail prices are obtained by applying sectoral markups to the delivered prices. The retail price markups are based on historical data. Entries in the TOTAL column are quantity-weighted averages of the regional prices.

TABLE 4: Regional Price Summary in 1978 $/Million BTU

TABLE 4 is the same as TABLE 3 with all prices converted to 1978 dollars per million BTU.

**TABLE 1**

1985 MID-RANGE/TRENDLONG SCENARIO (SERIES C)
WITH NATURAL GAS REGULATION

OIL IMPORT PRICE: 15.32
RUN DATE: 1.14

EXECUTIVE DATA SUMMARY

UNITED STATES TOTAL GROSS SUPPLY/CONSUMPTION OF ENERGY RESOURCES
ENERGY SOURCES IN STANDARD PHYSICAL UNITS PER YEAR

| SECTOR | COAL (MMST) | OIL (MMB) | GAS (BCF) | NUCLEAR (MMMKWH) | HYDRO, SOLAR, GEOTHERMAL (MMMKWH) | SOLAR/GEO FOSSIL SUBST. (TBTU) | TOTAL ELEC. DISTRIBUTED (MMMKWH) |
|---|---|---|---|---|---|---|---|
| DOMESTIC SUPPLY: | 1033.98 | 3735.42 | 16725.86 | 565.62 | 410.02 | 119.86 | 3042.54 |
| (COAL, GAS, ELEC.) | 1033.98 | | 13504.54 | 565.62 | 395.67 | | 3042.54 |
| (CRUDE) | | 3262.15 | | | | | |
| (CO-PRODUCTS/ASSOC. GAS) | | 456.11 | 3221.32 | | | | |
| (SYNTHETICS) | | | | | | | |
| (SHALE) | | 17.15 | | | | | |
| (DIRECT SOLAR/GEO) | | | | | 14.35 | 119.86 | |
| IMPORTS: | 74.00- | 4021.28 | 1848.07 | | | | |
| (CRUDE) | | 2828.99 | | | | | |
| (PRODUCTS) | | 1192.28 | | | | | |
| (LNG) | | | 942.07 | | | | |
| (CANADIAN/MEXICAN) | | | 906.00 | | | | |
| (COAL) | 74.00- | | | | | | |
| TOTAL SUPPLY | 959.98 | 7756.69 | 18573.93 | 565.62 | 410.02 | 119.86 | 3042.54 |
| GAINS(+)/LOSSES(-) | | 203.61 | | 46.31- | 35.70- | | 254.14- |
| CONSUMPTION: | | | | | | | |
| RESIDENTIAL | 1.03 | 707.45 | 5251.75 | | 4.46 | 43.39 | 841.10 |
| COMMERCIAL | .56 | 596.96 | 1841.34 | | 5.09 | 20.41 | 695.80 |
| INDUSTRIAL | 200.21 | 2044.22 | 9840.85 | | 4.80 | 56.06 | 1225.48 |
| TRANSPORTATION | .02 | 3901.61 | 398.50 | | | | 4.05 |
| ELECTRICAL GENERATION | 745.50 | 541.31 | 2035.61 | | | | 2766.43- |
| SYNTHETICS | 13.66 | 169.11 | 872.16- | | | | |
| TOTAL DOMESTIC CONSUMPTION | 960.98 | 7960.65 | 18547.89 | | 14.35 | 119.86 | .00 |

NOTE: OIL IMPORTS IN MMB/CD = 11.02
GAS CONSUMPTION IN THE TRANSPORTATION SECTOR INCLUDES NATURAL GAS TRANSPORTATION LOSSES.
INDUSTRIAL CONSUMPTION INCLUDES REFINERY FUEL CONSUMPTION.
GAINS ARE REFINERY GAINS, LOSSES ARE TRANSMISSION LOSSES.
SUPPLY/DEMAND IMBALANCES MAY BE DUE TO ERRORS WITHIN THE EQUILIBRATION CONVERGENCE TOLERANCE.

**TABLE 2**

1985 MID-RANGE/TRENDLONG SCENARIO (SERIES C)
WITH NATURAL GAS REGULATION

OIL IMPORT PRICE: 15.32
RUN DATE: 1.14

## EXECUTIVE DATA SUMMARY

UNITED STATES TOTAL GROSS SUPPLY/CONSUMPTION OF ENERGY RESOURCES
ENERGY SOURCES IN TRILLIONS OF BTU'S PER YEAR

| SECTOR | COAL | OIL | GAS | TOTAL FOSSIL FUEL | NUCLEAR | HYDRO SOLAR GEO. | TOTAL 6 SECTOR INPUTS | GROSS ELECT. INPUTS | TOTAL 4 SECTOR INPUTS | UTILITY ELECTRIC DISTRIB. | NET FOUR SECTOR INPUTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DOMESTIC SUPPLY: | 23062 | 21029 | 17261 | 61352 | 6222 | 4220 | | | | 10381 | |
| (COAL,GAS,ELEC.) | 23062 | | 13937 | 36999 | 6222 | 3957 | | | | 10381 | |
| (CRUDE) | | 18986 | | 18986 | | | | | | | |
| (CO-PRODUCTS/ASSOC. GAS) | | 1944 | 3324 | 5268 | | | | | | | |
| (SYNTHETICS) | | | | | | | | | | | |
| (SHALE) | | 100 | | 100 | | | | | | | |
| (DIRECT SOLAR/GEO) | | | | | | 263 | | | | | |
| IMPORTS: | 1918- | 23190 | 1907 | 23179 | | | | | | | |
| (CRUDE) | | 16465 | | 16465 | | | | | | | |
| (PRODUCTS) | | 6725 | | 6725 | | | | | | | |
| (LNG) | | | 972 | 972 | | | | | | | |
| (CANADIAN/MEXICAN) | | | 935 | 935 | | | | | | | |
| (COAL) | 1918- | | | 1918- | | | | | | | |
| TOTAL SUPPLY | 21144 | 44219 | 19163 | 84531 | 6222 | 4220 | 94973 | | | 10381 | |
| GAINS(+)/LOSSES(-) | | 362- | | | | | | | | 867- | |
| CONSUMPTION: | | | | | | | | | | | |
| RESIDENTIAL | 24 | 3826 | 5422 | 9272 | | 88 | 9360 | 9656 | 19016 | 2870 | 12230 |
| COMMERCIAL | 13 | 3560 | 1900 | 5473 | | 71 | 5544 | 7988 | 13532 | 2374 | 7918 |
| INDUSTRIAL | 5016 | 11302 | 10156 | 26474 | | 104 | 26578 | 14069 | 40647 | 4181 | 30759 |
| TRANSPORTATION | | 20954 | 411 | 21366 | | | 21366 | 46 | 21412 | 14 | 21380 |
| ELECTRICAL GENERATION | 15904 | 3328 | 2152 | 21385 | 6222 | 3957 | 31563 | | | 9439- | |
| SYNTHETICS | 208 | 889 | 900- | 196 | | | 196 | | | | |
| TOTAL CONSUMPTION | 21166 | 43857 | 19141 | 84164 | 6222 | 4220 | 94605 | 31759 | 94606 | | 72287 |

~ NOTE: GAS CONSUMPTION IN THE TRANSPORTATION SECTOR INCLUDES NATURAL GAS TRANSPORTATION LOSSES.
INDUSTRIAL CONSUMPTION INCLUDES REFINERY FUEL CONSUMPTION.
LOSSES ARE REFINERY CRACKING LOSSES AND ELECTRICITY TRANSMISSION LOSSES.
NUCLEAR AND HYD/SOL/GEO ENTRIES ESTIMATE BTU CONSUMPTION FOR AN EQUIVALENT FOSSIL FUEL PLANT AT 10000 BTU/KWH.
SUPPLY/DEMAND IMBALANCES MAY BE DUE TO ERRORS WITHIN THE EQUILIBRATION CONVERGENCE TOLERANCE
OR AVERAGE BTU CONVERSION OF AGGREGATES.
DIRECT SOLAR/GEO SUPPLY INCLUDES FOSSIL FUEL DEMAND REPLACEMENT IN TBTUS OF 119.86
AND ELECTRICITY DEMAND REPLACEMENT AT 16000 BTUS/KWH OF DEMAND IN TBTUS OF 143.50

TOTAL SUPPLY QUADS NET OF REFINERY CRACKING LOSS: 94.61
TOTAL GROSS QUADS CONSUMED: 94.61

TABLE 3

1985 MID-RANGE/TRENDLONG SCENARIO (SERIES C)
WITH NATURAL GAS REGULATION

OIL IMPORT PRICE: 15.32
RUN DATE: 1.19

DEMAND REGION RETAIL PRICE SUMMARY IN 1978 $/ STANDARD PHYSICAL UNIT

| SECTOR(FUEL) | DEMAND REGIONS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NW-ENG. | NY/NJ | MID-ATL | S.-ATL | MIDWEST | S.-WEST | CENTRAL | N-CNTRL | WEST | N.-WEST | TOTAL |
| RESIDENTIAL | | | | | | | | | | | |
| (ELECT.) | 45.42 | 54.27 | 47.39 | 37.69 | 40.96 | 40.50 | 43.32 | 32.92 | 43.21 | 13.91 | 39.97 |
| (DIST.) | 22.64 | 23.11 | 24.21 | 24.63 | 22.08 | 22.73 | 21.49 | 22.54 | 22.40 | 22.40 | 22.96 |
| (LG) | 15.62 | 16.08 | 17.33 | 17.33 | 15.99 | 15.73 | 15.69 | 16.32 | 15.80 | 15.80 | 16.21 |
| (COAL) | 46.56 | 43.89 | 41.32 | 44.29 | 39.48 | 36.59 | 37.79 | 30.84 | 39.39 | 39.68 | 40.93 |
| (NG) | 4.68 | 4.27 | 3.69 | 3.25 | 3.21 | 2.47 | 2.17 | 2.33 | 3.46 | 3.76 | 3.19 |
| COMMERCIAL | | | | | | | | | | | |
| (ELECT.) | 45.10 | 60.37 | 45.40 | 38.14 | 40.87 | 38.42 | 42.41 | 30.01 | 39.97 | 19.82 | 40.98 |
| (DIST.) | 21.21 | 21.61 | 21.90 | 21.92 | 20.99 | 21.22 | 20.45 | 21.18 | 20.77 | 20.77 | 21.30 |
| (RESID.) | 18.01 | 18.61 | 20.55 | 18.22 | 19.64 | 18.66 | 19.49 | 18.95 | 18.35 | 17.91 | 18.31 |
| (LG) | 13.10 | 13.10 | 13.10 | 13.10 | 13.99 | 13.10 | 13.88 | 13.93 | 13.10 | 13.10 | 13.54 |
| (COAL) | 46.56 | 43.89 | 41.32 | 44.29 | 39.48 | 36.59 | 37.79 | 30.84 | 39.39 | 39.68 | 40.93 |
| (ASPHALT) | 19.08 | 19.08 | 19.08 | 19.00 | 19.19 | 18.75 | 18.88 | 19.13 | 18.42 | 18.42 | 18.93 |
| (NG) | 3.98 | 3.64 | 3.21 | 2.72 | 2.86 | 2.54 | 3.57 | 3.23 | 2.92 | 3.15 | 3.04 |
| RAW MATERIAL* | | | | | | | | | | | |
| (LG) | 18.96 | 18.96 | 18.94 | 18.81 | 18.82 | 18.56 | 18.48 | 18.67 | 18.08 | 18.08 | 18.59 |
| (OIL) | 19.08 | 19.08 | 19.08 | 19.00 | 19.19 | 18.75 | 18.88 | 19.13 | 18.42 | 18.42 | 18.91 |
| (NG) | 3.19 | 2.92 | 2.77 | 2.26 | 2.52 | 2.23 | 3.20 | 2.73 | 2.52 | 2.44 | 2.41 |
| INDUSTRIAL*** | | | | | | | | | | | |
| (ELECT.) | 37.42 | 32.30 | 37.44 | 32.07 | 31.95 | 32.64 | 36.00 | 24.91 | 33.99 | 13.16 | 31.70 |
| (DIST.) | 21.20 | 21.51 | 22.46 | 22.40 | 20.97 | 21.12 | 20.40 | 21.41 | 20.77 | 20.77 | 21.35 |
| (RESID.) | 18.37 | 19.26 | 20.04 | 18.01 | 19.49 | 18.60 | 19.30 | 18.61 | 18.33 | 18.68 | 18.79 |
| (LG) | 14.67 | 15.01 | 15.82 | 15.89 | 15.31 | 14.85 | 15.07 | 15.46 | 14.81 | 14.91 | 15.20 |
| (COAL) | 46.56 | 43.89 | 41.32 | 44.29 | 39.48 | 36.59 | 37.79 | 30.84 | 39.39 | 39.68 | 39.51 |
| (MET COAL**) | 58.90 | 56.06 | 53.30 | 56.66 | 54.43 | 57.25 | 52.73 | 59.63 | 69.80 | 73.92 | 54.95 |
| (NAPHTHA) | 18.96 | 18.96 | 18.94 | 18.81 | 18.82 | 18.56 | 18.48 | 18.67 | 18.08 | 18.08 | 18.68 |
| (NG) | 3.39 | 2.92 | 2.77 | 2.31 | 2.52 | 2.23 | 3.20 | 2.73 | 2.52 | 2.44 | 2.39 |
| TRANSPORTATION | | | | | | | | | | | |
| (ELECT.) | 42.43 | 48.63 | 42.13 | 35.26 | 36.19 | 36.29 | 40.05 | 29.30 | 38.80 | 16.91 | 45.10 |
| (DIST.) | 27.88 | 28.19 | 29.14 | 29.08 | 27.65 | 27.90 | 27.98 | 28.09 | 27.45 | 27.45 | 28.07 |
| (RESID.) | 18.37 | 19.26 | 20.04 | 18.01 | 19.49 | 18.60 | 19.30 | 18.61 | 18.33 | 18.68 | 18.30 |
| (LG) | 13.10 | 13.10 | 13.10 | 13.10 | 13.99 | 13.10 | 13.88 | 13.93 | 13.10 | 13.10 | 13.27 |
| (GASOLINE) | 31.76 | 32.92 | 31.63 | 31.19 | 31.30 | 30.07 | 30.59 | 30.83 | 31.54 | 31.61 | 31.30 |
| (JET FUEL) | 22.98 | 23.57 | 25.04 | 25.29 | 22.55 | 23.19 | 21.91 | 23.18 | 22.85 | 22.85 | 23.51 |

*LIQUID GAS IN THE RAW MATERIAL SECTOR INCLUDES LIQUID GAS FEEDSTOCK.
**MET COAL INCLUDES 70% PREMIUM COAL AND 30% BITUMINOUS LOW SULFUR COAL.
***INDUSTRIAL SECTOR HERE DOES NOT INCLUDE REFINERIES.

TABLE 4

1985 MID-RANGE/TRENDLONG SCENARIO (SERIES C)
WITH NATURAL GAS REGULATION

OIL IMPORT PRICE: 15.32
RUN DATE: 1.14

DEMAND REGION AVERAGE RETAIL PRICE SUMMARY IN 1978 $/MILLION BTUS

| SECTOR (FUEL) | DEMAND REGIONS<br>NW-ENG. | NY/NJ | MID-ATL | S.-ATL | MIDWEST | S.-WEST | CENTRAL | N-CNTRL | WEST | N.-WEST | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RESIDENTIAL | 5.11 | 5.66 | 6.14 | 7.87 | 4.56 | 5.20 | 4.41 | 4.10 | 5.59 | 4.82 | 5.39 |
| (ELECT.) | 13.33 | 15.91 | 13.39 | 11.05 | 12.00 | 11.47 | 12.70 | 9.65 | 12.66 | 5.83 | 11.71 |
| (DIST.) | 3.89 | 3.97 | 4.16 | 4.23 | 3.79 | 3.90 | 3.69 | 3.87 | 3.85 | 3.85 | 3.93 |
| (LG) | 3.90 | 4.01 | 4.32 | 4.32 | 3.99 | 3.92 | 3.91 | 4.07 | 3.94 | 3.94 | 4.04 |
| (COAL) | 2.07 | 1.95 | 1.84 | 1.97 | 1.75 | 1.63 | 1.68 | 1.37 | 1.75 | 1.76 | 1.92 |
| (NG) | 4.53 | 4.13 | 3.58 | 3.15 | 3.11 | 2.39 | 2.11 | 2.26 | 3.35 | 3.65 | 3.09 |
| COMMERCIAL | 4.78 | 6.45 | 6.45 | 6.65 | 5.15 | 6.02 | 6.05 | 5.26 | 5.85 | 4.22 | 5.35 |
| (ELECT.) | 13.22 | 17.69 | 13.31 | 11.18 | 11.98 | 11.26 | 12.43 | 8.80 | 11.71 | 5.81 | 12.01 |
| (DIST.) | 3.64 | 3.71 | 3.76 | 3.76 | 3.60 | 3.64 | 3.51 | 3.64 | 3.56 | 3.56 | 3.66 |
| (RESID.) | 2.97 | 2.96 | 3.27 | 2.90 | 3.12 | 2.97 | 3.10 | 3.01 | 2.92 | 2.85 | 2.99 |
| (LG) | 3.27 | 3.27 | 3.27 | 3.27 | 3.49 | 3.21 | 3.46 | 3.47 | 3.27 | 3.27 | 3.38 |
| (COAL) | 2.07 | 1.95 | 1.84 | 1.97 | 1.75 | 1.61 | 1.68 | 1.37 | 1.75 | 1.76 | 1.92 |
| (ASPHALT) | 3.19 | 3.18 | 3.18 | 3.17 | 3.20 | 3.13 | 3.15 | 3.19 | 3.07 | 3.07 | 3.15 |
| (NG) | 3.86 | 3.53 | 3.11 | 2.63 | 2.78 | 2.46 | 3.46 | 3.13 | 2.83 | 3.05 | 2.94 |
| RAW MATERIAL* | 3.43 | 3.35 | 3.18 | 2.92 | 3.25 | 3.27 | 3.28 | 3.20 | 3.08 | 2.92 | 3.22 |
| (LG) | 3.61 | 3.61 | 3.61 | 3.58 | 3.59 | 3.54 | 3.52 | 3.56 | 3.44 | 3.44 | 3.54 |
| (OIL) | 3.18 | 3.18 | 3.18 | 3.17 | 3.20 | 3.13 | 3.15 | 3.19 | 3.07 | 3.07 | 3.15 |
| (NG) | 3.29 | 2.83 | 2.69 | 2.19 | 2.44 | 2.16 | 3.10 | 2.65 | 2.44 | 2.37 | 2.33 |
| INDUSTRIAL*** | 4.86 | 4.54 | 3.92 | 4.98 | 3.88 | 2.98 | 4.79 | 3.16 | 3.35 | 3.28 | 3.79 |
| (ELECT.) | 10.97 | 9.47 | 10.97 | 9.40 | 9.37 | 9.57 | 10.55 | 7.30 | 9.96 | 3.86 | 9.29 |
| (DIST.) | 3.64 | 3.69 | 3.86 | 3.85 | 3.60 | 3.61 | 3.50 | 3.68 | 3.56 | 3.56 | 3.67 |
| (RESID.) | 2.92 | 3.06 | 3.19 | 2.87 | 3.10 | 2.96 | 3.07 | 2.96 | 2.92 | 2.97 | 2.99 |
| (LG) | 3.66 | 3.74 | 3.95 | 3.96 | 3.82 | 3.70 | 3.76 | 3.85 | 3.69 | 3.69 | 3.79 |
| (COAL) | 2.07 | 1.95 | 1.84 | 1.97 | 1.75 | 1.61 | 1.68 | 1.37 | 1.75 | 1.76 | 1.76 |
| (MET COAL**) | 2.18 | 2.08 | 1.97 | 2.10 | 2.02 | 2.12 | 1.95 | 2.21 | 2.59 | 2.70 | 2.03 |
| (NAPHTHA) | 3.61 | 3.61 | 3.61 | 3.58 | 3.59 | 3.54 | 3.52 | 3.56 | 3.44 | 3.44 | 3.56 |
| (NG) | 3.29 | 2.83 | 2.69 | 2.24 | 2.44 | 2.16 | 3.10 | 2.65 | 2.44 | 2.37 | 2.31 |
| TRANSPORTATION | 5.74 | 5.79 | 5.67 | 5.63 | 5.67 | 5.22 | 5.52 | 5.49 | 5.38 | 5.42 | 5.55 |
| (ELECT.) | 12.44 | 14.25 | 12.35 | 10.33 | 10.61 | 10.64 | 11.74 | 8.59 | 11.37 | 4.96 | 13.22 |
| (DIST.) | 4.79 | 4.84 | 5.00 | 4.99 | 4.75 | 4.77 | 4.65 | 4.82 | 4.71 | 4.71 | 4.82 |
| (RESID.) | 2.92 | 3.06 | 3.19 | 2.97 | 3.10 | 2.96 | 3.07 | 2.96 | 2.92 | 2.97 | 2.99 |
| (LG) | 3.27 | 3.27 | 3.27 | 3.27 | 3.49 | 3.21 | 3.46 | 3.47 | 3.27 | 3.27 | 3.31 |
| (GASOLINE) | 6.05 | 6.27 | 6.03 | 5.94 | 5.96 | 5.73 | 5.83 | 5.87 | 6.01 | 6.02 | 5.96 |
| (JET FUEL) | 4.12 | 4.23 | 4.49 | 4.54 | 4.05 | 4.16 | 3.93 | 4.16 | 4.10 | 4.10 | 4.22 |
| AVERAGE PRICE | 5.16 | 5.62 | 5.08 | 5.76 | 4.67 | 3.93 | 5.01 | 4.40 | 5.11 | 4.42 | 4.82 |

*LIQUID GAS IN THE RAW MATERIAL SECTOR INCLUDES LIQUID GAS FEEDSTOCK.
**MET COAL INCLUDES 70% PREMIUM COAL AND 30% BITUMINOUS LOW SULFUR COAL.
***INDUSTRIAL SECTOR HERE DOES NOT INCLUDE REFINERIES.



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