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ABSTRACT

This handbook is designed to help teachers, supervisors, club leaders, and in-service directors lead workshops in energy education. It is based primarily on materials produced by Project for an Energy-Enriched Curriculum (PEEC), but can be modified for use with other materials. The handbook contains six chapters including: (1) Introducing the PEEC Packets: (2) What Are the Facts Behind the Energy Crisis: (3) Interdisciplinary Approaches to Teaching Energy: (4) Infusing Energy Topics into Traditional Subjects: (5) Adapting PEEC Materials to Regional Interests: and (6) Workshop Planning Aids. (Author/RE)

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Energy Education Workshop Handbook

A Guide to Materials by the Project for an Energy-Enriched Curriculum

Prepared by
National Science Teachers Association

For U.S. Department of Energy

Office of Education, Business and Labor Affairs
Washington, D.C. 20585

Under Contract No. EX-76-C-10-3841

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Copies of this handbook may be obtained from:

U.S. Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830

Energy Education Workshop Handbook

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Foreword

The National Science Teachers Association (NSTA) has, with support from the Department of Energy (DOE) and with the help of many teachers from all over the country, built up a wide offering on energy/environment/economics issues. These materials are designed to fit into the existing curriculum and to enable teachers to accomplish traditional tasks and teach about these important problems at the same time.

Materials, of course, are not enough. We must get them to the teachers, and, more importantly, convince teachers that they can use them. This calls for workshops, and lots of workshops. Our hope is that this handbook for workshop leaders will amplify this effort.

If you have ideas that will improve the handbook or the materials, please let us hear from you.

We hope workshop leaders will use this handbook to help teachers in all grade levels and teaching areas take on the crucial task of preparing a generation of students for the great transition the world must make from inexpensive and abundant fuels to new forms of, and attitudes about, energy. It is one of the most important challenges that education will face in our lifetime.

John M. Fowler

John M. Fowler
Project Director
Project for an Energy-Enriched Curriculum

NSTA
1742 Connecticut Avenue, NW
Washington, D.C. 20009

Contents

Organization of this Handbook

This handbook is designed to help teachers, supervisors, club leaders, and in-service directors lead workshops in energy education. It is based primarily on the materials produced by the Project for an Energy-Enriched Curriculum (PEEC) but can be modified for use with other materials.

PEEC produces these interdisciplinary materials on energy, the environment and economics under a contract from the U.S. Department of Energy.

The handbook consists of six chapters:

Chapter 1	Step-by-step methods for introducing PEEC instructional materials to workshop participants.
Chapter 2	A complete lesson from one of the PEEC packets, <u>Energy Policy: Which Direction?</u> This shows a complete lesson and will familiarize workshop participants with the current situation.
Chapter 3	Two models for organizing workshops on the interdisciplinary nature of energy.
Chapter 4	Four models for organizing a workshop on infusing energy topics into traditional teaching areas.
Chapter 5	A model for organizing a workshop on regionalizing existing lessons in the PEEC packets.
Chapter 6	Workshop planning aids, including a form for workshop evaluation and a checklist for setting up your workshop.

For a successful workshop, you will probably want to focus on a unifying theme. Chapters 3,4 and 5 present workshop models based on three themes: interdisciplinary approaches to teaching energy; infusing energy topics into traditional areas; and regionalizing energy education materials.

The workshop models include flow charts, suggested time allotments and masters for handouts or for transparencies for an overhead projector. Masters for handouts and transparencies are located at the end of each chapter.

1 Introducing the PEEC Packets

This chapter presents several ways of introducing the PEEC packets to workshop participants. The preview of the curriculum units should take about one hour. There are also two ideas for involving groups in lesson reviews. Each of these takes about an hour.

At the end of the chapter are masters for handouts and transparencies.

The material in this chapter could constitute a single workshop, or work as an introduction to a full-day workshop.

Transparency 1a
Handout 1a

Show transparency of packet titles. Then distribute copies of brief descriptions of each. Mention that the NSTA-PEEC materials are being printed and distributed free of charge by the U.S. Department of Energy. Point out address where teachers are encouraged to write for these materials.

10 minutes

Contents

1. Each packet is organized into clearly structured divisions. There is a Teacher's Manual containing special teaching information and techniques for each lesson and a Student Guide which provides the materials students will need to perform each activity.

2. The Teacher's Manual appears in the front of each packet. The materials in the Student Guide may be easily duplicated for distribution to students.

3. Each packet is a unit. Following a general introduction, the unit is divided into lessons, each built around a related energy concept.

Show transparency of a sample page. Each lesson has a simple structure. A concise overview precedes each lesson. Following the overview are these teaching aids:

Transparency 1b

suggested time allotment

specific learning objectives

background information for the teacher, where necessary

a list of materials needed for student activities

suggested teaching strategies

suggestions for extending the learning beyond the classroom

20 minutes

All lessons include activities and questions that involve the student in acquiring and processing information as well as reinforcing the basic skills in reading, listening, writing and working with numbers.

We suggest you have teachers look at the titles and lesson overviews for the variety of student-centered lessons.

Activities generally accommodate the wide range of individual abilities found in most classrooms.

Activities generally involve critical thinking. The student learns to weigh evidence, make choices among alternatives, predict trends and evaluate consequences. Presented with a range of choices, the student gains power in learning how to learn.

Most student activities require a large amount of student participation, with the teacher's role being that of facilitator. All of the activities can be modified and adapted to meet individual student needs.

10 minutes to half hour.

Important concepts are introduced and developed in each lesson.

To help students understand these concepts, most packets provide teaching lessons for both science and social studies classes.

More about the lesson

PEEC presents these concepts in ways that will help students think about the energy information put before them.

The major energy concepts may be summarized under the following general headings:

Handout 1a

You may wish to distribute copies of the complete list at this time.

1. ENERGY IS A BASIC NEED
2. ENERGY USEFULNESS IS FINITE
3. ENERGY AND THE ENVIRONMENT ARE INTERRELATED
4. ENERGY USE AFFECTS SOCIETY
5. ENERGY AND POLITICS ARE CLOSELY LINKED
6. WHAT IS IN THE FUTURE FOR ENERGY?

Working with Concepts

Handout 1b

10 minutes

Distribute copies of the complete list of major energy concepts to group participants.

Ask teachers to think of some examples of lessons or activities students particularly like doing.

20 minutes

Divide the group into "curriculum design" committees of two or three teachers each. Have the committee choose an energy concept and tailor activities to it.

20 minutes

Conclude with a short report period.

Working with Skill Development

10 minutes

This is a variation of the idea above. Instead of identifying activities that support the teaching of particular concepts, you will ask teachers to identify the study skill emphasis in one or more of the lessons in a PEEC packet.

Handout 1c

20 minutes

Distribute duplicated copies of the list of skills essential to every student's education to workshop participants. Then divide the group into "skill search" committees of two or three teachers each. Ask each committee to identify specific pages where skills are introduced or practiced in the lessons of a specific packet. Have teachers write the page numbers of the lessons beside the appropriate skill on the skills list.

20 minutes

Conclude with a short report period. Discuss the significance of skills development, and how energy as a topic can help students gain skill competency.

PROJECT FOR AN ENERGY-ENRICHED CURRICULUM

Packet Titles:

How a Bill Becomes a Law to Conserve Energy
Agriculture, Energy, and Society
Energy, Engines, and the Industrial Revolution
Transportation and the City
The Energy We Use
Community Workers and the Energy They Use
Energy and Transportation
Mathematics in Energy
U.S. Energy Policy — Which Direction?
Energy Transitions in United States History
Networks: How Energy Links People, Goods and Services
Bringing Energy to the People: Ghana and the U.S.
Energy in the Global Marketplace
Two Energy Gulfs
We :ern Coal: Boom or Bust?

Write to:

U.S. Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830

National Science Teachers Association
1742 Connecticut Avenue, N.W.
Washington, D.C. 20009

2. Energy Converts to ... What? And ... Why?

Overview

One very important property of energy is that almost any form of energy can be converted into almost any other form. Changes in energy are most useful when controlled. Mastery of energy has been the key to technological progress; it is what made the Industrial Revolution possible. Unwise use of energy might be the key to humankind's destruction.

The automobile, being familiar to all, is a good example of a way in which changes in energy have been controlled and used.

Objectives

The student should be able to:

1. Describe the energy conversions that take place in an automobile.
2. Demonstrate how stored chemical energy can be converted to heat energy.
3. Demonstrate that heat energy can be converted into mechanical energy.
4. Give examples of energy conversions, using everyday things around them.

Time Allotment

Two - three class periods

Materials

Parts 3 and 4 of this lesson will need some special materials. A list can be found at the beginning of each of these parts.
Ditto copies of "Energy Conversion: A Fact Sheet."
Ditto copies of "Tracing the Energy Conversions in an Automobile."

Teaching Strategies

Ask students when they last used energy. Do they have any idea how energy is used? Is energy heat, light, electricity, magnetism? What is energy anyway? *(The ability to produce heat, light, or to do work.)* What has to happen before energy can be used to do work? *(It often has to be changed into another form.)*

This sample page is taken from the packet, Energy, Engines, and the Industrial Revolution, for grades 8 and 9.

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Free Classroom Materials on Energy

The instructional packets described below are available free from:

U.S. Department of Energy
Technical Information Center
Box 62
Oak Ridge, Tennessee 37830

Please use the Stock Number, where indicated, when ordering.

<u>The Energy We Use</u>
<u>Grades 1,2</u>

An introduction to energy that begins with student recognition of common energy forms, and progresses through important energy sources such as the sun, wind, water, and fossil fuels.
Stock No. EDM-1029

<u>Community Workers and the Energy They Use</u>
<u>Grades 2,3</u>

This unit highlights "helpers" such as the oil deliverer, the gas station attendant and the meter reader, who are all involved in the delivery of energy, as well as the farmer and the baker whose jobs are closely linked to energy.
Stock No. EDM-1030

<u>Energy and Transportation</u>
<u>Grades 3,4,5</u>

Using classification activities, picture studies, and other development approaches, students learn about transportation in the neighborhood, community, and nation.
Stock No. HCP/U 3841-001

<u>Networks: How Energy Links People, Goods, and Services</u>
<u>Grades 4,5</u>

Lessons include making models of electrical systems and naming the interacting parts. In such lessons as "The Electrical Energy System in a City," students learn about the importance of systems and how we depend on the electrical systems in our community.

<u>Two Energy Gulfs</u>
<u>Grades 6,7</u>

A comparative case study of the energy potentials in the Gulf of Mexico and the Persian Gulf. Considers geography, geology, climate, and production technology, as well as the effects of oil production on the cultures of the two regions.

Bringing Energy to the People: Ghana and the U.S.
Grades 6,7

Comparing the energy uses in Ghana and its capital city, Accra, with the Washington, D.C. metropolitan area, this unit considers energy as a basic need in terms of climate, location, existing and planned power sources, transportation systems, and life styles.

Mathematics in Energy
Grades 7,8

Middle school students deal with a wide range of energy problems through the use of basic mathematical processes. Included are fractions, decimals, graphs, conversions, statistics, and the manipulation of energy units such as watts, calories, and joules.
Stock No. HCP/U 3841-002

Transportation and the City
Grades 8,9

Relates transportation to energy use. Social studies lessons deal with transportation systems and concepts of efficiency, and with the effects of the automobile on the urban community. Science lessons apply supply and demand calculations to oil resources and present some simple experiments which anticipate new transportation technology.
Stock No. EDM-1031

Energy Transitions in United States History
Grades 8,9

Charts the growth of American energy use and traces the history of the major sources of energy in the U.S. Examines the past interactions between man as an energy user and his environment, and investigates the future of alternative energy technologies.
Stock No. HCP/U 3841-004

Energy, Engines, and the Industrial Revolution
Grades 8,9

A natural theme at the junior high level where the Industrial Revolution is an important topic in U.S. history and World Geography courses. The social studies lessons focus on the relation of energy sources to the growth of cities and industry, inventors and inventions, and the effects of the Industrial Revolution on cities and people. Science lessons are concerned with energy sources and energy conversions, with special attention to the heat engine.
Stock No. EDM-1032

Energy in the Global Marketplace
Grades 9,10,11

Explores the role of energy in world trade and in the global balance of power. Examines the major energy "haves" and "have-nots," and investigates the process by which energy prices are determined.

How a Bill Becomes a Law to Conserve Energy
Grades 9,11,12

Activities focus on the legislative process and include a fabricated Citizen's Band (C.B.) radio conversation, a simulated congressional hearing on the 55 MPH speed limit bill, adapted from the actual hearing record, and exercises in graph construction and interpretation.
Stock No. EDM-1033

Agriculture, Energy, and Society
Grades 10,11,12

Based on the conviction that an energy/food production crisis of serious dimensions is already with us, and that students need to understand this problem in order to contribute to its solution. Lessons present basic energy-economics facts of food production and social studies themes such as profit and loss, and the law of diminishing returns. Science lessons build skills in data analysis, graph interpretation, and an understanding of energy units and their conversions.
Stock No. EDM-1034

Western Coal: Boom or Bust?
Grade 11

Investigates energy resources in the West and studies the effects of possible large-scale resource development on the economy, environment, and social structure of the Western United States.

U.S. Energy Policy - Which Direction?
Grades 11,12

Designed as a companion to the unit, "How a Bill Becomes a Law to Conserve Energy," which studies the workings of the legislative branch, this unit concentrates on the administrative arm of government and the various forces that go into formulating a national policy.
Stock No. HCP/U 3841-003

OTHER FREE ENERGY EDUCATION MATERIALS

Available from the National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, D.C. 20009:

Energy & Education

In October 1977, Energy & Education was published in response to the communication needs of the growing number of teachers and administrators involved in energy education. A bi-monthly newsletter designed to serve as an information exchange medium, Energy & Education is available free of charge from NSTA.

19 Factsheets on Alternate Energy Technologies

Available from the Department of Energy Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830.

Factsheet Number	Title
1	Fuels from Plants (Bioconversion)
2	Fuels from Wastes (Bioconversion)
3	Wind Power
4	Electricity from the Sun I (Solar Photovoltaic Energy)
5	Electricity from the Sun II (Solar Thermal Energy Conversion)
6	Solar Sea Power (Ocean Thermal Energy Conversion)
7	Solar Heating and Cooling
8	Geothermal Energy
9	Energy Conservation: Homes and Buildings
10	Energy Conservation: Industry
11	Energy Conservation: Transportation
12	Conventional Reactors
13	Breeder Reactors
14	Nuclear Fusion
15	New Fuels from Coal
16	Energy Storage Technology
17	Alternative Energy Sources: Environmental Impacts
18	Alternative Energy Sources: A Glossary of Terms
19	Alternative Energy Sources: A Bibliography

Major Concepts for Energy/Environment/Economics Education

I. Energy: A Basic Need

A. Forms and States

1. Heat, light, motion
2. Potential, kinetic

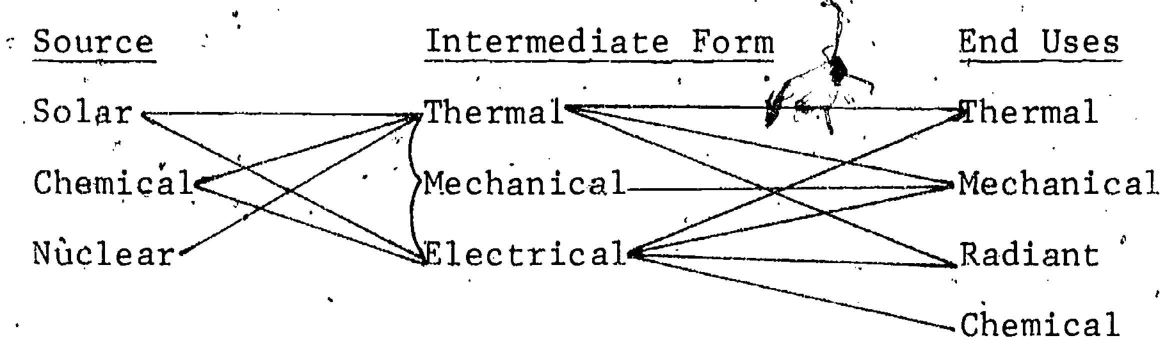
B. Earth's Energy

1. Solar
2. Chemical (electrical)
3. Nuclear
4. Geothermal
5. Tidal

C. Power and Energy Units

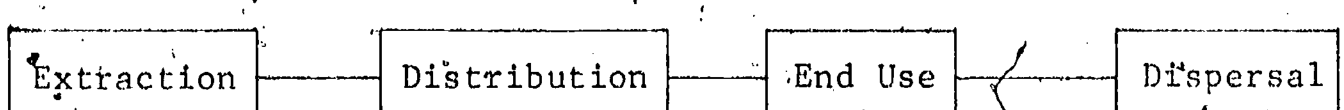
D. "Used" by Conversion

1. Important conversion processes:



E. Energy Flows

1. To earth
2. In biological systems
3. In society
4. An abstract flow diagram for energy



II. Finite Usefulness

A. Losses and Efficiency (First Law)

B. Loss of Usefulness (Second Law)

C. Resources Vary in Amount and Usefulness

1. Depletable resources (fossil fuels, inexpensive uranium, etc.)

2. Continuous or inexhaustible resources (solar, fission with breeder, fusion, etc.)

D. Energy Consumption

1. Direct and indirect

2. U.S. and world.

E. Causes of Growth

III. Environmental Effects

A. Extraction

1. Mining

2. Oil production

3. General land use

B. Transportation and Distribution

1. Oil spills

2. Pipelines

3. Electrical transmission

4. Nuclear fuels and waste

5. Liquified natural gas

C. Consumption

1. Air pollution

2. Water

3. Waste disposal

4. Climatic effects

IV. Societal Effects

A. Economic

1. Capital as resource
2. Effects of energy prices (effects on inflation, etc.)

B. Lifestyle

C. Employment

1. Energy and employment
2. Energy-related careers

D. International Relations

1. Oil politics
2. Trade deficits

E. Energy Inequities

1. National
2. International

V. Energy Policy

A. Roles

1. Federal
2. State and local
3. Private sector
4. Public interest groups
5. Linkages

B. Cost/Benefit Considerations

1. Environmental
2. Risk reduction
3. Ethical considerations

C. Conservation

1. Strategies -- building sector
2. Strategies -- transportation
3. Strategies -- industry
4. Conservation policy

VI. Energy Futures

A. Mid Term

1. Conservation technologies
2. Transition technologies

B. Long Term

1. Fission
2. Fusion
3. Solar
4. "Appropriate technology"

C. Socio/economic/environmental futures

1. Risks, costs, and benefits
2. Changes in social structure

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Student Skill Development in Energy Education

Specific Social Studies Skills in:

I. Acquiring and Reporting Information from:

A. Books, Encyclopedias, Newspapers and Magazines

1. Find information
2. Choose an appropriate magazine for a particular purpose
3. Read between the lines of an advertisement

B. Interviews, Surveys, Field Trips

1. Collect specific information from observation and listening
2. Record and summarize information
3. Design questions appropriate for a particular field study, interview, or survey

C. Maps and Globes

1. Interpret map-key symbols
2. Locate places and routes
3. Use the location of a place on one map to find the location of the same place on another map
4. Identify real things (oil, gas, coal, cities, development sites, etc.) represented by map symbols
5. Make inferences from maps:

   a. about human activities
   b. about land use
   c. to explain geographic factors in the location of energy sources

D. Graphs, Charts, and Tables

1. Use the title as a guide to content
2. Determine numerical amounts shown on graphs, charts, and tables
3. Interpret relationships shown in graphs, charts, and tables
4. Make inferences from graphs, charts, and tables
5. Construct graphs (bar, circle, line pictograph)
6. Compare and contrast data contained in different types of graphs

1c

II. Organizing Information

A. Take Notes and Record Observations

B. Classify Data

C. Summarize Main Points of Information Gathered in Research

III. Weighing Information

A. Distinguish between:

1. Fact and opinion
2. Hypothesis and a guess
3. Primary and secondary sources

B. Examine evidence for:

1. Accuracy and consistency
2. Reliability of a source
3. Adequacy and relevance

IV. Communicating in Writing

V. Communicating Orally

A. Participate in Group Discussions

B. Participate in Simulations, Role-Playing, Debates, Etc.

C. Prepare an Oral Report

Specific Science Skills in:

I. Acquiring and Reporting Information by:

A. Observing

B. Ordering Observations

C. Exploring

D. Devising Experiments

E. Systematic Recording

F. Classifying

G. Using Numbers

H. Measuring

I. Controlling Variables

J. Determining Space-Time Relationships

II. Processing Information by Developing Increasing Competency in:

A. Comparing

B. Predicting

C. Inferring

D. Using deduction

E. Analyzing

F. Synthesizing

G. Comparing

H. Formulating and Hypothesizing

I. Communicating Results of Observations and Experiments

Getting Involved in Energy Education

DIRECTIONS: Give your name, school, grade level you teach, addresses, and phone numbers to the workshop leader if you would like any or all of the following. The leader will send your requests on to NSTA.

____________________ Your Name

____________________ Grade Level/Course

____

____________________ Home Address

____

____________________ School Address

____________________ Home Phone

____________________ School Phone

__________ I would like to be placed on the mailing list to receive the free newsletter, <u>Energy & Education</u>.

__________ I would like to serve as a test teacher for newly developed teaching units.

I would like to teach one or more of the existing PEEC packets. Please send me:

____

____

____

____

2 What Are the Facts Behind the Energy Crisis?

This chapter is designed to do two things: 1) to give workshop participants a balanced view of the complicated situation called the "energy crisis" and 2) to introduce a complete lesson from one of the PEEC packets. The presentation should take about one hour.

At the end of the chapter are figures and tables taken from the PEEC packet, U.S. Energy Policy: Which Direction? (grades 11 and 12). These figures and tables may be duplicated and distributed, or presented on an overhead projector.

The chapter also includes a reprint of an article by Dr. John M. Fowler, (Project Director of PEEC), published in the March 1978 issue of Science and Children. The article, "Energy: Present Problems and Future Potential," covers the current energy situation and discusses the role energy education must play in the future. This article may be duplicated and sent to participants prior to the workshop.

Participants will learn these things:

The Energy Production - Consumption Balance
How Long Will Our Resources Last?

Begin by telling participants that the graphs are part of an energy lesson from one of the PEEC packets. In this lesson students gain a balanced view of the complicated situation we call the "energy crisis." It is made up of financial and political components as well as components having to do with the quality and quantity of energy.

Figures 1, 2 and 3

What is the common feature of all these curves?

(They are all increasing.)

Figure 1

Is there a way to measure the rate of increase? What does doubling time mean?

(Point out that a straight line would pass through two points in the curve between 1960 and 1970; then, extend it in either direction until it covers a doubling of the total consumption.)

Approximately how many years were required for total energy consumption to double?

(20 years.)

At the rate of population growth between 1960 and 1970, how long will it take the U.S. population to double?

(Approximately 44 years.)

Figure 2

During what years did we produce about as much energy as we used?

(1950 through 1956.)

During what years did U.S. consumption of energy drop? Can you give a reason for this?

Figure 4

(1974, 1975. This drop followed the oil embargo with its emphasis on conservation, and more importantly, coincided with large price increases in all forms of energy.)

Which is larger now -- U.S. consumption or production of energy?

(Consumption.)

For which year was the gap between consumption and production the greatest?

(1977.)

Figure 3

Using the technique for figuring doubling time, find the doubling time for world energy consumption growth between 1960 and 1970.

(Approximately 14 years.)

Which were growing most rapidly over the 1960-1970 period -- U.S. or world energy consumption? U.S. or world population?

(U.S. energy consumption. World population doubling time is 34 years. In the U.S. it is 44 years.)

Figure 4

Which energy price has changed the most over this time period?

(Fuel oil. Price has increased by a factor of 3.)

Which energy prices actually fell for part of this period?

(Electricity, natural gas, and gasoline.)

Which energy price showed the greatest change in any one year? Can you give a reason?

(Gasoline, in 1973, due to the price increase and the oil embargo.)

Figure 5

During which years was the increase in the price of oil the greatest?

(Between 1972 and 1974.)

How has the price of oil affected the U.S. economy?

(All energy prices have increased, and since all products use energy, this has contributed to inflation. The fact that we are sending billions of dollars abroad has also reduced employment opportunities in this country.)

Figures 6a, b, and c

What U.S. energy gap is illustrated by these graphs?

(Gap between U.S. energy consumption and production. Though we actually produce more coal than we use, we are producing less and less oil and natural gas while using more and more.)

Table I

At the 1977 rates of consumption how long will each of these resources last?

(Coal: 1977 consumption 625.8 million tons, total resources 437 billion tons, coal will last 698 years.

Oil: 1977 consumption 6.7 billion barrels, total resources 276-440 billion barrels, oil will last 41-66 years.

Gas: 1977 consumption 19.2 trillion cubic feet, total resources 891-1290 trillion cubic feet; gas will last 46-67 years.)

Table I and Figure 1

Suppose we received all of our energy from coal. How long would our coal supply last?

(437×10^9 tons of coal $\times$ 24.2×10^9 joules/ton = 10,580 EJ. U.S. energy consumption in 1977 was 80.0 EJ. Coal reserves would last 10,580/80 = 132 years.)

Figure 7

These data are from 1976, but do not change very much from year to year.

How much of our energy comes from fossil fuels?

(92%. Most of this is from oil and natural gas.)

But we saw that our production of oil and natural gas is declining. Where are we getting the fuel we need?

(We import it. We are importing almost half our crude oil and oil products.)

Figure 8

Where does our imported oil come from?

(A large fraction comes from OPEC--Organization of Petroleum Exporting Countries.)

Consider these two facts: (1) Oil makes up almost half of the total energy we use; and (2) we import almost half of our oil. Taken together, what do these facts imply?

(Our economy and our national security can be influenced by other nations.)

Adjust your session so that no matter what happens you have time to discuss the following questions. Answers may be recorded on chalkboard or butcher paper.

1. What did we find out about the "energy crisis" from our investigation with graphs and tables in this session?

2. How can we summarize in one or two generalizations our investigation and discussion?

Note: It is important to keep these questions open-ended because people may look at them from different viewpoints.

3. What do we do now? What are some ways we can begin to reduce growth, especially in terms of Earth's finite resources?

4. What part can education play in helping people understand the need to conserve energy?

Table I U.S. Fossil Fuel Resources

Fuel	Amount in Indicated Units[1]	Energy Content (in EJ)[2]
Coal	437 B tons[3]	10,580
Oil	276-440 B bbls	1684-2684
Natural Gas	891-1291 Tcf	962-1394

[1] Btons = billion tons

Bbbls = billion barrels

Tcf = trillion cubic feet

[2] Conversions are 1 ton of coal =

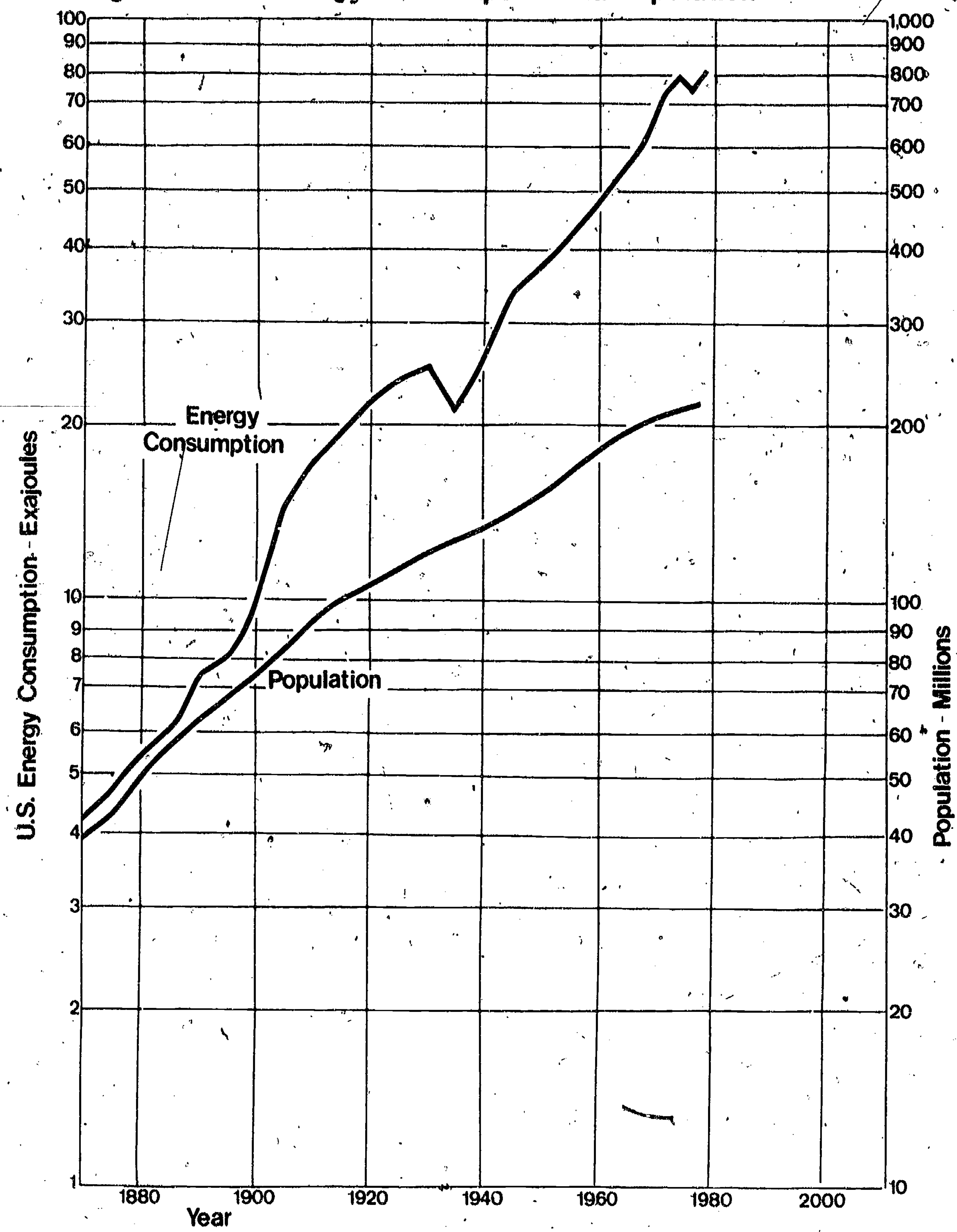
24.2×10^9 joules or 22.9×10^6 Btu

1 bbl of oil = 6.1×10^9 joules or 5.8×10^6 Btu

1 cf of natural gas = 1.08×10^6 joules or 1020 Btu

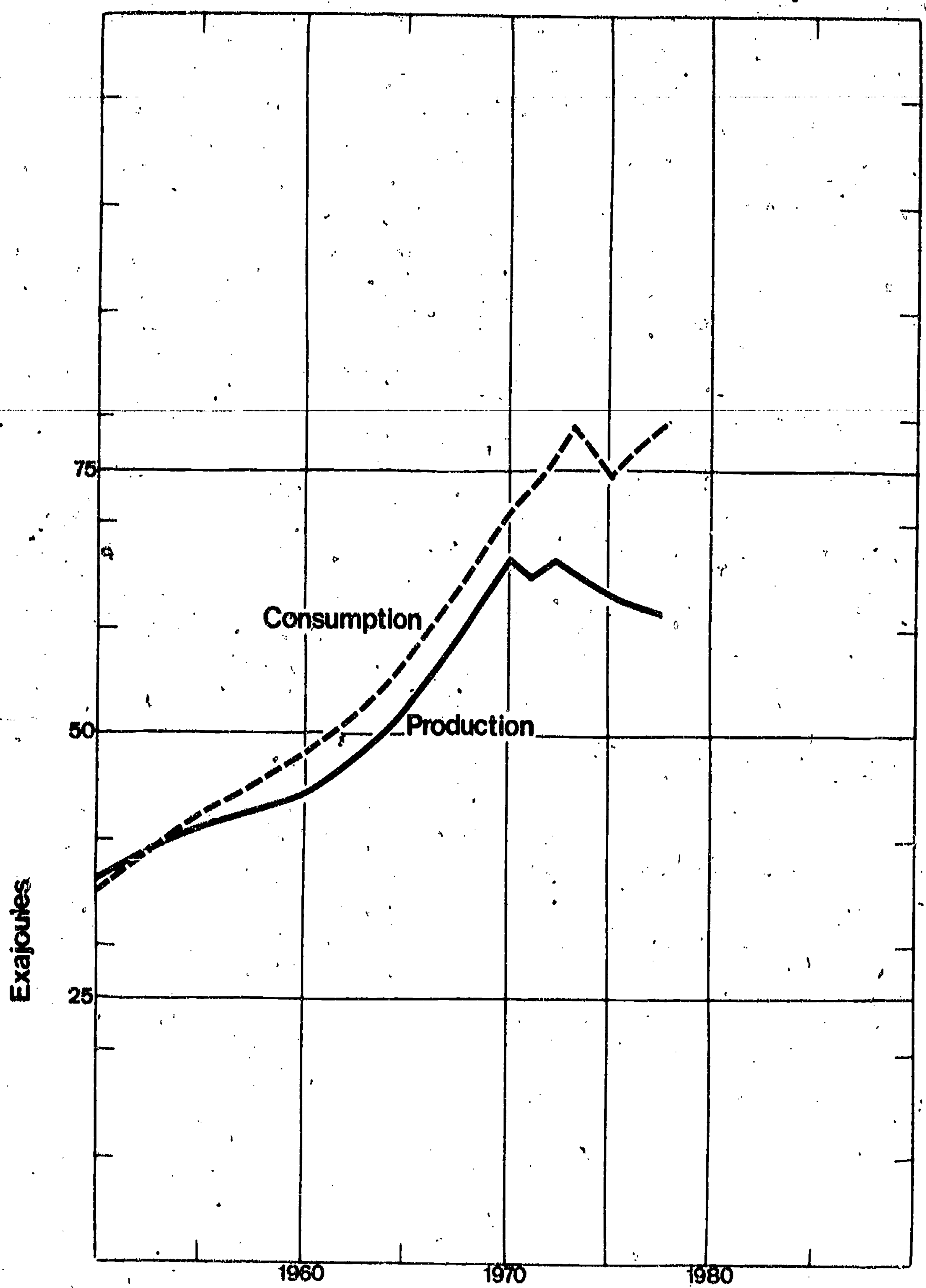
[3] This is actually a "Reserve" figure. Coal deposits are much better known than are oil and natural gas deposits.

Figure 1 U.S. Energy Consumption and Population



Data from: Schurr and Netschert. Energy in the American Economy. (Baltimore: Johns Hopkins University Press) 1960.
Statistical Abstract of the United States, 1976. Bureau of Census (Washington, DC: Department of Commerce) 1976.
Monthly Energy Review. (Washington, DC: Department of Energy) 1978.

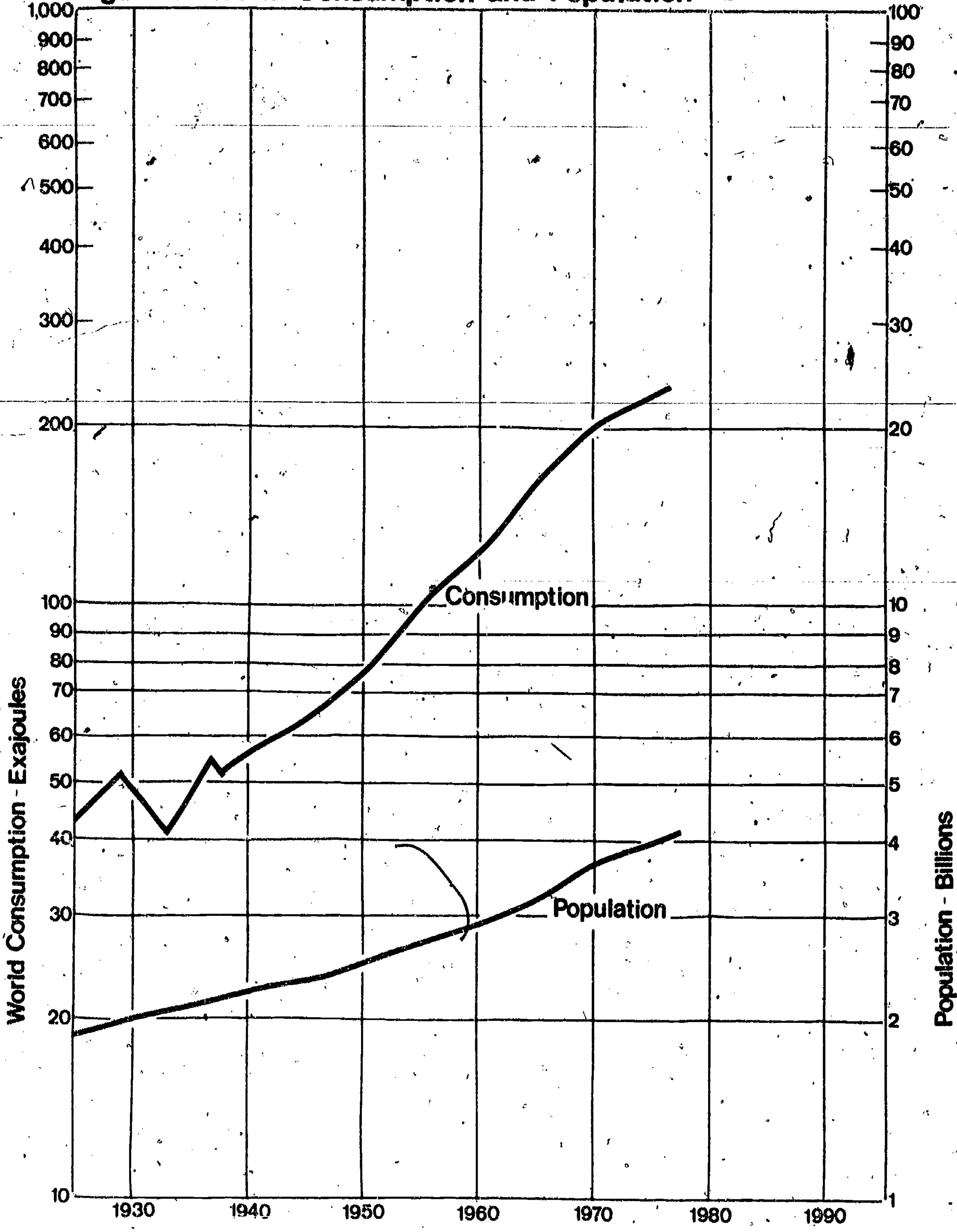
Figure 2 - U.S. Energy Production and Consumption



Data from: Energy in Focus: Basic Data. (Washington, DC: Federal Energy Administration) 1977.

Monthly Energy Review. (Washington, DC: Department of Energy) 1978.

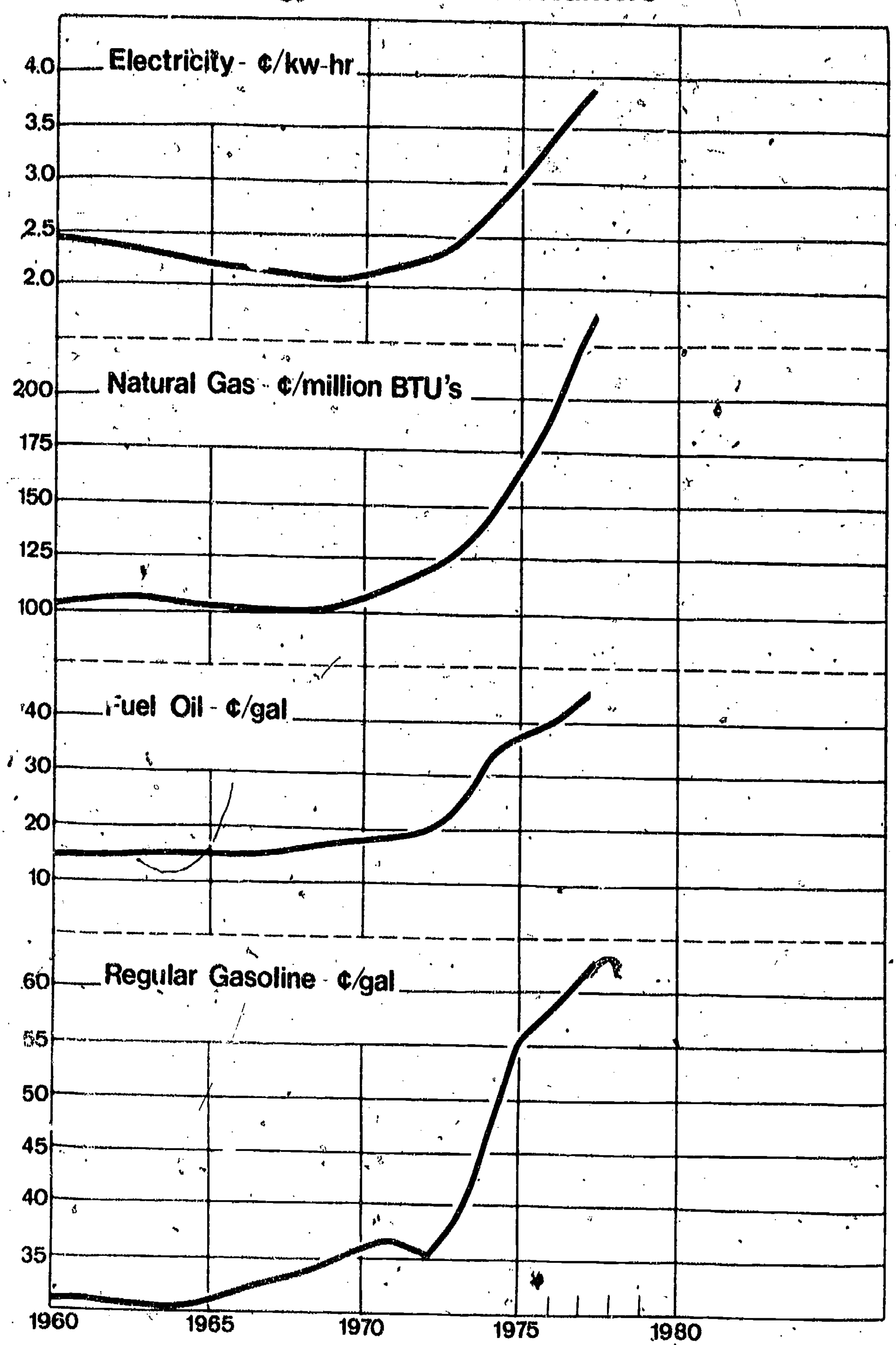
Figure 3 - World Consumption and Population



Data from: Statistical Abstract of the United States, 1976. Bureau of Census (Washington, DC: Department of Commerce) 1976.

World Energy Supplies: 1950-1974. Statistical Paper, Series J, #19 (New York: United Nations) 1975.

Figure 4 - Energy Prices to Consumers



Data from: Statistical Yearbook. (New York: Edison Electric Institute) 1974.

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"Retail Prices and Indexes of Fuels and Electricity." Bureau of Labor Statistics (Washington, DC: Department of Labor) 1960-73.

United States Petroleum Statistics, 1974. (Washington, DC: Independent Petroleum Association of America) 1974.

Monthly Energy Review. (Washington, DC: Department of Energy) 1978.

Figure 5 - Persian Gulf Oil Prices

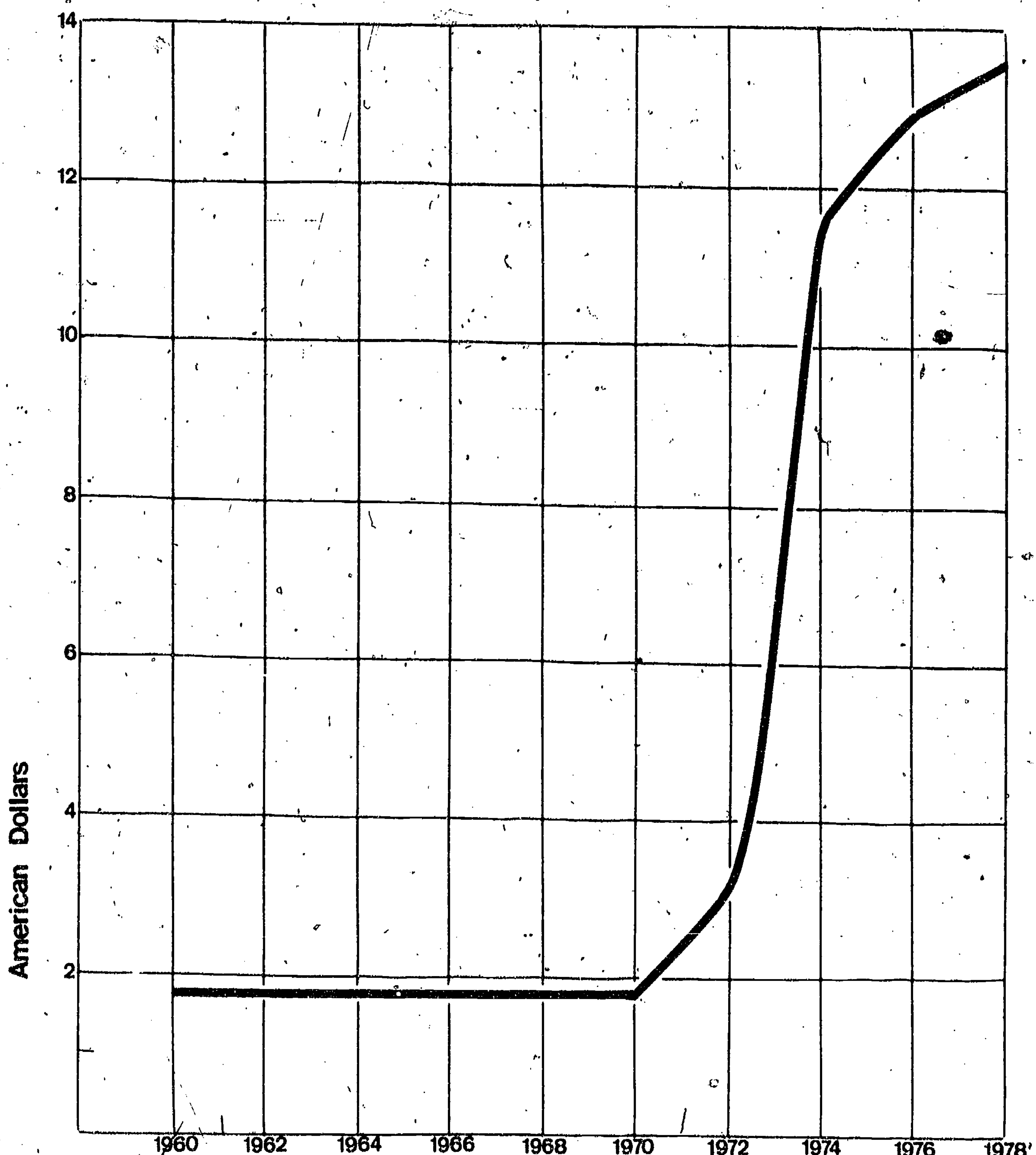
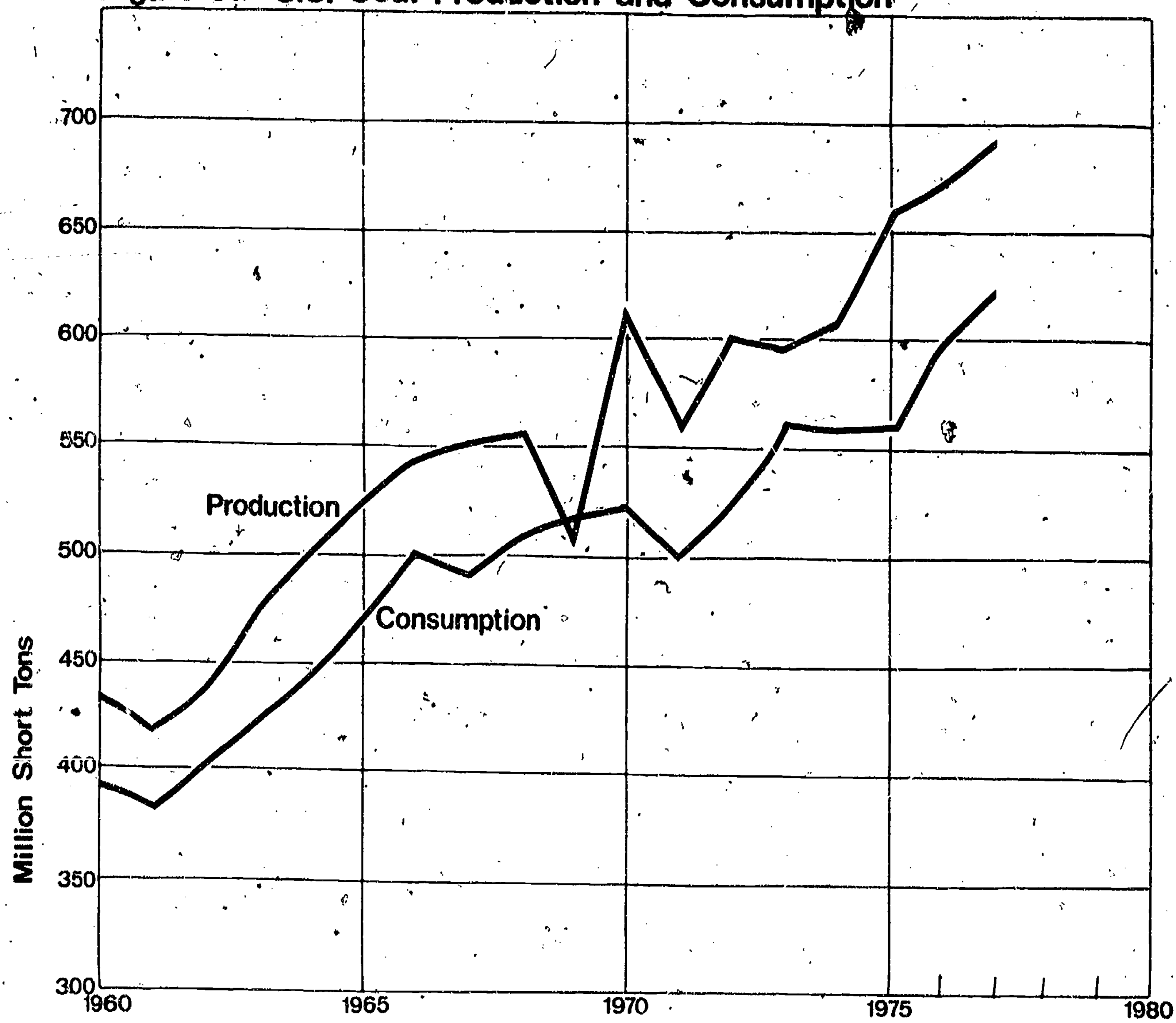


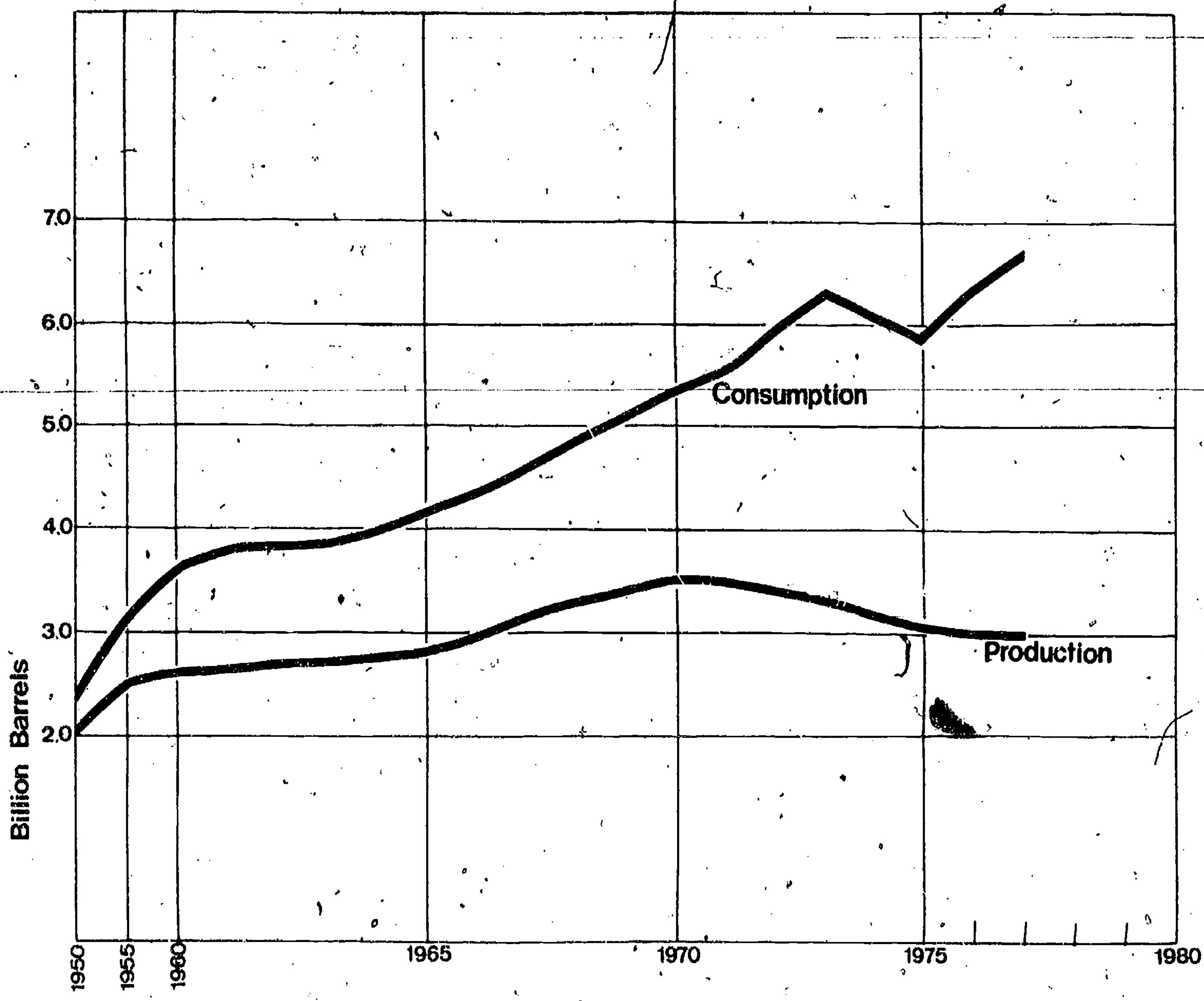
Figure 6a - U.S. Coal Production and Consumption



Data from: Energy in Focus: Basic Data. (Washington, DC: Federal Energy Administration) 1977.

Monthly Energy Review. (Washington, DC: Department of Energy) 1978.

Figure 6b - U.S. Oil Production and Consumption



Data from: Energy in Focus: Basic Data. (Washington, DC: Federal Energy Administration) 1977.

Monthly Energy Review. (Washington, DC: Department of Energy) 1978.

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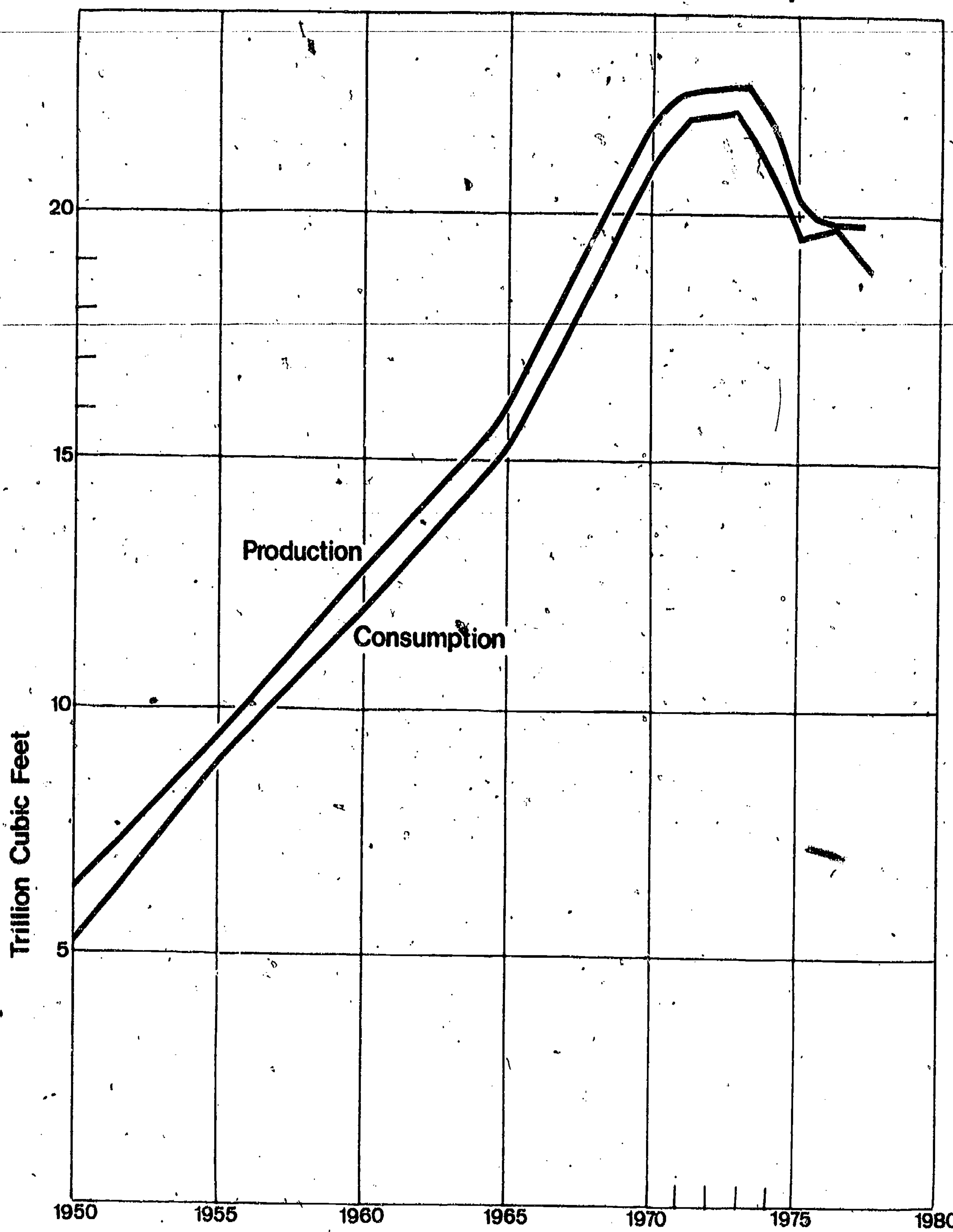
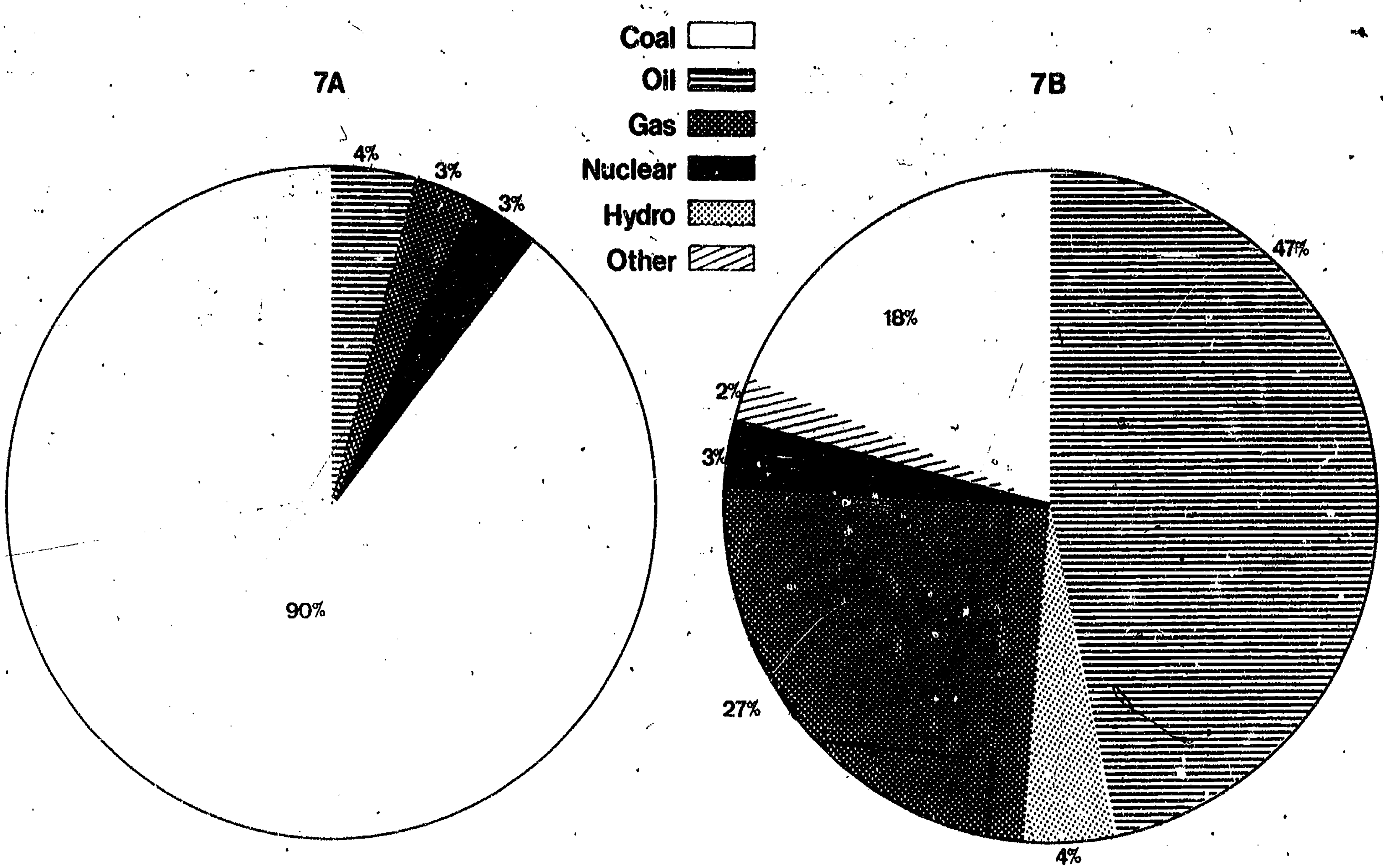
Figure 6c - U.S. Natural Gas Production & Consumption



Data from: Energy in Focus: Basic Data. (Washington, DC: Federal Energy Administration) 1977.

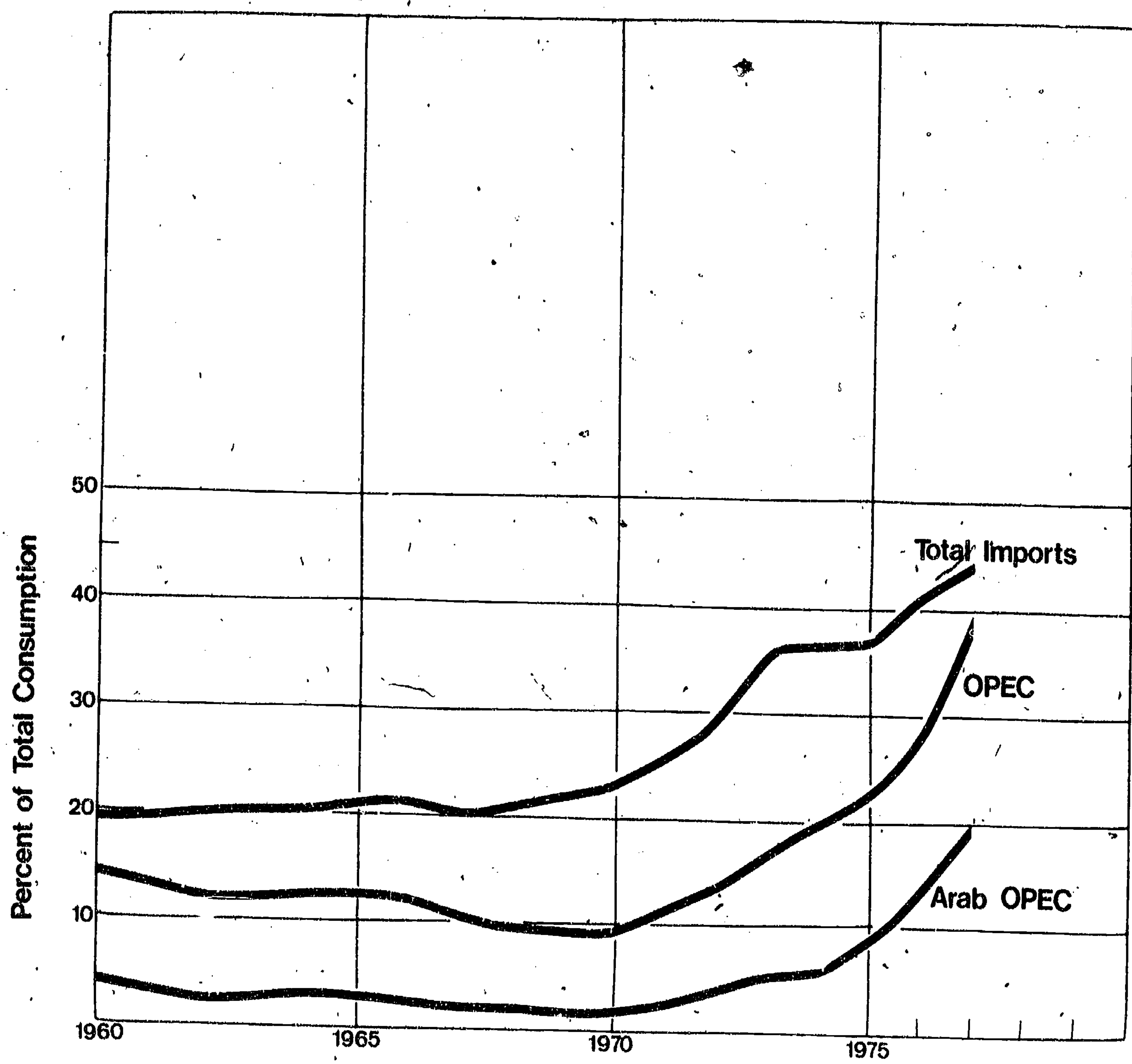
Figure 7 - Energy Outlook



Proved Reserves Economically Recoverable With Existing Technology

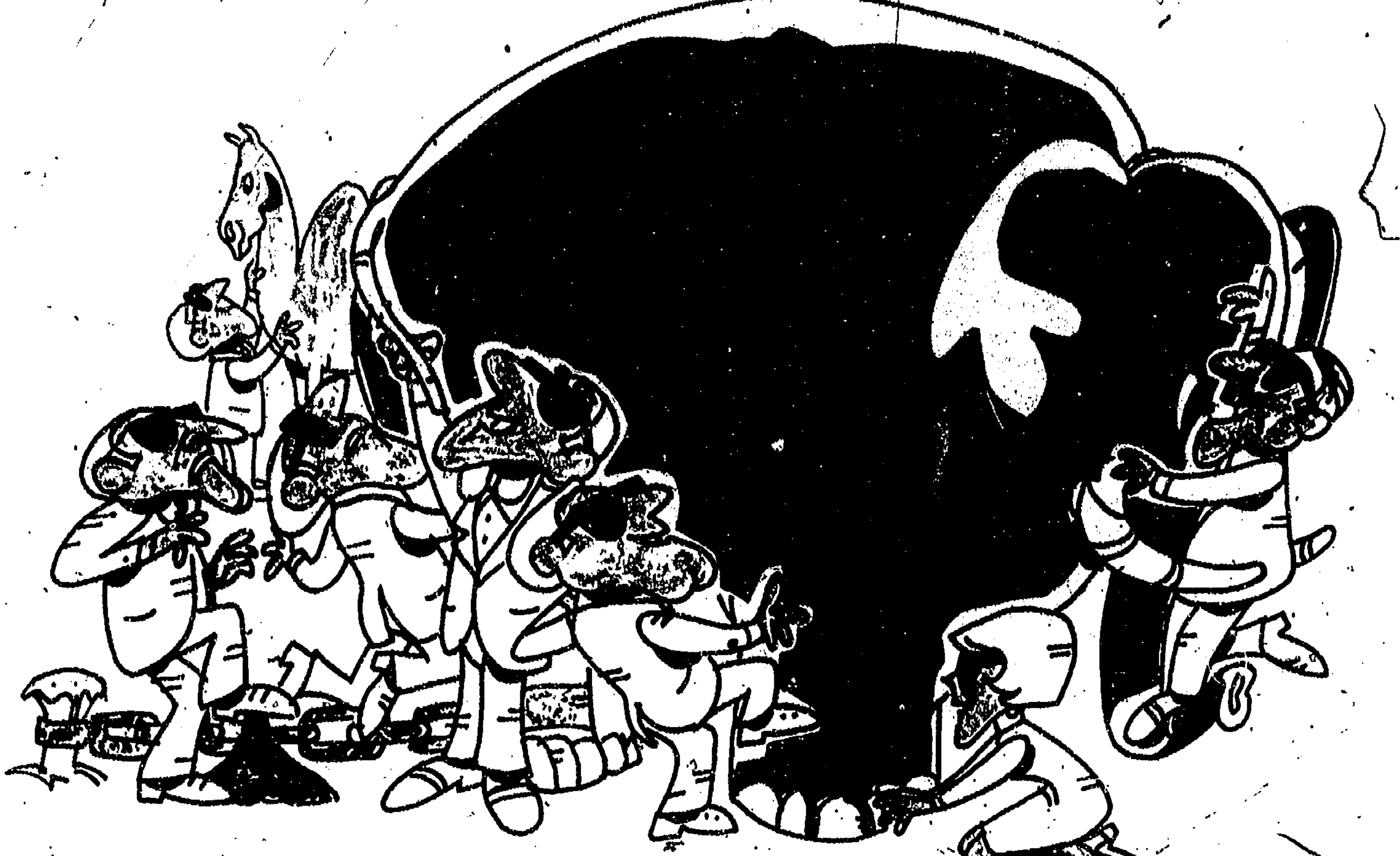
Consumption Pattern

Figure 8 - Oil Imports



Data from: Energy in Focus: Basic Data. (Washington, DC: Federal Energy Administration) 1977.

Office of Marketing, Department of Commerce.



TOM GLADDEN

ENERGY: PRESENT PROBLEMS AND FUTURE POTENTIAL

WE SEE only what we want to see in public issues. Depending upon our experiences and beliefs, we construct our own explanations complete with causes, heroes and villains, and solutions that suit us.

The energy crisis is no exception. It is pictured quite differently in oil company advertisements, Sierra Club publications, and in the Carter Administration's Energy Plan. As I sat through a panel discussion of the energy situation recently I was reminded of the fable of the blind people and the elephant.

I pictured an engineer, initially, from the Department of Energy, blindly feeling the head of the elephant and saying: "This beast has an enormous brain. If we allow him to use it he'll invent new ways to get energy and solve all our problems."

A blind man from a conservation group had bumped against the elephant's huge gut. "This beast is too fat," he said. "We have to put him on a diet. He's using too much energy."

A blind woman in my vision concentrated on the elephant's heavy foot. "What about the poor consumer?" she asked. "We're getting trampled underfoot by this greedy beast."

JOHN M. FOWLER
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and
Manager of Publications
National Science Teachers Association
Washington, D.C.

The blind man from a utility company (or was he from an oil company?) had tripped across the chain that held the elephant and fallen against the beast's powerful hip. He quickly saw the solution. "This is a strong animal. If he were released to let him make his own way, everything would be all right."

There was someone from a public interest group in my vision. He had found the elephant's tail. "You can't believe what they tell you," he said. "There's a string attached."

An "investigative reporter" was standing nearby, hoped to make his reputation with an exposé. In his blind seeking, he found himself several paces behind the elephant and stepped in the dirt he was looking for. "This whole thing stinks," was the beginning of his lengthy summary.

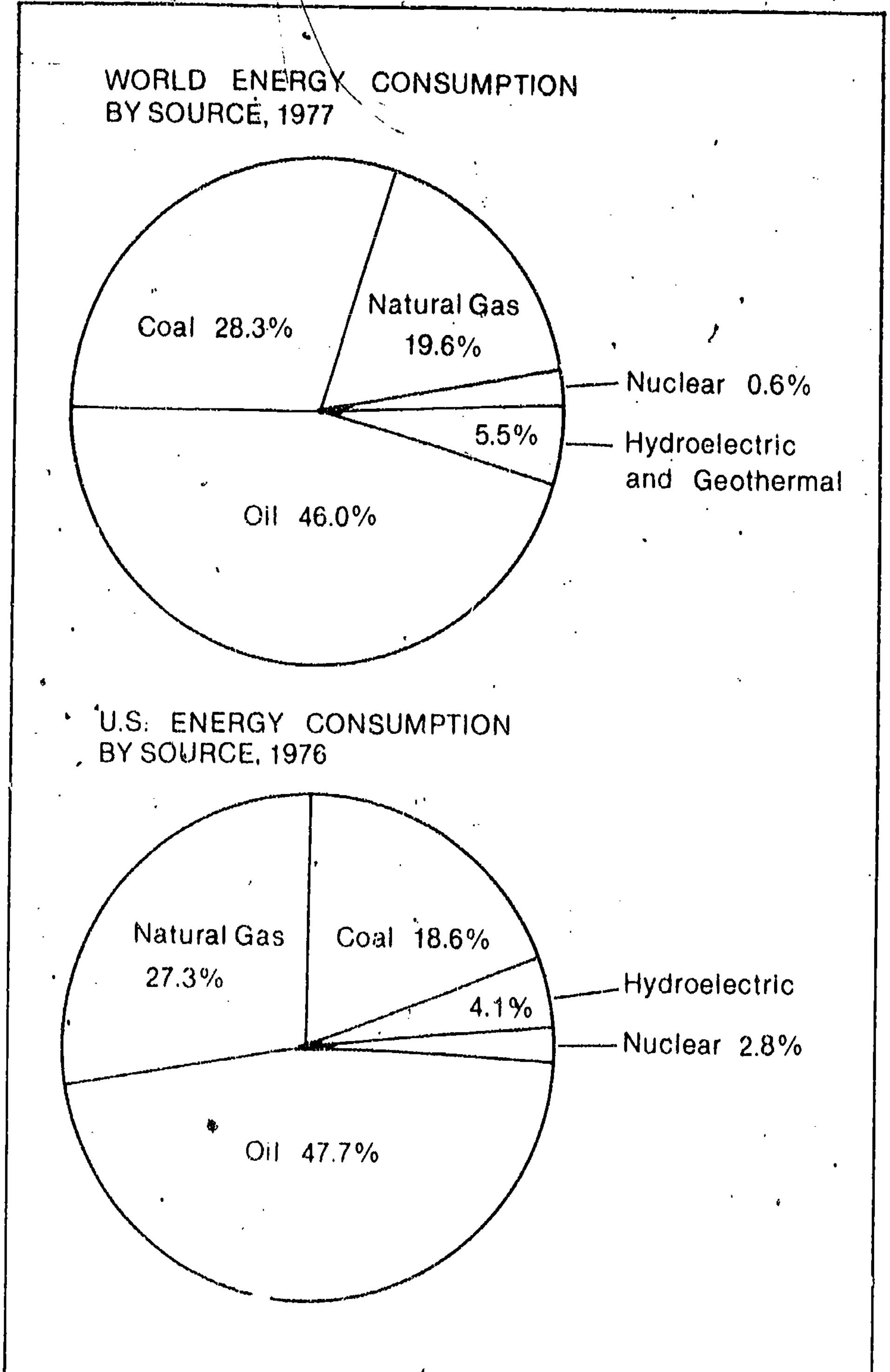
And last a futurist, blind naturally (as are all who try to look too far ahead), missed the elephant altogether and was in the next stall with a camel.

The role for educators is to open eyes. As this fable implies, the energy situation is multifaceted. We must help our students—tomorrow's voters—to see the whole elephant and together, lead it in the desired direction.

The whole picture of the energy situation must include research on and development of new energy sources. It must include protection of the energy consumer and incentives for energy producers. Someone must worry about threats to the poor or disadvantaged, as well as about threats to the environment.

We cannot present the whole picture in this article, but only focus on some background information: the nature of the present emergency and the prospects for easing the situation in the future.

FIGURE 1.The percentages of each of the primary sources of energy which make up United States and world energy consumption. Oil and natural gas are the most popular and also the most limited.



The Resources Crunch

The demand for energy has outrun the supply. The supplies are limited at present not because there is not enough in the ground. (See Figure 1.) The oil producing countries are in a "seller's market." They have something everyone needs, and so have raised the price as high as the market will bear. And they sell only as much as they need to—there's a limit to the usefulness of foreign money. Kept in the ground, the rest of the oil increases in value each year.

The result is that oil and oil products have more than doubled in price since 1970. The price of all other forms of energy, including electricity—whose generation depends on coal, oil, natural gas, or uranium—has gone up with oil.

The U.S. is particularly vulnerable to the effects of these price increases because it uses so much energy compared to its supply. The American appetite for energy was established during the days of energy abundance. Until the 1950's the U.S. was an energy exporter, but we now import oil and a little natural gas. About 42 percent of our total oil supply was imported in 1976. There were months in 1977 when we imported half of our oil supplies.

How Much Is Left?

Our nation's dependence on foreign sources of oil is the major component of the present emergency. In a decade or so the U.S., along with the rest of the world, will face a more serious problem. By the beginning of the next century *all* oil and natural gas resources will have been severely depleted.

How long these limited resources will last is a controversial question. Scientist Gloom says, "Only 20 years' worth of oil left," but Mr. Sales, Vice President of the Pump-It Oil Company says, "We have enough for 100 years."

There are two major reasons for such disagreement.

The amount of any fuel resource can be given in different ways as "reserves," "ultimately recoverable resources," and the "total resource base." Reserves are the most conservative; they have already been discovered. At the other extreme is the total resource base, an educated guess at how much there is totally, regardless of price or other factors. The reasonable number is the ultimately recoverable resource, the amount of a resource which experts thinks can be recovered *at an appropriate profit with present extraction techniques.* (See Figure 2.)

The emphasis reminds us that the cost of extracting a resource is important. There is more oil available at $30 a barrel than at $15. This is true for any other fuel.

We can see in the chart, however, that oil and natural gas, and even uranium, can power our machinery and warm our buildings for only a few more decades. Only the resources of coal are relatively large.

Rebalancing the Scale

When demand outruns supply then the supply must be increased or the demand decreased. The Carter Administration's energy plan emphasizes demand reduction through energy conservation. This means more than turning out lights, lowering thermostats, and driving less. While there are a wide variety of wasteful energy practices which can and are being eliminated, the more important part of conservation will come from using energy more efficiently to do the things which need doing. This means making present equipment—automobiles' engines and electrical power plants, for example—more efficient. It also means changing entire processes, warming buildings with a "heat pump" (a device which pumps heat from the outdoors during the winter and in the other direction during the summer). It means generating electricity with a fuel cell (a device which generates electricity by combining hydrogen and oxygen). Conservation is the quickest and the least expensive way to attack the supply-demand imbalance. A barrel saved is a barrel we don't have to buy from Saudi Arabia.

More Energy Is Needed

Our energy needs will grow with population and with our efforts to bring more goods and services to all our people. Conservation alone will not be enough.

In the immediate future the two leading energy candidates are coal and uranium. Coal is more versatile; it can be burned in power plants to generate electricity and soon gaseous and even liquid fuels may be made from it. To rely heavily on coal, however, we have to solve its pollution problems and find ways to mine it safely and without destroying our land. Eventually, coal will run out or become too expensive.

Uranium poses different problems. It can only give us electricity. The problems include disposal of waste, the controversial subject of reactor safety, and in the long run, the danger of spreading nuclear bomb material around the world.

The New Sources[1]

Sometime in the next century we will have to turn away from the fossil fuels completely, and develop an entirely new energy system for our nation and the world. There are basically three major contenders for this honor: nuclear energy based on fission (the breeder reactor will be the workhorse of this option), nuclear energy based on fusion, and solar energy. Since any of these options will need a massive investment of manpower, money, and technological effort to be brought to the level of widespread commercialization, it is unlikely that we will have an equal mix of the three. One will dominate; the others will have smaller roles.

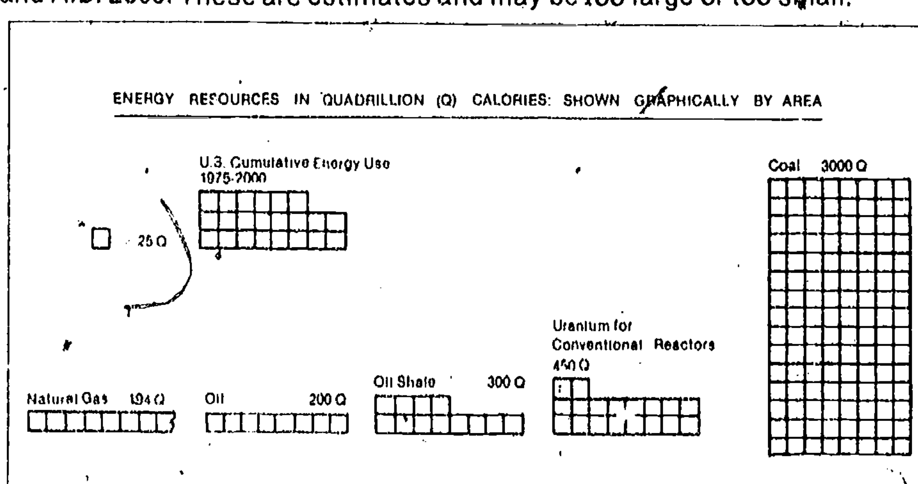
Fission

The most controversial option, yet the closest to realization, is nuclear fission. We have already entered the nuclear age. There were some 65 nuclear power plants licensed to operate in this country at the beginning of 1977, with a generating capacity of 46,400 million watts of electricity. If we add the plants under construction or on order, we can expect by mid 1980's, a total of 215 reactors capable of generating about 210,000 million watts of electrical power.

As Figure 3 shows, the U.S. uranium resources are not very large. Conventional reactors use rare Uranium 235 as fuel. The breeder reactor can convert the common form of uranium (Uranium-238) into fissionable fuel. A mixture of breeder and conventional reactors could raise the efficiency with which we use our minimal uranium resources, as the conven-

[1] All of these technologies were discussed in some detail in the 19 NSTA Fact Sheets on Alternate Energy Technologies. A list of these Fact Sheets and instructions for obtaining them appears in the announcement on page 12 of this issue of *S&C*.

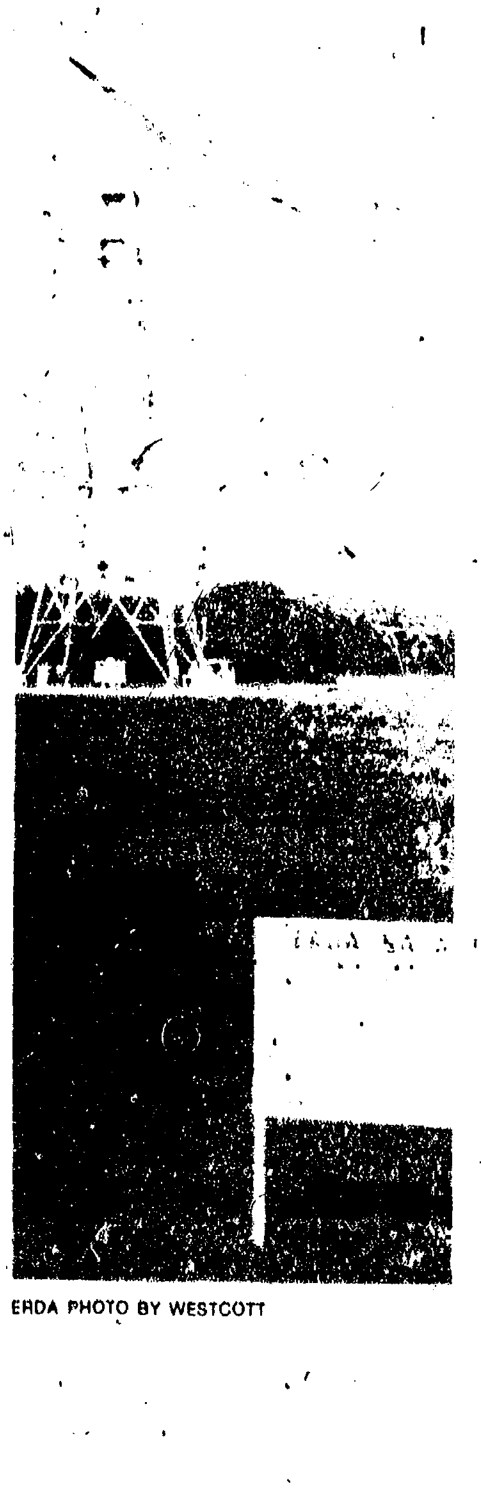
FIGURE 2. This country's "ultimately recoverable resource" and a comparison with the amount of energy the U.S. is expected to use between now and A.D. 2000. These are estimates and may be too large or too small.



tional reactor uses the fuel produced by the breeder. This system could assure us energy for 1,000 or so years.

A future dominated by fission reactors would be quite different from the present. It would be essentially all electric. This would mean great changes in transportation and industry. However, in addition to having to find safe disposal sites for radioactive waste and assure ourselves of the safety of the plants themselves, we would need to solve the political problems caused by access to the raw material for nuclear weapons. Plutonium, created by the breeder reactors (by the thousands of tons) can be made into bombs.

Experimental windmill.



ERDA PHOTO BY WESTCOTT

Reliance on fission would also be beneficial in that it would remove much of the smoke from our skies, reducing air pollution and lessening the worries over long-term atmospheric buildup of carbon dioxide.

Fusion

Another source of nuclear energy is the fusion reaction. In fission, energy is the result of breaking up a large nucleus; in fusion, the energy comes from the fusing of two small nuclei. The fuel for this reaction is deuterium, a rare form of hydrogen. Even though it is rare (only 1/6500 hydrogen atoms are of this type), there is so much hydrogen in the ocean that the resource for this reaction is virtually unlimited.

The problem with fusion is that after 30 years of trying, we have yet to create a controlled energy releasing process. A method has to be found for holding deuterium nuclei together and heating them to 100 million degrees Fahrenheit. Even if this difficult scientific/engineering challenge is met—something not expected before the mid 1980's—a host of engineering problems will remain. It will still be necessary to design a commercial plant which will last 30 years or so and produce electricity at competitive prices. Fusion may never be a successful energy source. If it becomes available at all, it will not begin to help our energy needs until sometime in the next century.

Solar Energy

Solar is the most glamorous of the three systems. On the average, the energy equivalent of 10 barrels of oil falls on each U.S. acre per day. However, solar energy must be converted to a form we can use. The obvious conversion is to heat. More and more buildings with solar water or space heating are appearing each year. The President's Energy Message called for 2½ million solar heating and cooling units by 1985. While solar heating over the long run is already competitive with electrical heat, a solar unit now costs \$5,000 to \$10,000. It takes 15 to 20 years for it to pay for itself; few of us can make that kind of investment at once.

We need electricity if we are to base our whole energy consumption on solar energy. There are several research efforts underway to develop solar-electric converters.

Two promising conversions are through windpower and heat-engines (using solar energy to produce steam, for instance, and then driving a turbine-generator). (See photographs and captions.)

Another way to convert sunlight to electricity is through solar cells, which collect electrons knocked out of a carefully prepared transparent material and produce an electrical current. Solar cells are not very efficient; the best of them can convert to electricity only about 15 percent of the solar energy which falls on them. The conversion is free of waste heat and environmental pollutants, however. And the fuel is free of charge.

Solar cells are expensive. The largest array in use is a one-kilowatt panel being tested by the Mitre Corporation outside Washington, D.C. This large panel (made up of hundreds of individual solar cells) costs about \$30,000. The cost of generating capacity in the most expensive nuclear power plant is only about \$1,000 a kilowatt. In order to be competitive the cost of solar cells will have to be reduced to about 1/50th of their present cost.

For any solar energy use we must face the problem of energy storage. Since the flow of solar energy is interrupted by the Earth's rotation and by clouds, we will need to store either the electricity or the heat energy. Solar buildings can store enough heat for two or three days in large insulated containers of water or pebbles. Storage of the output from power plants will be difficult to accomplish on a large scale. In the immediate future solar energy will probably be counted on for daytime "peak" loads; supplementary power sources will be used nights and cloudy days.

Other Sources

Geothermal energy is the energy from the Earth's molten interior. The only U.S. installation is at the Geysers near San Francisco and it produces almost half of that city's electricity. This country is now being explored for more geothermal resources. If we learn to use hot water and the heat in hot dry rocks, geothermal energy could become more important. But it can only be expected to produce 10 or so percent of our total energy. Its use may also be restricted to certain regions.

Another form of solar energy is the energy stored in living materials by photosynthesis. Wood was an important fuel in this country until early in the Twentieth Century, and is experiencing a minor resurgence. There is some experimentation underway with fast-growing plants like sugar cane and with water plants like kelp and water hyacinth. Such plants can either be dried and burned, digested by bacteria to produce methane (natural gas is chiefly methane), or fermented to produce alcohol. The growing of "energy crops" will probably not become very important. The need for lumber and food is even more important.

The organic fraction of our trash and garbage, however, will become an important energy resource. This nation generates a lot of waste material, more than a billion tons per year. About 200 million tons of that is municipal waste. As much as 75 percent of the municipal waste is organic and to this can be added crop and logging residue, feedlot manure, and others. Restricting expectations to that smaller amount of waste material that is "readily collectable," such as waste from large cities, and converting it to energy, could still contribute 10 percent or so of the total demand.

Organic waste can be converted to energy by the same processes we described above, by burning directly or converting it to methane or alcohol. Pyrolysis, a more sophisticated process (heating in the absence of oxygen), can produce a liquid fuel -- "garboil" -- in addition to gaseous and solid fuel. Many cities are now operating or constructing waste conversion plants. These waste conversion plants face a problem with paper which makes up over half of the organic material and provides much of its energy. More energy would be saved, however, if it were recycled. This is an important reminder. We can get energy from our waste, but the real energy-efficient practice is not to create it in the first place.

There are other possible energy sources but their potential is smaller. Much of the untapped water power in this country is now protected by acts of Congress. Tidal power has some small potential and is used in France and the Soviet Union. The Bay of Fundy at the tip of Maine has been studied several times as a potential site for tidal generation but the economics have always been unfavorable.

Appropriate Technology

Much of this country's energy research and development effort is designed to produce electricity. This means more centralization of energy production and distribution. There has been increasing interest among those who write and talk about the energy problem in applying the thesis of E.F. Schumacher's *Small is Beautiful*[2] to energy. A leading spokesperson has been Amory Lovins, whose article formed the beginnings of a small crusade.[3]

The "appropriate technology" approach is also solar-based but uses a different collection of solar conversion devices. Energy conversion is to be accomplished, whenever possible, at the consumer's home, not at a central station. Solar home heating and cooling, small digesters to convert organic waste to methane gas, or fermentation devices to produce alcohol for use as a fuel, photovoltaic cells (solar cells) on building roofs, "total energy systems" (motor-generator sets which produce both electricity and heat), and windmills would be emphasized.

Industries would use solar energy both for space and process heat (high temperature heat), convert industrial and municipal waste to methane gas, and generate electricity from waste heat. Conservation would be essential. The three big options, fission, fusion, and centralized solar would be supply or production oriented, to an extent; however, demand would be kept to a minimum in the "appropriate technology" approach.

SANDIA LAB

The experimental "power tower" converts solar heat to electricity. Mirrors focus the sun's rays on a boiler on top of high tower. Here, the rays were focused on a steel target, which melted.

Enthusiasts who champion this fourth option are obviously trying to change the country through its energy system. The country *will* change as it goes through the present transition into a new energy era. The question is not "Will it change?" but "How will it change?"

Teachers and their students must be prepared to help answer this question. We must all watch developments in the energy area carefully over the next decade, keep an eye on each of these four technological options as they are developed, and look beyond them to see what kind of a country they imply. Then we must decide whether we like and want that country while there is still time to influence the choice.

Schumacher, E.F. *Small is Beautiful: Economics as If People Mattered.* Harper Torchbooks, New York City, 1973.

Lovins, Amory. "Energy Strategy: The Road Not Taken." *Energy Affairs.* October 1976.

3 Interdisciplinary Approaches to Teaching Energy

In this chapter you will find two models for workshop activities. They are designed to: 1) help participants understand cooperative teaching and 2) encourage teachers to include energy topics in their curriculum.

The first model is built around an attitudinal survey and an exercise that demonstrates how energy concepts cross over the traditional boundaries between disciplines. It should take about 1½ hours.

The second model is more structured, offering a 3-hour group session based on team teaching.

Energy is Interdisciplinary

20 minutes
Handout 3a

Divide workshop participants into groups of four to eight with a mix of disciplines. Ask each participant to complete the attitudinal survey. Afterwards have a discussion of the responses within the small groups. If time permits, you may wish to invite each group to discuss its opinions with the entire group and attempt to reach consensus.

Refer back to Handout 1b

Next distribute the list of major energy concepts to group members. Ask the groups to sort the concepts into three categories: concepts that would be taught in science classes only (S); would be taught in social studies, humanities, or economics (SS); could be included in both science and social studies (B).

Identifying those that are clearly interdisciplinary

15 minutes

The workshop leader should briefly survey each group to determine which concepts were most frequently identified as belonging to category B. Three or four of these should be recorded on a chalkboard. These concepts will form the basis for identifying those energy concepts which fall naturally into interdisciplinary teaching.

Handout 3b

30 minutes

Distribute "Questions About Interdisciplinary Concepts." Ask the groups to write brief answers to the questions.

Have individuals suggest which interdisciplinary energy concepts they would consider using in their classes. Ask participants how they would overcome obstacles to their inclusion in standard fare courses.

Teaming-Up to Teach Energy

In this session teachers prepare a half-hour team-taught lesson on energy.

40 minutes

Begin by dividing the group into teams, with at least two different disciplines represented. Have the teams decide on a specific energy topic, and then build a lesson around two or three learning objectives. Specific assignments may be made within the group to collect data, design simple demonstrations, or improvise visual aids.

30 minutes

Then the members of one group should teach their lesson to the members of another. Example: If there are three groups, A,B, and C, two teachers from Group A should team teach a 30-minute lesson to Group B; Group B to Group C; Group C to Group A. The PEEC materials can be used as the primary materials.

Science teacher discusses engine inefficiency and air pollution.
and
Social Studies teacher discusses the social implications of air pollution.

Example:

Major topic: Energy
Sub-topic: Automobile Air Pollution
Learning Objective: Students should be able to identify the pollutants released by incomplete combustion in the gasoline engine. They should be able to explain the social implications of automobile air pollution.
Materials: "The Great Joule Robbery" from Lesson 3 of PEEC packet Energy, Engines, and the Industrial Revolution; and "The City of Windshields" from the packet, Transportation and the City.

20 minutes

Conclude with a whole group meeting focusing on other interesting possibilities for teaching energy as a team project.

Handout 3a

An Attitudinal Survey of Interdisciplinary Teaching

DIRECTIONS: Circle the number that most closely reflects your degree of agreement or disagreement. Use the following key:

1 Strongly Agree
2 Agree
3 No Opinion
4 Disagree
5 Strongly Disagree

1 2 3 4 5 1. There are concepts or topics traditionally thought to belong to another discipline that should be taught in my course(s).

1 2 3 4 5 2. The energy crisis can ultimately be solved by technology.

If a student asks me a question that I feel is outside the range of my own teaching, I think I should:

1 2 3 4 5 3. tell the student to see another teacher--someone who teaches that subject.

1 2 3 4 5 4. try to find out the answer myself and then pass the information on to the student.

1 2 3 4 5 5. tell the student that the question is not an appropriate one to ask in my class.

1 2 3 4 5 6. My subject area has more to offer students about energy than another. Why? In what way? Explain below.

1 2 3 4 5 7. In order to teach energy effectively social studies and humanities teachers must have some scientific or technological know-how.

1 2 3 4 5 8. Science teachers must have information about the political, economic, and social impact of energy issues to teach energy effectively.

Questions About Interdisciplinary Concepts

DIRECTIONS: Please consider the following questions in relation to those concepts that your group listed as potentially useful in both science and social studies courses.

1. Do your curriculum guidelines and/or your school district administration encourage or prohibit any kind of interdisciplinary teaching? To what degree? Explain.

2. Would you need information that you do not have now in order to teach the interdisciplinary energy concepts? Where would you expect to obtain this information?

3. Would you feel uncomfortable teaching some of these concepts, even if you did know them well? Why?

4. Can you find a logical place within your course of study to include one or more of these concepts? Give an example.

5. Do you feel that some concepts have absolutely no place in your classroom? Which ones? Why?

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4 Infusing Energy Topics into Traditional Subjects

In this chapter you will find four models for helping workshop participants incorporate the topic of energy into existing courses. The workshop models aim for two goals: 1) to acquaint teachers with the PEEC packets and energy concepts and 2) to identify topics in the existing curriculum where energy plays an integral part.

The introduction to all of these workshop models is identical. Opposite each model description is a flow chart which graphically summarizes the group work process.

All participants should be instructed to bring a copy of their curriculum's Scope and Sequence charts or a copy of the Table of Contents of each of their textbooks.

Introduction to Energy Infusion

Begin by having participants introduce themselves. Have each give his fields of teaching, geographic area (or school) and information of interest. Topics of concern may include incorporating another urgent topic (such as energy) into an already existing heavy schedule. Then choose the following model that best fits the group's needs:

Model 1a and 1b - Using an analysis sheet, have each group analyze one PEEC packet; OR analyze various programs for places where PEEC lessons would fit.

Model 2 - Working in groups, have participants fit several PEEC packets into their traditional instructional programs.

Model 3a and 3b - Using PEEC Major Energy Concepts list, have group members infuse as many concepts as possible into their programs; OR choose one major energy concept and infuse it as often as possible into their total teaching program.

Model 4 - Have group members choose topics within their teaching programs and list places where energy can also be discussed.

Divide the group into smaller groups. See each infusion model for specific strategies for grouping.

Match A PEEC Packet to the Regular School Curriculum

Materials:

- Participants' Scope and Sequence Charts
- Duplicated copies of Content Analysis Sheet, Handout 4a (one for each participant)
- Copies of Student Skill Development in Energy Education, Handout 1c (optional)
- PEEC learning packets

Handout 4a
PEEC packets

Divide workshop participants into small groups comprised of those who have primary responsibility for one grade level. Have a mix of disciplines, if possible. Then distribute Handout 4a and an appropriate PEEC packet to each group. Tell the participants that the purpose of this part of the workshop is to become familiar with the curriculum materials.

Have participants fill in column I on the Content Analysis Sheet. The suggestions should come from the overview and table of contents of the packet they are reviewing.

Next, have group members use column II on the Content Analysis Sheet to indicate where lessons in the PEEC learning packets (or parts of them) fit with chapters or units of social studies or science programs.

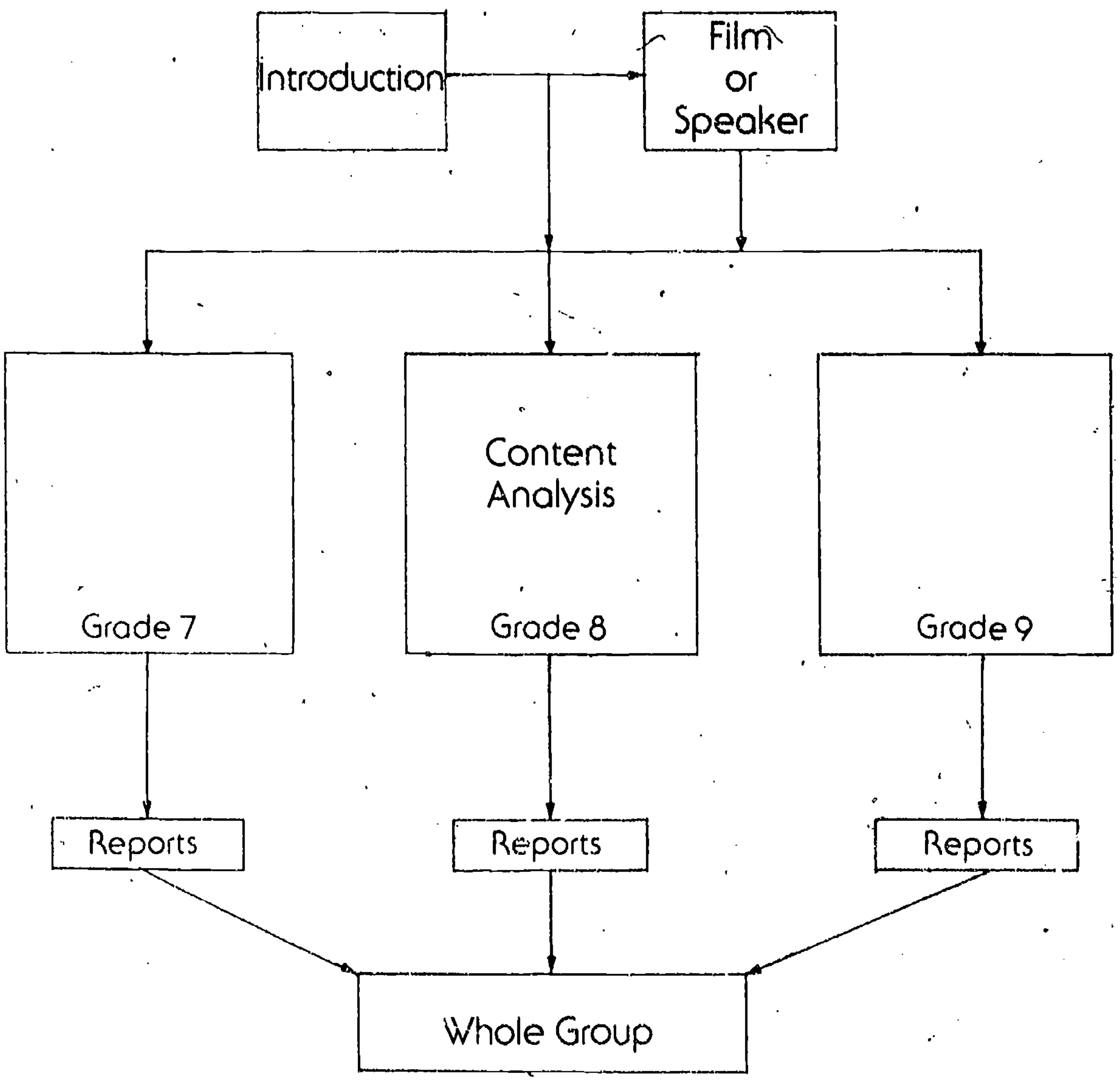
Finally, have teachers go through the packet(s) one more time to see how energy concepts can be developed through exercises and activities which also reinforce basic skills.

Fill in column III on the Content Analysis Sheet.

Group Reports

Assemble entire group. Each group should give a brief report. Discuss general questions about infusing energy topics into regular school subjects.

Workshop Flow Chart
Model 1a



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A PEEC Packet and a Subject to Teach: Finding the Best Fit

Materials:

Participants' Scope and Sequence Charts
PEEC learning packets (one copy per participant)

PEEC packets

Divide workshop participants into small groups by grade level or subject area. Distribute the PEEC packets. Tell the participants that the purpose of this workshop session is to become familiar with PEEC curriculum materials and to find places in their own curriculum where these materials can be used.

Start by scanning the packet Table of Contents and brief descriptions of the lessons. Look at each lesson Overview. Using their own Scope and Sequence Charts, teachers should identify those major ideas built into their teaching subject. Make a list of the PEEC lessons which would cover nearly the same ground--plus adding some important information about energy.

Group reports

Allow groups enough time to compare their findings in a brief report period. Discuss general questions about infusing PEEC materials into a typical teaching program in a final whole group session.

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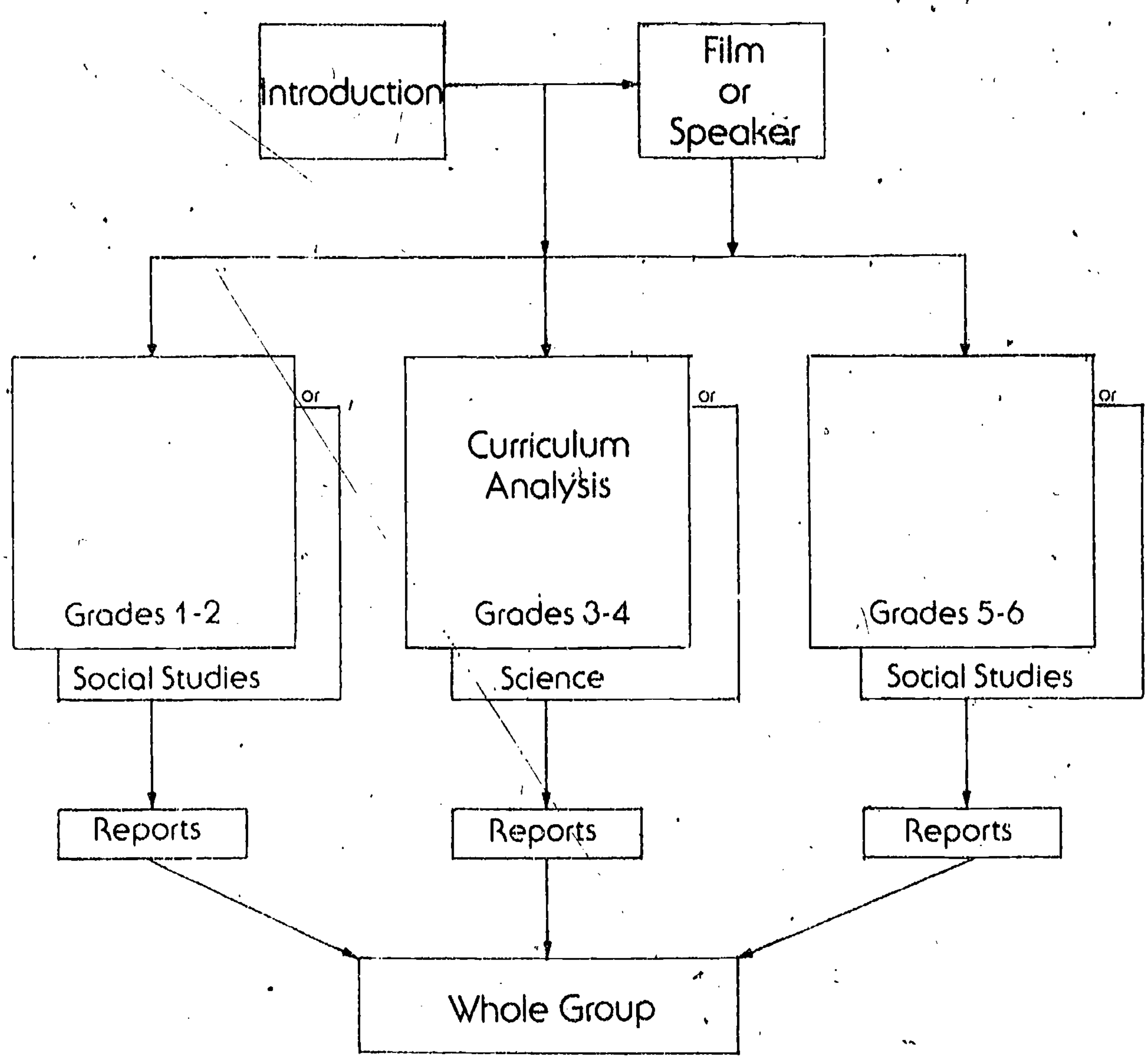
Workshop Flow Chart
Model 1.b



Infusing Many PEEC Packets into the Classroom

Materials:

Participants' Scope and Sequence Charts
PEEC learning packets (at least two for each participant)
Copies of Where I Can Use PEEC Teaching/Learning Materials in My Classroom, Handout 4b
Duplicated copies of Skill Development Lists, Handout 1c (optional)

Divide workshop participants into small working groups. Groups should be comprised of teachers of the same grade level or in the same discipline.

Each person should skim through two different PEEC packets focusing on lessons that would be appropriate for his classes. This part of the workshop offers participants a close look at the packets and gives them a chance to see how these lessons can be used in their own classrooms.

Handout 4b

Using Handout 4b, teachers should jot down as many locations as possible where PEEC lessons might be used within their courses of study, and tell why.

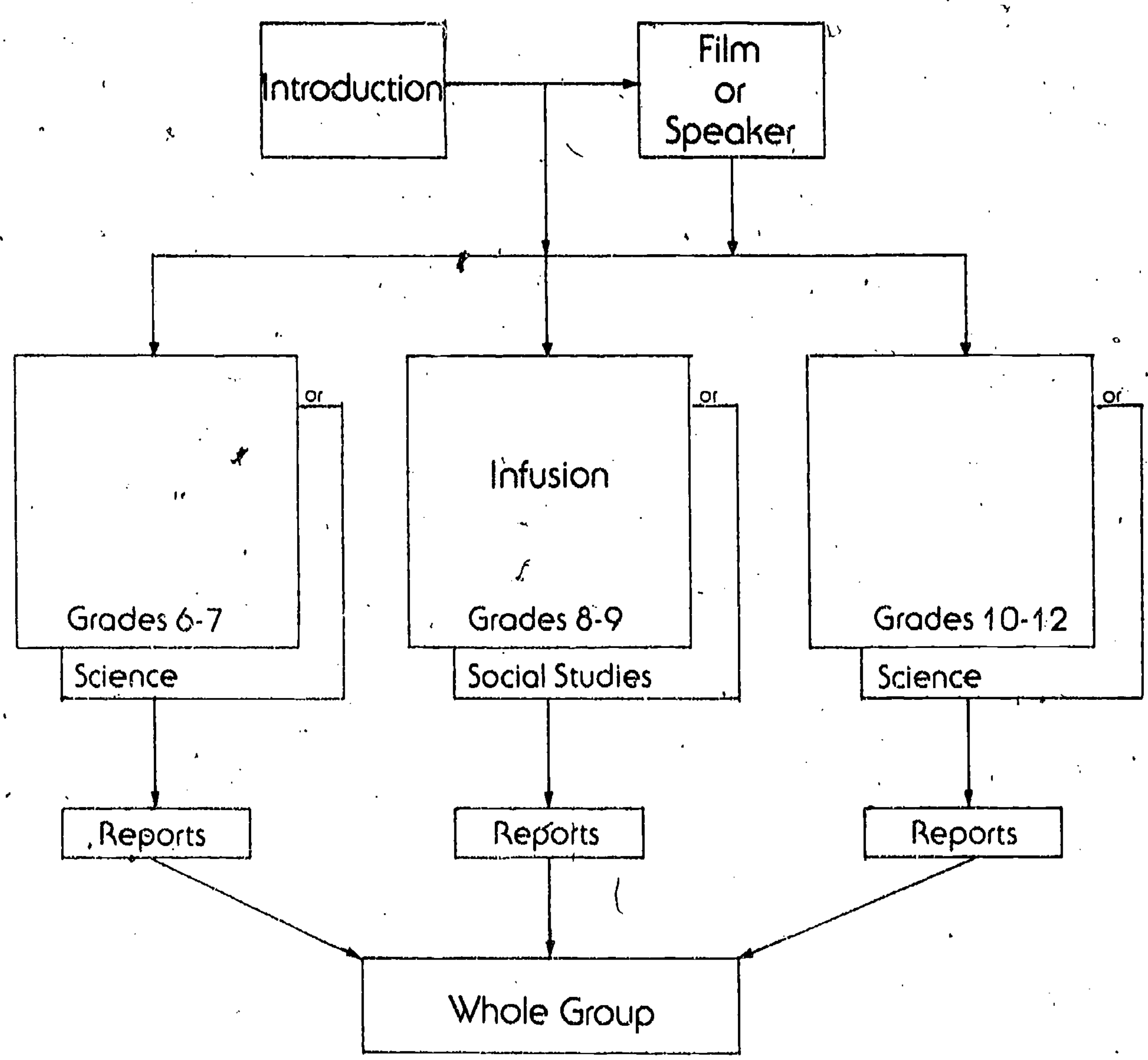
Participants can suggest ways to infuse the whole packet somewhere into the curriculum, or identify places where parts of one packet, along with lessons from another, would fit the needs of their pupils and their programs already scheduled.

Allow just a brief time for teachers to work alone. The meeting will be greatly enhanced by drawing from examples and situations offered in free exchange by all members.

Group Reports

A brief report should be given by each group on the general usefulness of various packets in year-long class programs.

Workshop Flow Chart
Model 2



Infusing Energy Concepts into Current Teaching Programs

Materials:

- Participants' Scope and Sequence Charts
- Duplicated sets of Major Energy Concepts, Handout 1b (one set for each participant)
- PEEC learning packets (at least one per participant)

Handout 1b

Participants should read through the list of Major Energy Concepts, paying attention to the sub-concepts under each main heading. On the same sheets of paper, make a note of slots within traditional courses of study where each energy concept can be either introduced or developed further.

Point out that participants should look for places where energy concepts fit with chapters or units of social studies and/or science programs.

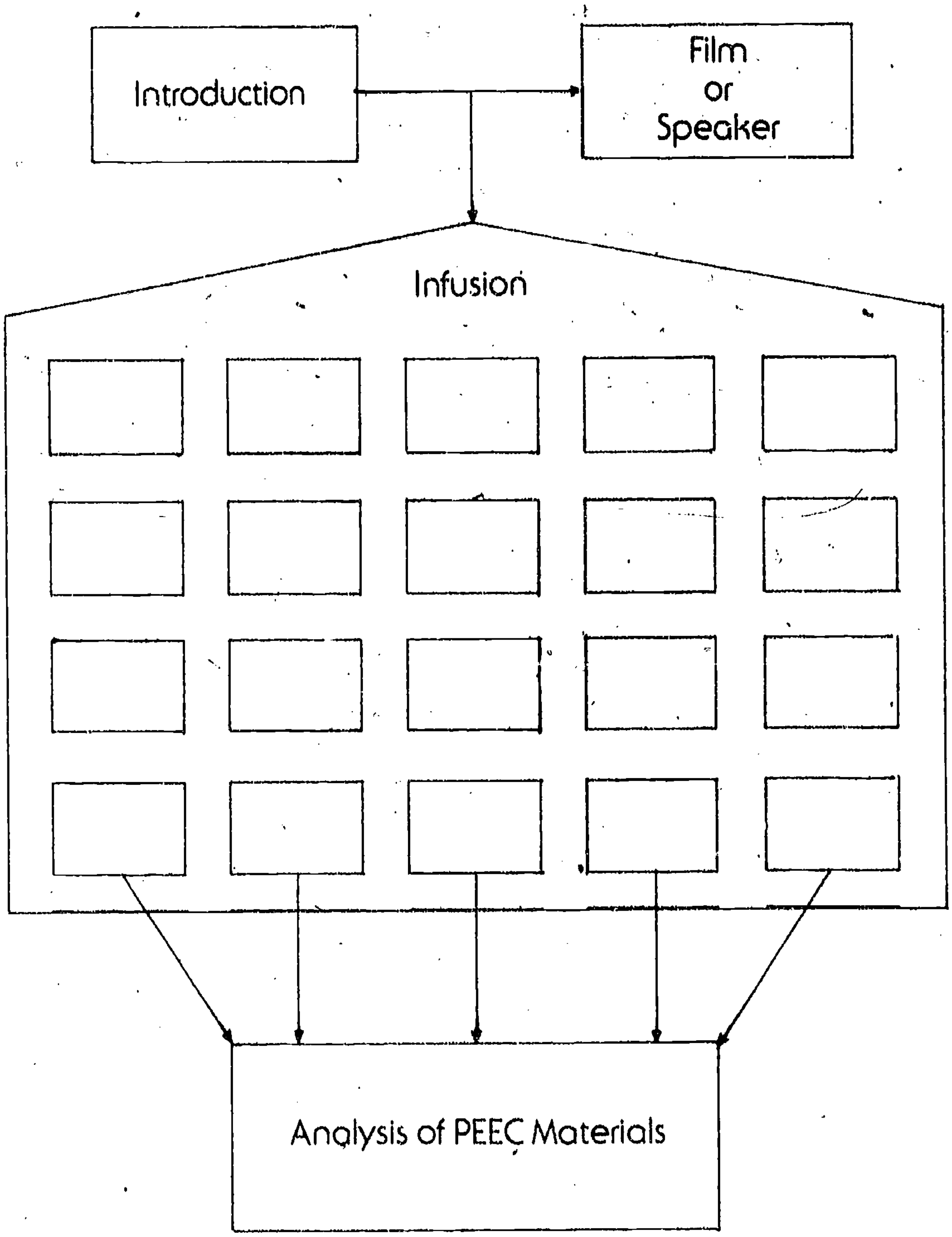
To help participants get started, ask: Where can we present the concept that energy exists in different forms? Where are probable places at the elementary level in science? In social studies? Where can this concept be developed in secondary school courses?

Suppose you want to teach the concept that energy can be bought and sold. Where are likely places to teach this concept in the school curriculum?

Then ask participants to write brief notes about where energy concepts fit into various other courses of instruction.

Wrap up session with an examination of several PEEC packets. The purpose of this part of the workshop is to have teachers identify the energy concept(s) introduced or reinforced in each lesson of each packet.

Workshop Flow Chart
Model 3a



Infusing One Energy Concept in Many Places: All it Takes is Imagination

Materials:

Participants' Scope and Sequence Charts
Duplicated sets of Major Energy Concepts, Handout 1b

This workshop session is a variation of the previous one. We suggest you divide the participants into small groups by grade level or by discipline (or even interest).

Handout 1b

Have group members choose one energy concept and explore all the possible places within a program or course where the concept can be taught. These can be jotted down by a group recorder.

Teachers may need an example. Suppose they choose "Energy Use Affects Society" from the Major Energy Concepts list. Understanding this concept may come from its incorporation into social studies units such as:

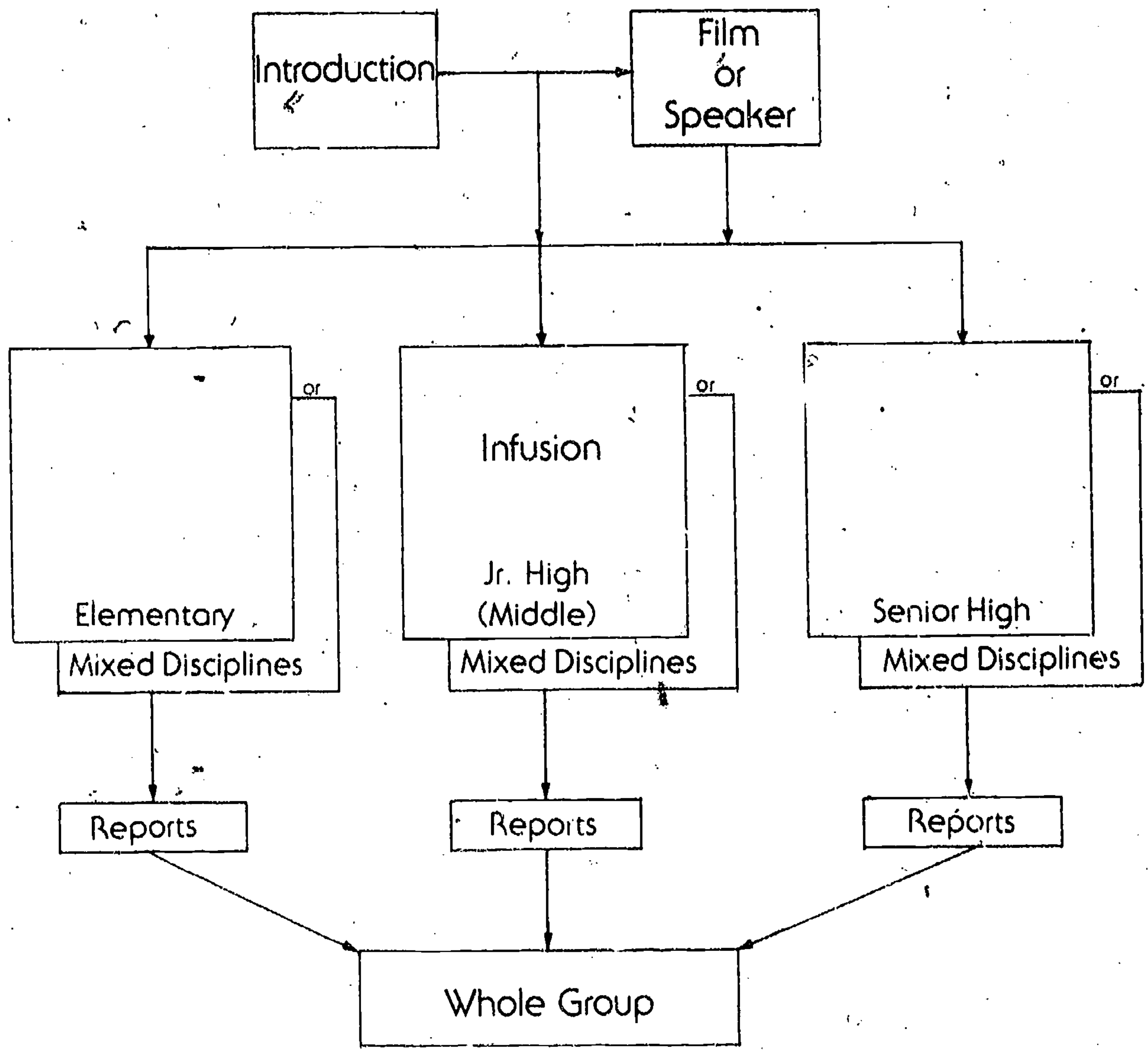
Colonial America - The use of wood as a resource and as a fuel helped shape the theory of mercantilism. England's adoption of this theory fed the resentment of the colonies.

Wood also dictated building styles and, in some cases, the patterns of towns. Colonial life depended on this inexpensive, renewable energy source for housing, heating, trade, and ship-building.

Industrial Revolution - The invention of the steam engine ushered in the industrialization of America. None of the vast changes that led to our modern way of life could have come about without the heat engine; that is, an engine which converts the energy of heat into mechanical energy.

The Growth of Cities: Problems and Promises - Many problems of air, water, and land use are directly or indirectly related to the use of fossil fuels.

Workshop Flow Chart
Model 3b



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Expanding Topics to Include Energy Implications

Materials:

Participants' Scope and Sequence Charts
Duplicated sets of Major Energy Concepts, Handout 1b
Copies of Student Skill Development in Energy Education, Handout 1c

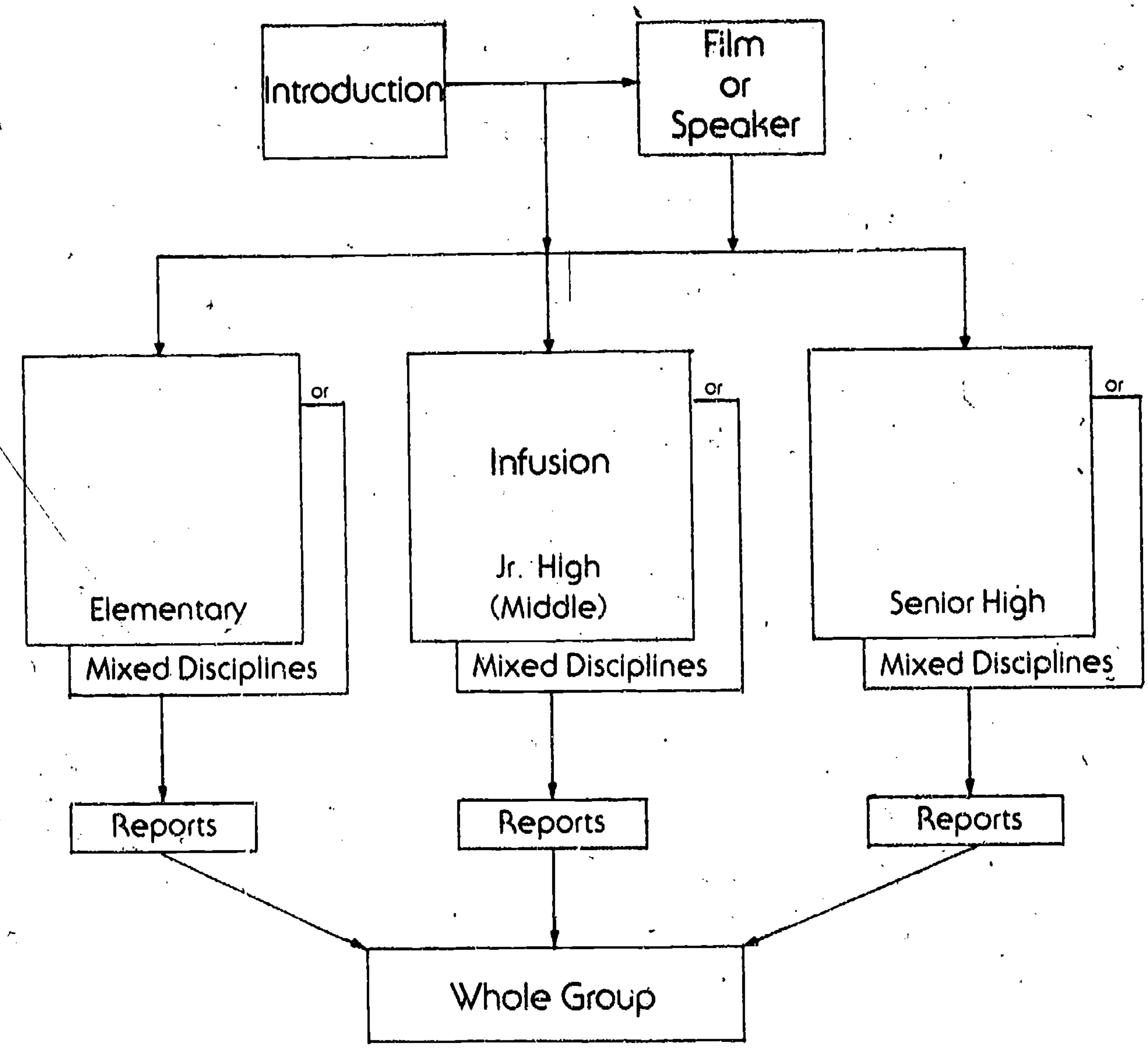
This workshop focuses on classroom activities that tie energy to the topics studied in social studies or science and to skill development. The following activities can be mentioned to get ideas generating.

ACTIVITY	TOPICS	ENERGY IMPLICATIONS
Micro-tracing Trace a common object back to its origins. Example: pencil--back to wood and graphite mine, with intermediate manufacturing steps.	Social Studies Tracing: Immigration Migration Industrialization Settlement Urban Services	Energy is a Basic Need Energy Use Affects Society
Using Numbers (Quantifying) Invent some games	Science Scientific notation; graphing exponential growth of populations.	
Tracing and Predicting Try a "You Are There" Approach	Fossil Fuels--from the millenia to their global use today.	
Field Trip Follow the power lines from school to power plant	The operation of a steam turbine to the production of electricity--to the uses of electricity (light, appliances, etc.)	

Group Reports

After sufficient time for a brief report period, have teachers summarize how this approach can make energy interesting and useful to students.

Workshop Flow Chart
Model 4



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Content Analysis for Infusing Energy Topics into Traditional Classroom Subjects

NSTA-PEEC Packet Title ________________ Grade Level ______ Your Name ________________
School ________________
Date ________________

Column I			Column II		Column III
Packet Lesson #	School Subject	Concepts	Suggested Place in Regular Programs	Name of Program, Text, or Unit	Skills

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Handout 4a

Column I			Column II		Column III
Packet Lesson #	School Subject	Concepts	Suggested Place in Regular Programs	Name of Program, Text, or Unit	Skills

Where I Can Use PEEC Materials in My Classroom

My Subject Area ______________________ My Name ______________________

Grade Level Taught ______________________ School ______________________

PEEC Packet Title ______________________

Lessons I Could Use

Reasons

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PEEC Packet Title ______________________

Lessons I Could Use

Reasons

Handout 4b

5 Adapting PEEC Materials to Regional Interests

In this chapter you will find a model for a three-hour workshop on fitting PEEC materials to local resources. It could be used for a regional conference or as part of an all-day energy educators workshop.

In this workshop teachers are encouraged to think of as many ways as possible to make PEEC learning units fit regional interests.

Questions such as the following will generate ideas for adapting PEEC materials:

1. Which parts of unit lessons would be most useful and interesting to students in my school?

2. Which topics bear most directly on the energy situation in my community? My school? My region?

These questions may be mailed to participants in preparation for the workshop.

3. How can the PEEC materials be adapted to bring them more in line with energy concerns in my region?

4. What regional or local resources might be used to supplement these materials?

5. How might students be encouraged to take advantage of local resources?

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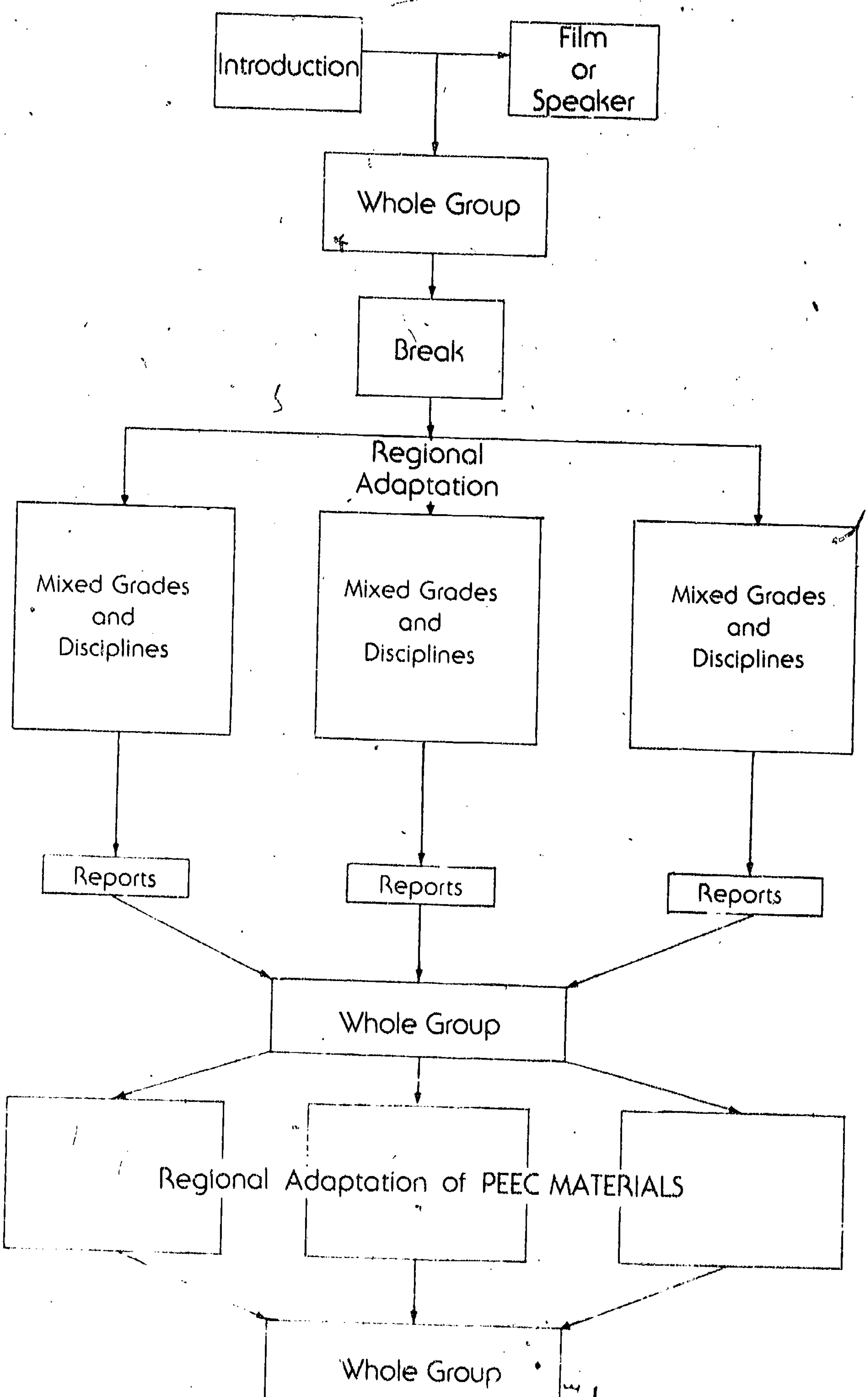
Workshop Flow Chart
Regional Interests



How to Use Local Problems and Resources to Teach About Energy

Begin by defining the workshop goal: Finding ways to adapt PEEC teaching units to fit local or regional concerns.

Make clear what products are expected to come from the workshop and what follow-up activities will be expected from the group or workshop leaders.

One good approach would be to have a speaker or a good film to introduce workshop participants to the complicated situation we call the "energy crisis." Such an activity would prepare teachers to think about energy concerns that affect their community or region. It would also set the stage for their consideration of energy concerns most relevant to the students.

Plan enough time to ask and discuss these questions:

50 minutes

1. What did we find out about the energy situation that bears most directly upon my community (my state or region)?

2. What regional or local resource could my students investigate that would help them understand our dependence on energy?

Then divide the participants into small working groups, with a mix of grade levels and teaching areas.

Handout 5a
20 minutes

Ask group members to brainstorm the following questions and reach consensus on two or three responses. Later a summary of the groups' conclusions should be noted on chalkboard or on large sheets of paper.

Attention should be paid to the history and economy of the region as well as to <u>specific</u> resources such as speakers and field trips.

1. What three or four local or regional concerns most clearly reflect national or global energy issues? (A possible example: This region is in oil shale country. Decreased supplies of fossil fuels increase the pressure to develop shale, thus affecting local employment, economy and population.)

2. What resources now exist in the community or the region that can be used to teach about these issues? (An example: A prototype shale project is in operation in the region. Field trips are a possibility.)

3. What regional materials now exist concerning these issues (printed materials, graphics, films, etc.) that could be adapted for use in the classroom? Related questions are: Are any now being used? What has to be done to the materials in order to adapt them for classroom use? What difficulties are presented in trying to adapt existing materials to classroom use? (A sample answer: Oil company supporting the shale program has produced literature on the mining process.)

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20 minutes	Next, have groups report the results of their brainstorming activities to the whole group.
40 minutes	Now move the meeting toward a discussion of how to regionalize PEEC teaching materials. Have the meeting break into small groups again, providing each group with one of the PEEC units. (If participants have not had time to become familiar with the packets, allow enough time for this.) Have group members consider these materials in light of the conclusions of the first session findings. Ask:

1. How might this unit (the one your group is examining) be used to teach about the local concerns we identified? (Example: A unit on oil imports, Energy in the Global Marketplace, illustrates why western coal is being considered.)

2. How can the unit be used to supplement those community resources we identified? (Example: A unit in which oil shale is discussed can be used together with a field trip.)

3. How might these materials be adapted to fit local concerns? (Example: A unit which features a simulated trial--"The Car on Trial," from Transportation and the City--can be used as a hearing on the arguments for and against oil shale or coal.)

20 minutes	Conclude the session with short oral reports of the groups' new conclusions.
Suggestions for follow-up activities	Teachers who actually use these materials in the classroom could report back to future workshops. Selected workshop participants could do research on the availability of local resources. (Check to see if a resource file exists in the school district. If not, participants may wish to start one.)

How to Use Local Problems and Resources to Teach About Energy

Name of Recorder | Date

DIRECTIONS: Ask group members to think o ideas as quickly as possible. Accept and write all suggestions. Then move on to the next question. Begin by reading the first question aloud.

1. What three or four local concerns most clearly reflect national or global energy issues?

2. What resources now exist in the community (or region) that can be used to teach about national energy issues?

3. What regional materials (print, graphics, film, etc.) now exist that could be adapted for use in the classroom? Why might students find these materials useful and interesting?

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6 Workshop Planning Aids

In this chapter you will find a checklist for planning an energy workshop, a list of guidelines for evaluating energy curriculum materials and a form for participants to evaluate your workshop.

The checklist is divided into three categories: long range preparation, short range preparation and activities to be performed on the day of the workshop. Although the activities listed under each of these categories are in roughly chronological order, they may not be in the best sequence for your particular circumstances.

"Guidelines for Evaluating Energy Curriculum Materials" may be mailed to participants prior to the workshop.

The workshop evaluation form should be distributed to participants on the day of the workshop.

Checklist for Planning an Energy Workshop

Long Range

_______ Decide on focus of workshop.

_______ Identify who will be eligible to participate.

_______ Secure a workshop location which has:
- _____ large room for group session
- _____ food services available
- _____ parking space
- _____ access to office equipment and telephone
- _____ access for handicapped and elderly.

_______ Find a local person to host or coordinate arrangements.

_______ Construct a budget. Include items such as equipment rentals, copying, mailing costs, food and beverages. Consider fees for participants, pay for substitute teachers, publicity.

_______ Determine methods of attracting potential participants.

_______ Prepare registration forms.

_______ Order PEEC instructional materials well ahead of time.

_______ Prepare a schedule, keeping in mind:
- _____ total number of participants
- _____ number of staff needed
- _____ number of rooms and space needed.

_______ Line up speakers, workshop leaders and films.

_______ Check with service personnel on mealtimes and menus. Arrange for beverages during the sessions.

_______ Make a list of necessary equipment:

Equipment	Specifications	Number
screens		
projectors:		
overhead, slide, film		
microphones		
chalkboards		
tape recorders		
writing materials		

_______ Consider potential problems such as illnesses or bad weather that can change session dates. Arrange for assistants to notify participants of short-notice change in plans.

Short Range

_______ Prepare final list of participants.

_______ Inform workshop participants of the purpose of the workshop and what is expected of them well in advance. Identify any materials participants should bring to the workshop.

_______ Mail a packet of materials to each participant, including:
- _____ maps
- _____ schedules
- _____ sample units
- _____ list of fellow participants
- _____ preparatory reading.

_______ Notify hosts and staff of final number of participants.

_______ Prepare all materials such as charts and laboratory supplies.

_______ Assign someone to run registration on day of workshop.

_______ Prepare name tags.

_______ Make one copy of workshop evaluation for each participant.

_______ Assign someone to produce a workshop report and to collect and summarize workshop evaluations.

_______ Become thoroughly familiar with material to be presented.

Day of the Workshop

_______ Put up signs for meeting rooms, dining areas and special meetings.

_______ Display a copy of schedule.

_______ Check with service personnel on schedules for food and beverages.

_______ Make sure display materials are visible and labeled.

_______ Make sure audio-visual equipment is set up and functioning.

_______ Make sure seating arrangements reflect purpose of sessions.

_______ Arrange for reporters in each group to record ideas.

Guidelines for Evaluating Energy Curriculum Materials

General

1. Do the lessons contain a clear statement about their recommended or suggested role in the curriculum?

2. Are the materials clear about the task the student is asked to do, or the approach the student is to take?

3. Do the lessons adequately fulfill the requirements of the stated goals or objectives?

4. Do the materials appeal to student interests and concerns?

5. Do you think students and teachers will be motivated to use the materials?

Usefulness of the Learning Materials

1. Does the material fit fairly easily into the existing curriculum?

2. Do they have immediate usefulness, i.e., is teacher training needed first?

3. Do they include everything the teacher needs?

4. Is the material technically accurate?

5. Is it sufficiently different from that already available in present texts or other sources to justify its development?

Content Organization (Scope and Sequence)

1. Is the sequence logical?

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2. Are the materials useful in both social studies and science classes, or is their usefulness limited to only one of these disciplines?

3. Are adequate alternative methodologies presented?

4. Are the examples and graphic materials sufficient and pertinent?

Evaluation

1. Are the evaluative suggestions useful? Are they in line with the stated objectives?

2. Are the questions useful, i.e., do they invite critica thinking?

3. Are adequate answers supplied to the teachers?

Overall Assessment

1. In your judgement, how effective are the materials?

   How would you compensate for the deficiencies?

2. Are the topics covered of particular interest to people in your region?

Additional Comments

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Workshop Evaluation

The responses of workshop participants on this evaluation form will enable the staff to conduct more effective sessions in the future. Responses will be confidential.

Indicate on the continuum your personal feelings about the workshop by circling the number that comes closest to your views.

1. The workshop site is:

   inconvenient — convenient

   1 2 3 4 5 6 7 8 9 10

2. The workshop site is:

   uninspiring — inspiring

   1 2 3 4 5 6 7 8 9 10

3. The workshop facilities were:

   unsatisfactory — very satisfactory

   1 2 3 4 5 6 7 8 9 10

4. The organization of this workshop was:

   rough with too many problems — smooth with few problems

   1 2 3 4 5 6 7 8 9 10

5. The workshop instructors:

   were poorly organized — were well organized

   1 2 3 4 5 6 7 8 9 10

   failed to consider level of participants — put instruction on level of participants

   1 2 3 4 5 6 7 8 9 10

6. How clear were the workshop objectives?

   not at all clear — very clear

   1 2 3 4 5 6 7 8 9 10

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7. Did the activities meet the workshop objectives?

not well matched 1 2 3 4 5 6 7 8 9 10 very well matched

8. Was there enough time allotted to this workshop?

inadequate time 1 2 3 4 5 6 7 8 9 10 more than adequate time

9. How helpful were the workshop sessions?

Session A (or 1st hour)

no help 1 2 3 4 5 6 7 8 9 10 very helpful

Session B (or 2nd hour)

no help 1 2 3 4 5 6 7 8 9 10 very helpful

Sessions C-E (or 3rd hour)

no help 1 2 3 4 5 6 7 8 9 10 very helpful

10. Other comments about the workshop: