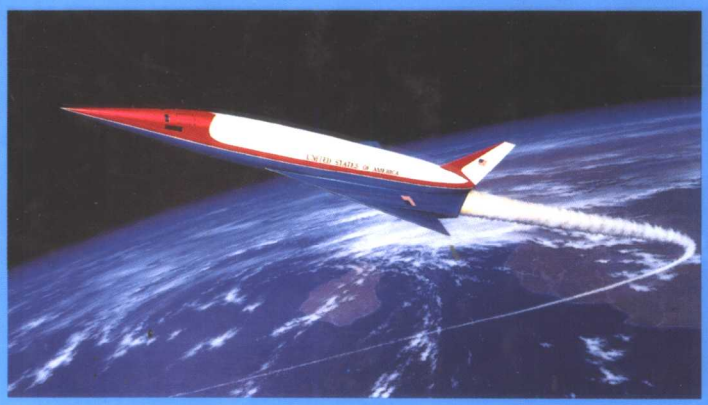
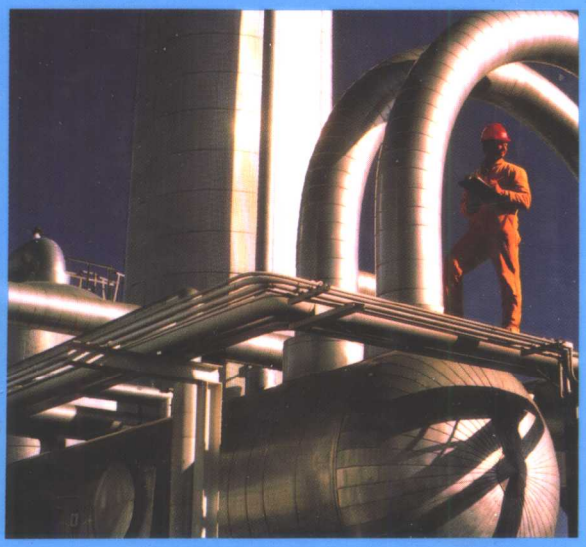
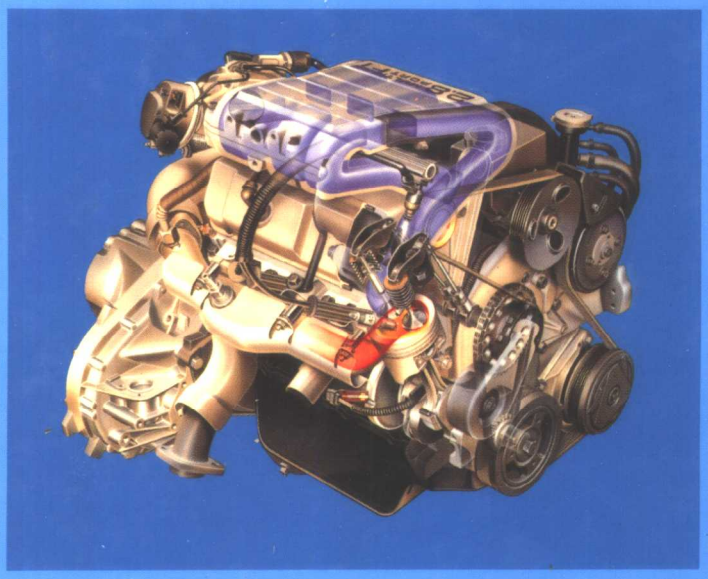
TRANSPORTATION ENERGY *and* POWER TECHNOLOGY

Anthony E. Schwaller







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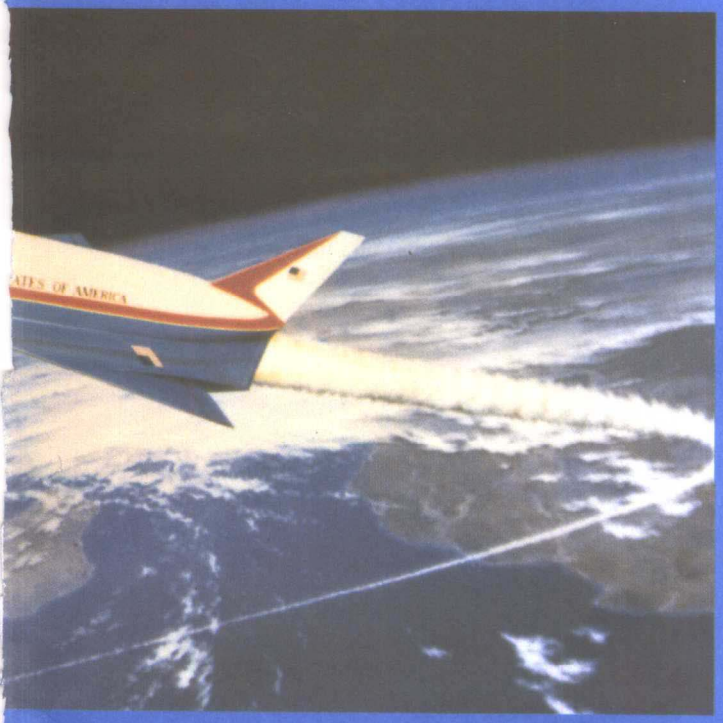
TRANSPORTATION, ENERGY, AND POWER TECHNOLOGY

ANTHONY E. SCHWALLER



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DEDICATION

The author would like to dedicate this book to his sons, Matthew and Joshua, for their continued support and understanding during the writing of this textbook.

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PREFACE

THE IMPORTANCE OF TRANSPORTATION IN OUR SOCIETY

We live in a society that is reliant upon many forms of technology. These technologies give citizens choices for improving their lives. Transportation is one of the most important of these technologies. Transportation technology has become integrated into every part of our lives on a daily basis. Because of this, most citizens today take transportation technology for granted. Due to the increased ease of moving people and products, our society has changed considerably. We are a much more mobile and transient society. Today, millions of people, products, and goods are transported continuously to keep our economy and society running efficiently.

Energy and power technology play an important part in keeping our transportation systems operating smoothly. Various forms of energy are needed to produce the correct type of power required to move people and products within our society. In addition, energy technology has taken on an increased importance within our society. Energy is not only used in transportation technology, but is also part of all other technological systems. Since the oil embargo of 1973, our society has become keenly aware of the need to develop more efficient and economical energy systems in all aspects of our lives.

SCOPE OF THE TEXT

Transportation technology is a composite of many other technologies. These technologies are all integrated and interrelate with one another. To study the total picture of transportation technology, both energy and power technology must also be studied.

Transportation, Energy, and Power Technology is a text designed for students to learn the basic concepts and principles of transportation, energy, and power. It is designed to introduce all of the major scientific and mathematical concepts supporting transportation, energy, and power. In each chapter, various scientific and mathematical principles are presented along with the technological content.

The content of this textbook is subdivided into five major sections with 20 chapters. These sections include:

Section One Introduction to Transportation, Energy, and Power (Chapter 1)

Section Two Transportation Technology (Chapters 2-8)

Section Three Energy Technology (Chapters 9-14)

Section Four Power Technology (Chapters 15-19)

Section Five The Future (Chapter 20)

SPECIAL FEATURES

This text has been developed to include a number of learning aides to help the student study transportation, energy, and power technology. Special features include:

- **Safety Guidelines.** Highlight general safety rules and procedures required in any transportation, energy, and power technology laboratory.
- **Objectives.** Show the expected learning that will take place as a result of studying the chapter.
- **Key Terms.** Highlight important vocabulary to be learned. Definitions are provided in the Glossary at the back of the textbook for all key terms.

- **Chapter Introductions.** Provide statements of the intent and overall content of each chapter.
- **Colorful Art Program.** Illustrates concepts and shows current technologies, components, and systems.
- **Chapter Summaries.** Highlight the important concepts covered in each chapter.
- **Review.** Reinforces and tests readers' comprehension of content.
- **Boxed Articles.** Cover interesting topics drawn from the transportation, energy, and power industries. Each boxed article includes one or more photographs and descriptions of the topic.
- **Techlinks.** Show how transportation, energy, and power content correlates to math and science principles and to other areas of technology.
- **Chapter Activities.** Reinforce the technological concepts presented in a hands-on laboratory setting.
- **Glossary.** Provides definitions of all terms introduced in the chapters.
- **Mathematical Appendix.** Highlights all of the mathematical formulas discussed throughout the textbook.

ACKNOWLEDGMENTS

The author would like to thank several people who contributed to the completion of this textbook. Thanks should go to the staff at Delmar for their continued help, support, and encouragement during the writing of the manuscript. Special thanks should also go to Patricia Zak, who helped in preparation of the manuscript. In addition, the following individuals reviewed the prospectus and offered suggestions for improvement. Their assistance is appreciated.

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ABOUT THE AUTHOR

Anthony E. Schwaller has been involved with transportation, energy, and power technology for many years, beginning as an automotive technician. He also worked as a technical trainer for General Motors in Detroit, Michigan. After leaving Detroit, he taught energy and power technology at Eastern Illinois University, Charleston, Illinois, and at St. Cloud State University, St. Cloud, Minnesota. He is currently serving both as a professor and administrator within the Department of Industrial Studies at St. Cloud State University.

The author received his B.S. and M.S. degrees from the University of Wisconsin-Stout, and his Ph.D. from Indiana State University. He is the author of three other textbooks, as well as more than 35 articles, and has presented some 40 papers and addresses at various conferences in the field of transportation, energy, and power technology.

SAFETY GUIDELINES

SAFETY GUIDELINES FOR THE TRANSPORTATION, ENERGY, AND POWER LABORATORY

Many safety rules and guidelines must be followed when working in any technology laboratory. Accidents often happen because laboratory rules are not followed. Common laboratory rules to follow in any transportation, energy, and power laboratory are:

1. Always wear safety glasses in and around the laboratory. Make sure the glasses fit comfortably and have side shields.
2. Make sure you know the location and operation of all fire extinguishers. Also, check them occasionally to make sure they have been inspected and are filled correctly.
3. Keep all flammable materials in nonflammable, explosion proof cabinets and containers.
4. Always wear protective gloves when working with cleaning chemicals, when grinding, and when working with hot metals.
5. Make sure you know the location of the first-aid kits in the laboratory. Also, check the contents occasionally to make sure there are sufficient first-aid materials available.
6. Always wear sound protection devices for your ears when working in areas where engines are operating.
7. Make sure you use proper lifting and carrying procedures for heavy parts. When lifting, get as close to the object as possible and keep your back straight. Remember to lift with your legs, not your back.
8. Good housekeeping is important to a safe laboratory. Always put all tools away, keep floor surfaces clean from grease, and keep all tools and equipment in proper working order.
9. When running engines in the laboratory, always remember to run the exhaust outside. Carbon monoxide could build-up and cause headaches, nausea, ringing in the ears, tiredness, and a fluttering heartbeat.
10. Always use proper clothing when working in any transportation, energy, and power laboratory.
11. When working with batteries, always guard against acid spills and splashes. Always have baking soda on hand to neutralize acid burns. Make sure there is an eyewash area in the lab to rinse and wash eyes.
12. Always use the proper tools for the job. If you are unsure of the correct and proper use of the tool, always check with your instructor first.
13. Many operations in a transportation, energy, and power laboratory have a *correct procedure list*. Always follow this list exactly to complete the job safely and correctly.
14. In most cases, parts should never be forced together. Parts are usually designed so that they assembly easily and without force.
15. Always remove all metal jewelry (rings, watches, and so on) when working with moving parts and electrical and mechanical components.

Courtesy of The General Fire Extinguisher Corporation

SPECIFIC SAFETY RULES

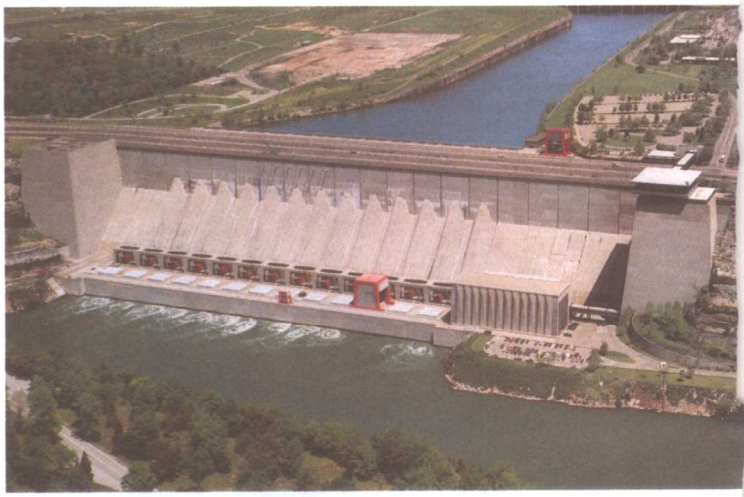
Many situations call for more specific safety rules, such as the following:

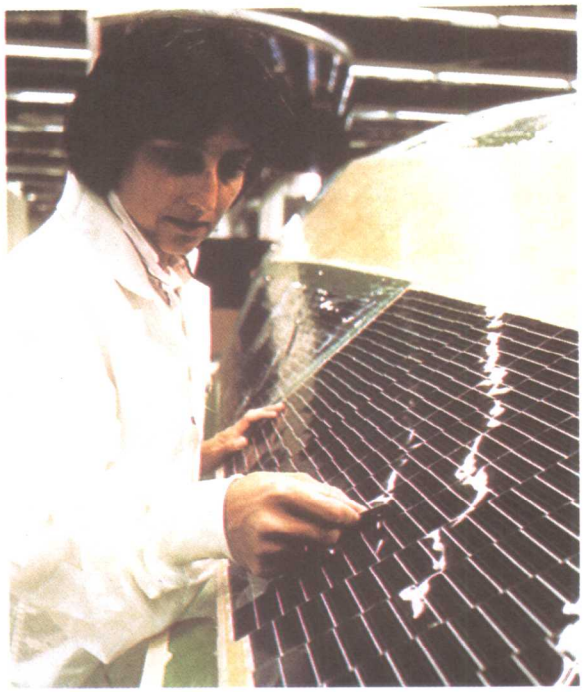
1. Always tighten all bolts and nuts with a torque wrench to the correct specifications.
2. Never use an air gun with high pressure to dry or spin roller bearings or ball bearings.
3. Many engine, transmission, and energy components have sharp metal corners. Always be careful not to cut your hands when lifting or moving these parts.
4. Many engine, transmission, and energy components are very heavy. Always use the proper lifting tools when moving these parts. Jack stands, block and tackles, hydraulic lifts, and so forth should be used as necessary to lift these parts.
5. Often, parts that are under tension need to be removed. Always be careful to account for this tension when removing parts and other objects from transportation components.
6. Certain transportation and energy components contain fluids that are under pressure. Always be sure to release this pressure correctly before working on these components.
7. Gasoline and other fuels are very toxic when inhaled, and also dangerous to the skin and eyes. Be careful not to inhale these fumes, and always protect your skin from these fuels by washing with warm water to flush away the fuel. Also, never work on any electrical components when fuel has been spilled nearby. An explosion and/or fire may result.
8. Many transportation, energy, and power components have spinning parts, such as fans, motors and blades. Always be careful to protect your hands from these spinning objects.
9. Many components on transportation, energy, and power devices are very hot. Always be careful not to touch hot parts to prevent burning your hands and skin.
10. When batteries are charged and discharged, a hydrogen gas is often produced. Any small electrical arc could cause this gas to explode violently. Never disconnect any electrical wire near a charging or discharging battery.

Courtesy of Eagle Manufacturing Co. and Sellstrom Manufacturing Co.

Courtesy of Western Drinking Fountains, Emergency Equipment Division

CONTENTS

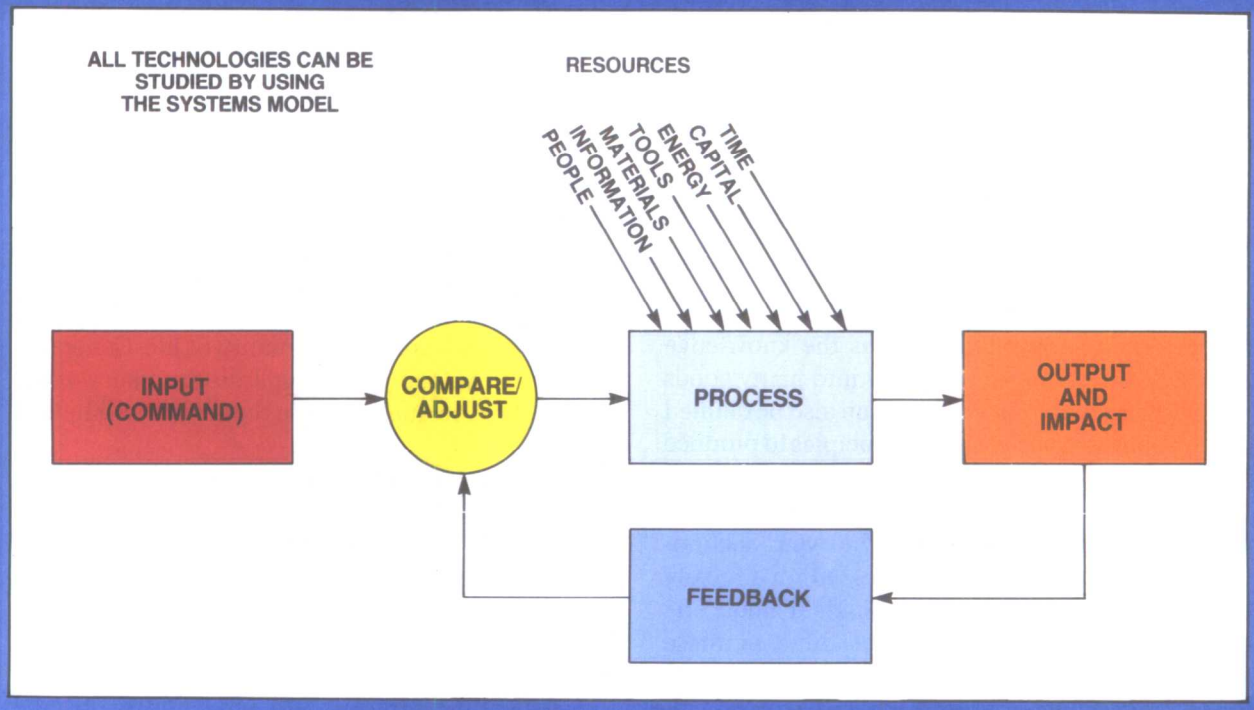




SECTION ONE

INTRODUCTION TO TRANSPORTATION, ENERGY, AND POWER TECHNOLOGY

This section addresses transportation, energy, and power technology. Transportation is supported by energy systems and energy systems are further supported by power technology. Other technologies such as production and communications also require energy technology. The text is organized so that transportation (a major system of technology) is presented first. Then energy is addressed, followed by power technology. A systems model can be used to study all three of these technologies. As shown, the systems model includes input, process (including resources needed), output and impact, and feedback elements.



CHAPTER 1

Transportation, Energy, and Power Technology

OBJECTIVES

After reading this chapter, you will be able to:

- Define *transportation, energy,* and *power,* and tell how they are interrelated.
- Describe the systems approach to studying technology.
- Explain how to make logical and sound decisions about technology.
- Identify potential careers in transportation and power technology.

KEY TERMS

Technostructure	Process	Feedback Loop
Input	Output	Technological Impact

Introduction

Our society is made up of many systems of technology. *Technology* is defined as the knowledge used to change various resources into many goods and services used by a society. It can also be defined as the application of scientific principles to produce products needed by a particular society.

Many technological systems work together to form a total technostructure. The word *technostructure* means that technologies within a society are highly interrelated and dependent upon one another. This textbook is about three of these systems of technology: transportation, energy, and power technology.

Transportation over the past years has become an ever-increasing part of our lives. The transportation revolution has taken place in the past 150 years or so. Transportation systems and networks help all of society to improve the quality of life. Generally, the more choices one has regarding transportation, the higher the quality of life that exists within that society.

Energy is also very important within our society. Energy is the fuel for all of our transportation systems. Without energy, our transportation systems would not function efficiently.

Power, the third area, is also very important. The power section in this textbook is designed to show how energy is converted into useful forms to be used in transportation and other forms of technology. This chapter introduces transportation, energy, and power.

Transportation, Energy, and Power Technology

Many technological systems are used within a society. The most common technological systems include communication, production and transportation. This book is about transportation technology, and the necessary support needed from energy and power technology.

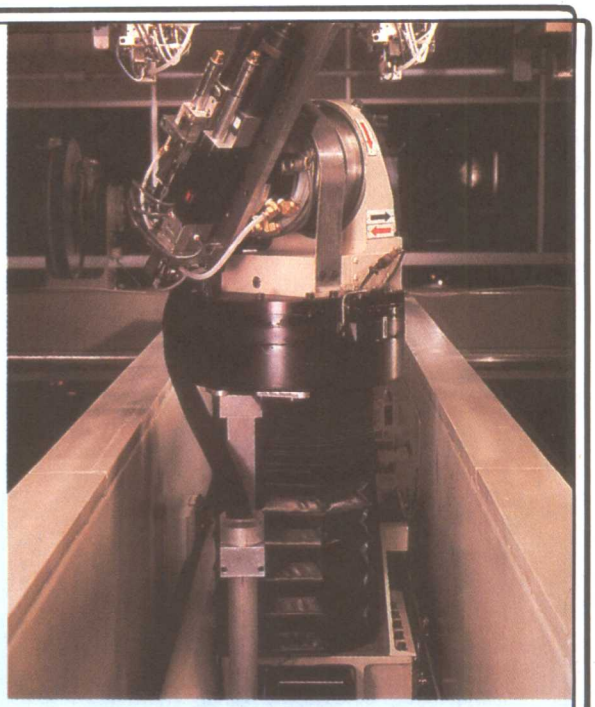
Transportation

Transportation is defined as any technology that is used to move people and products (goods) within a society. Figure 1-1 shows several forms of transportation. In order for our technological society to function, many things must be transported. People are transported by automobiles, buses, trains, ships, aircraft, bicycles, and so forth. Goods, such as food,

FIGURE 1-1 These technologies are all considered forms of transportation. *Courtesy of (A) Freightliner Inc., (B) British Airways, (C) Sante Fe Southern Pacific Corporation, and (D) Texaco Inc.*

Gantry Robot

Robots are also considered a form of transportation within industry. In any industrial process various parts must be moved from one point to another. In addition, robots perform a variety of tasks during manufacturing. Robots are used to do particular processes such as drilling, welding, etc. Moving on a 50-foot long gantry, two feet above the work surface, this robot drills and deburrs holes in the 47-foot long floor panels for an aircraft. Because of their efficiency, accuracy and cost, robots are fast being integrated in all manufacturing and industrial processes. *Courtesy of Lockheed Corporation, Dick Luria, photographer*



merchandise, and such fuels as natural gas and coal are transported in several ways, including trains, trucks, buses, aircraft, ships, pipelines and conveyers.

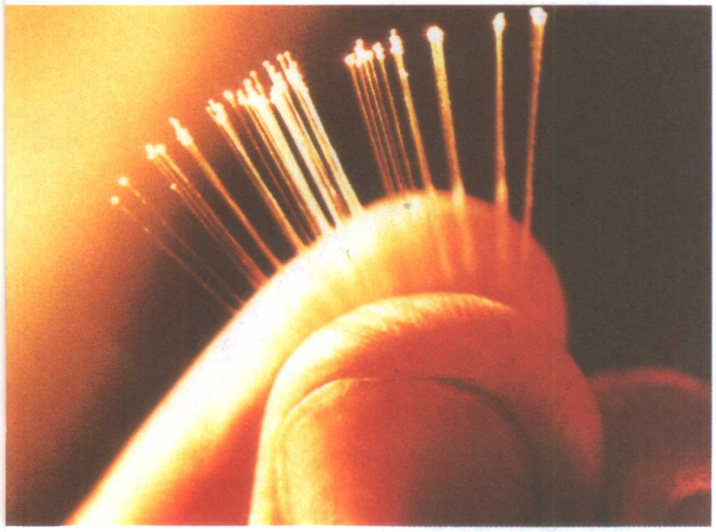


FIGURE 1-2 Information can be transported by using glass fiber technology. Information can be sent and received at an extremely rapid rate. *Courtesy of United Telecom*

In today's advanced technological society, information, as a product, must also be transported. Information can be transported by electrical means and satellite technology, and through glass fibers built into a single cable. Figure 1-2 shows glass fibers that have been installed to link several communication centers together. This technology is one of the fastest and most powerful means available to transport (send and receive) information.

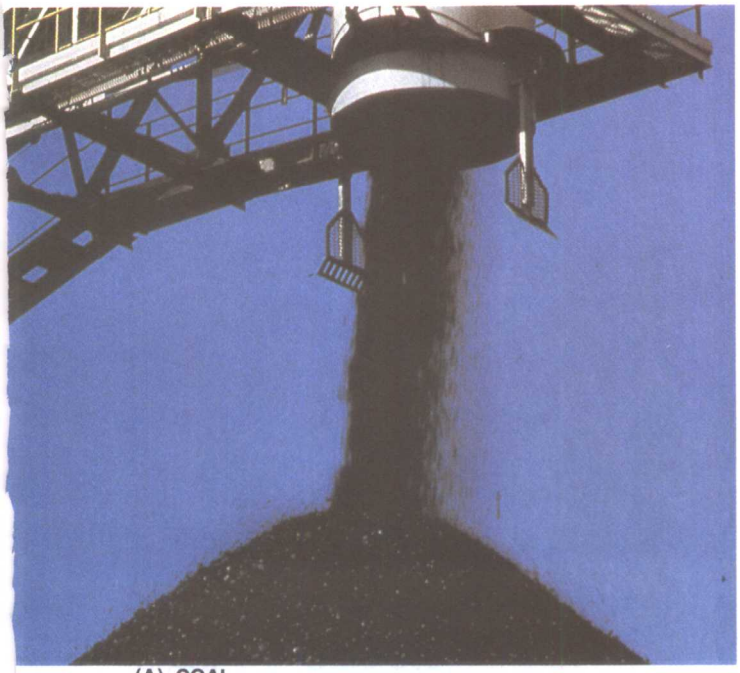
When looking at the total scope of transportation in a society, one finds a variety of modes used to satisfy transportation needs. Some of the many modes of transportation technologies include:

Automobiles	Spacecraft	Lift Trucks
Buses	Motorcycles	Hovercraft
Aircraft	Snowmobiles	Rafts
Bicycles	Ships and Boats	Monorails
Conveyers	Skis	Trains and Subways
Elevators	Pipelines	
Escalators	Farm Tractors	Moving Sidewalks
Trucks	Cable Cars	

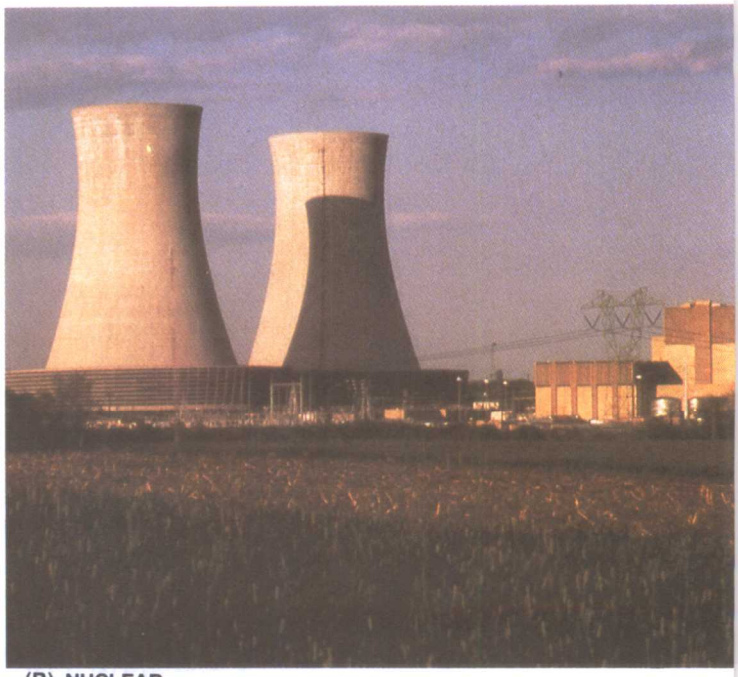
Energy

Energy is defined as the ability to do work. Energy is usually associated with fuels and other resources. These resources may include coal, oil, natural gas, nuclear, wind, solar and hydroelectric, among others.

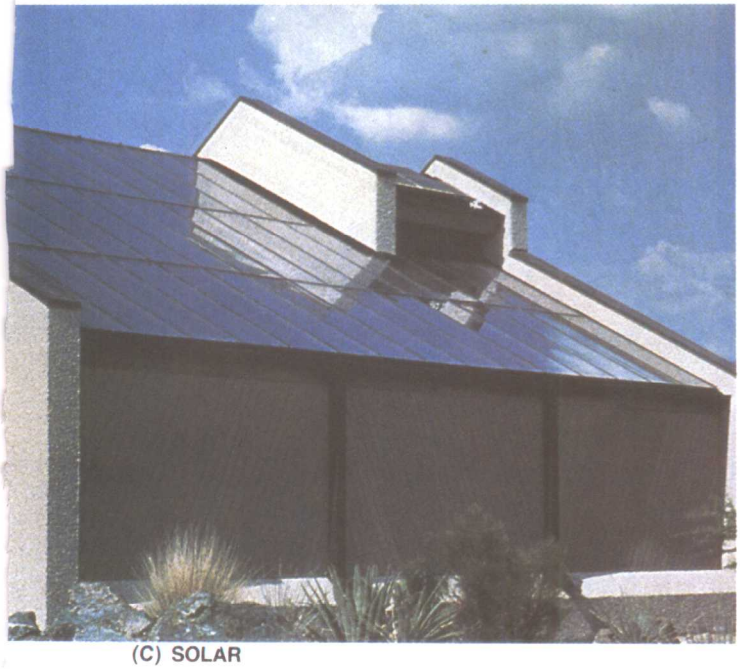
Figure 1-3 shows several forms of energy. The resources shown are all considered energy, waiting to be used in a power source. Usually, however, the energy must be converted into the correct form before being used.



(A) COAL



(B) NUCLEAR



(C) SOLAR

(D) WIND

FIGURE 1-3 All of these examples are considered forms of energy. *Courtesy of (A) Gulf Oil Company, (B) Bechtel Group Inc., (C) Standard Oil Co., (D) Southern California Edison Company*