

## Preface

The history of energy and man's use of energy is the history of the inventions that have become modern manufacturing, transportation and communications. Energy industries have evolved from small-town shops to a few very large firms with annual sales approaching one trillion dollars per year. Contests between the industrial barons seeking to maximize their profit and government officials elected to represent the interest of individual U. S. citizens read like novels with villains and heroes crossing the battle lines in both directions. Add to this mix the special interest groups (often representing a single issue) usually speaking with a shrill voice, and there is little common ground that represents acceptable energy strategy for the 21<sup>st</sup> century. The average citizen is lost in the confusion of the battle between economic, political, environmental and social issues. In this confusion, knowledge is power, and the average citizen has yet to yield this power to its potential.

Our purpose for writing this book is to help you, our reader, better understand energy sources and the ways they are made available for your use. While biology, chemistry, and science are commonly taught in secondary schools, colleges, and universities; energy science and technology are only sparingly covered outside college curriculum in engineering or geology. It is important that every citizen be well enough informed to ask candidates for elected office to explain proposed energy policy. Our objective is to provide energy information that can help this interested citizen.

Energy's history on earth starts with the sunlight that helped form wood and living organisms. Wood and living organisms are the raw materials stored by nature and transformed by geological processes over millions of years to give us coal, petroleum and natural gas. Wood warmed the cradle of civilization. Coal was probably first used 2000 years ago, and more recently, it powered the industrial revolution starting about 1700. Liquid fuel is easiest to use in engines and served to power the modern automobile. The first fixed wing aircraft flew using this same liquid fuel just after 1900. Liquid petroleum fuels made the 20<sup>th</sup> century the petroleum age with the mid-century addition of natural gas pipeline distribution.

Our ancestors didn't know it, but it was this solar energy that produced the winds to push ships and turn windmills. It evaporates water from the salty oceans that the winds carry to high places where the fresh water of rains fed streams and rivers that turned their water wheels. The rain that is essential for our food supply and our lives would end in hours without the energy from the sun. Solar energy is the source of life on earth!

Prior to the sun's radiation touching earth, atomic energy was shaping the universe. Man tapped into the power of nuclear energy near the end of

World War II with two thunderous explosions over Japan. Two city centers were leveled and thousands of people evaporated.

This unfriendly introduction to nuclear energy has produced the attitude among many that everything nuclear should be banned. Even the name ~~Nuclear~~ Magnetic Resonance Imaging (an important medical diagnostic tool) had to be changed to calm patient anxiety. Attitude withstanding, nature's nuclear energy touches us in the form of the sun's radiation and geothermal heat every day. And when confronted with depleting oil and coal reserves, we cannot ignore the huge energy reserves available through nuclear energy.

Today, there are over 100 nuclear power plants in the U. S. producing about 20% of the electricity we use every day. A few pounds of "nuclear fuel" replaces thousands of tons of diesel or coal fuel, allows a submarine to cruise under water for months instead of hours, and provides electrical power without the air pollution associated with burning coal, petroleum, and vegetation.

The source of this nuclear energy goes back to the time when atoms were formed, long before our solar system existed. All of the atoms that we find in the gases, liquids and solids on earth were assembled in and among the stars from the particles and energy that make up our sun and the rest of the Milky Way Galaxy. The history of energy starts, and ends, with nuclear energy.

### **Organization of the Book**

The chapters of this book are intended to be self contained. This results in duplication of topics, but it should be easier to read where you have special interest.

Chapters 1, 2, and 3 cover the history of energy, the reserves and some of the renewable resources available to us.

The story of energy through the 19<sup>th</sup> and 20<sup>th</sup> century depends on the work produced by hot gases expanding in engines (machines designed to do work). The science and technology of the development of these machines is summarized in Chapter 4. Chapters 5, 6, and 7 describe the technologies that provide transportation, electricity and the equipment we use to heat and cool our homes and workplaces.

Chapter 8 looks at the battle between economic, political, environmental and social issues from an entirely new perspective. The perspective is on government policies and how these policies can unintentionally take away incentives to invest into new U.S. technology and infrastructure. The defaults are either investment into foreign infrastructure or simply not commercializing the very technology that will solve today's greatest social problems. Here, the widespread identification of this problem is the most important step toward its solution.

Chapter 9 evaluates alternative energy sources and technologies. We depend exclusively on petroleum fuels for transportation, and any interruption of our

supply of imported petroleum can become an instant economic and social problem. Coal is the main source of fuel for electric power production; here, the competition from other energy sources keeps the price of electricity fairly stable. Known and emerging technologies can stabilize energy prices and create security from unemployment and military conflict.

Chapter 10 considers how changes in the energy infrastructure and economy can occur. The energy industries and the distribution network are run by a few huge industries. It will take billions of dollars to build any alternative energy source that can provide even 5% of our current use. Any changes made in the national energy system won't happen by accident, and these changes will take two or three decades to occur. The energy future is much too important to society to be left to industrial leaders. Informed citizens, and especially the government officials they elect, must be involved in these decisions.

### **Acknowledgements**

Discussions with colleagues led us to write about the strong interaction between science and technology, economics and legislation in our modern society. We thank the hundreds of students who have been patient with our presentations and taught us that the KISS (Keep It Simple Stupid) theory of teaching really works. Complex solutions are best formulated by answering a series of well-stated simple questions.

The hospitality of the Chemical Engineering Department shown to a professor in retirement (TSS) served as an inspiration and made this writing project possible.

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