

Franklin Hadley Cocks

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# Energy Demand and Climate Change

Issues and Resolutions



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Issues and Resolutions



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*To the memory of my parents,  
Ruth and Charles*

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## Prologue

Global warming will pluck the strings of Nature's many instruments, but we may not like the melody they play. Much has been said about climate and the interdependence of civilization and energy. Numerous writings advocate particular aspects of the problems that climate change and energy shortages will cause. Some people take the position that there is no problem at all. The book now in your hands presents the facts—the scientific and engineering rules of the game—that govern the chess match now underway between humanity and nature, so that you may judge for yourself what is happening and the validity of the various positions being advocated. Science and engineering truths are independent of political viewpoint or vested interest.

A huge knowledge base envelops every facet of the energy and climate debate. The goal of this book is to pull together the fundamental facts of this ongoing saga and to present the near-term and long-run choices ahead of us and their consequences. The temperature of our planet has changed repeatedly in the past and is in the process of doing so again, with far-reaching and complex effects that will slowly unfold. Knowing what has happened in the past can help us to understand what is underway now. The fossil, nuclear, and renewable resources of our planet are a guide to planning what might be done, while there is still time.

Part I gives an overview of the human use of energy as it has evolved through the ages as well as the astronomical and atmospheric factors that have dominated our planet's climate. Earth's slow but inevitable orbital changes have an enormous and long-term influence on global climate, especially the periodic onset of ice ages. Humanity's ever-expanding consumption of energy has contributed greatly to the betterment of living standards, which depend critically on fossil fuels, whose supply is not infinite. Earth's nuclear fuel resources are large, but making use of them generates its own special problems.

Part II presents energy options that can be called into being with the technology that exists right now. Increased efficiency of energy usage and energy from renewable resources including wind, sunlight, and many others offer a variety of possibilities, each having different potentials and limits.

Part III discusses the energy and climate-changing possibilities that are only dreams now but might someday come to be. Thermonuclear fusion, breeding nuclear fuel, artificial changes in planetary albedo, magnetohydrodynamic



electricity production, power from ocean thermal and salinity gradients, and other technologies are possible. Each of these also has both potentials and limits.

Part IV offers a glimpse of the devastating energy and climate possibilities that might envelop us if we just keep going along the way we are.

Our age is filled with problems and promises. The more people there are who understand the basic facts of the energy and climate events now underway and the options we have for dealing with them, the better chance there is for all of us to find a path that leads to a more abundant future for ourselves and our posterity. The choices we make now may determine whether or not our age marks the onset of Nature's checkmate move.

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## Part I Questions





## Introduction

Civilizations come and go, but why? There are many reasons, especially the proverbial four horsemen of the Apocalypse—war, famine, disease, and death. Battles have been won or lost. Droughts have desolated rich agricultural lands, and animals have been hunted to extinction. Epidemics have waxed and waned. In the 21<sup>st</sup> century our planet supports a larger population than ever before in its long history. The climate of the world has begun to change, and that unfolding event will affect everyone. Those four horsemen might begin to saddle up, armed now with nuclear weapons and virulent diseases. The number of mouths to be fed and the world's demand for energy grow larger with each passing day. The Earth is not infinite in extent, and neither are its resources. How is this to end?

Recent history shows that average birth rates may decline as living standards improve, and in many lands living conditions have been progressing. Before the advent of chemical means of birth control, better living conditions usually led to an increased rate of population growth, except under particular conditions. The French aristocracy in the 18<sup>th</sup> century, for example, made special attempts to limit any increase in their numbers in order to decrease difficulties associated with inheritance and the subdivision of estates. But as a general rule, increased prosperity can reduce population growth by making birth control and education available to more men and women, who have a greater expectation that their children will survive to adulthood. Overpopulation, posited in 1798 by the English demographer Thomas Malthus in his *Essay on the Principle of Population*, has been kept at bay by improved farming technology, genetic manipulation of crops, better education, birth control, greater prosperity, and the increased use of energy. In the year 2000 the world's population was 10 times higher than it was 300 years earlier. The population of the Earth has increased from 2.5 billion to more than 6 billion since 1950 alone, and average energy consumption per person more than doubled in that same period. The peril of runaway population growth might be eliminated if the world's economic output could increase sufficiently. Standards of living and energy consumption rise in unison. The energy from fossil fuels is the horse out in front pulling the world's economic wagon, but fossil fuels are not inexhaustible. Petroleum is especially limited in its total planetary supply. When there is demand for more oil than the Earth can readily yield, its cost will increase until supply and