
Interest in alternative, renewable sources of energy has been heightened over the past decade by a number of factors. Economics: To most people, the oil price shocks of 1973 and 1979 signaled the end of cheap and plentiful liquid fuel; the large investment cost of building central-station electric generating facilities, combined with a slowed rate of growth of demand for electricity, has many planners rethinking construction of large nuclear and coal-fired power plants. The Environment: The atmospheric warming that will accompany a continued release of carbon dioxide (which results from fossil fuel combustion) may lead to significant alteration of global climatic patterns, with attendant effects on climate-dependent activities like agricultural production; acid rain, resulting from the burning of high-sulfur coal, is beginning to adversely affect the growth of forests in Canada and the Northeastern United States. Global Security: The disrupted flow of Middle Eastern oil supplies in the 70s highlighted the uneasy dependence that many nations have on imported oil; the danger of nuclear weapons proliferation will increase with the spread of reprocessing-based nuclear power technologies like the breeder reactor.

Transitions to Alternative Energy Systems attempts to understand, through a series of case studies, the roles of technical and social entrepreneurs, policy-makers, and other change-agents in the development of alternative energy technologies (solar, wind, geothermal, wood, peat, and heat pumps) which would help alleviate some of the foregoing problems. As the book clearly indicates, the introduction of a new technology requires more than simply showing technical and economic feasibility to guarantee success. Also of major importance are sociopolitical elements, including public perceptions of a new technology (as affected by marketing strategies), the influence of monopolistic industries (e.g., through political lobbying efforts), the inclinations of politically powerful individuals and institutions, and the degree of change required from traditional systems.

Baumgartner and Burns begin by posing a number of questions which the authors of the case studies attempt to answer: How has energy-related innovation been introduced? Who were key actors and what were their motivations and strategies? What were major facilitating and constraining factors? How were constraints overcome? What role did federal, state, and municipal agencies play in affecting the transition? What are current constraints on and opportunities for further development of alternative technologies? Answers to these questions are sought through the use of a methodology that the authors term compatibility analysis, involving the study of how a new technology will fit into an ongoing social system, how effectively it can be used in this system, and the positive and negative consequences of introducing it.

As is clear from the individual case studies, the successful introduction of alternative energy systems depends on very different mechanisms from one case to the next. For example, the development of solar energy use in Israel, an undisputed alternative energy success story, was facilitated primarily by the interest that Ben Gurion maintained in the technology during his tenure as Prime Minister, resulting in continuous research and development funding even during times of plentiful and cheap petroleum supplies. In addition, Israel's unstable relationship with oil exporting neighbors has always acted as an incentive to develop alternative supply sources. Israel, being a relatively young nation, has grown up with solar energy as part of its culture, an unquantifiable factor, but also one that greatly aided development of the solar energy sector.

The introduction of solar water heating in California resulted largely from a movement among "lifestyle-conscious" people and was aided by legislated incentives and those that addressed quality control and solar easement questions. While the oil price shocks of the 1970s tilted the economics of water heating in favor of solar systems, only swimming pool owners utilized solar technologies to any significant degree. As a result, marketing strategies are now turning away from the lifestyle emphasis toward encouraging pragmatic consumers to make their own economic comparisons to see the cost advantage of solar.

As with solar in California, wind energy use developed in Denmark as a result of lifestyle-conscious individuals who made significant technological breakthroughs on their own. The environmental movement, aided by oil price increases, helped to spread the awareness of these achievements. In addition, the formation of a wind energy trade association lent legitimacy to wind energy, facilitating its further development.

Other case studies deal with the introduction of heat pumps in the Federal Republic of Germany, the development of geothermal energy for electricity production in California, the increasing use of wood for industrial processes in Northern New England, and the evolution of peat as a common energy source in Finland.

Citing the case studies for specifics, Baumgartner and Burns conclude that alternative technologies evolve within sociotechnical systems in which a number of players with different motivations act to establish the success or failure of the technology. Energy prices, legislation, and accepted cultural norms are all important factors which can facilitate or impede technological development. As well, utilities and sociopolitical movements can play major roles throughout the development process.

The editors continue to try to develop a theoretical framework to apply more generally to the analysis of technological innovation, but given the complexity of the
interaction (as is emphasized throughout the book) among all the different factors leading to introduction of an alternative technology in any one case, such a framework is both difficult to develop and of questionable value.

Perhaps the most useful chapter in the book is the last one in which guidelines are suggested for facilitating the development of new technologies. For all actors involved (government, utilities, individuals, etc.), these include maintaining open information networks, discouraging monopolization, and minimizing biases, so that from an equal footing, the "best" technologies can be selected for development. Two principles are set forth concerning governmental action, which is singled out as particularly influential in the process of technological change: (1) Generally, the earlier the phase of development, and hence the greater the uncertainty in the value of a certain technology, the less government should be directly involved—winners should rise to the top, they should not be picked. In this phase, indirect government support, in the form of research and development funding, as an information supplier, and in general as a facilitator of an unconstrained development process, is still important; (2) The greater the role that a government will ultimately play in the production, distribution, and use of a given technology, the greater can be its involvement once some of the uncertainty surrounding the success of a given technology is lessened. Within the constraints of these principles, Baumgartner and Burns suggest a number of specific policy strategies for effecting transitions to alternative energy systems, ranging from manipulation of energy prices to encouraging (e.g., through incentives and subsidy programs) economically weak groups to invest in alternative energy technologies.

While many of these specific policy strategies and the general lessons drawn from the case studies could be applied to both new energy supply technologies and to new energy conserving technologies, the authors have focused on the former—how to replace troublesome supply sources (fossil fuels, nuclear power) with less troublesome ones (solar, wind, geothermal, wood, peat). However, it is often cheaper and less disruptive from a societal perspective to utilize alternative technologies that provide the same, or higher, levels of energy services (e.g., hot water, light), but which require significantly less energy than technologies in common use today. Given this fact, the focus on energy supply, rather than on the services energy provides, is one of the substantive shortcomings of a book that otherwise addresses important issues concerning the evolution of energy systems for the "post-petroleum" era in industrialized societies.

The book is useful reading for energy policy analysts, members of social change movements, technological entrepreneurs, and others with an interest in effecting greater use of alternative, renewable energy technologies, but the language used is heavily sociological, reflecting the training of most of the contributors, so the substance may best be appreciated only by sociologists. This is unfortunate because, as is also one of the main theses of the book, communication between and interaction among many disciplines is essential for the successful introduction of alternative energy systems.


The emphasis of this excellent book lies on the end use, rather than on the supply of energy. Thus it is a good complement to texts on power generation such as Engineering Evaluation of Energy Systems by A. P. Fraas (McGraw-Hill, New York 1982), to name a fine example. Mitchell looks at energy use in buildings, transportation, in industry, etc., with special attention to opportunities for energy conservation. He surveys all the relevant technologies, analyzes their performance, and evaluates their economics.

The introduction sets the stage by showing how energy has been supplied and how it has been used in the past. Consumption patterns since 1950 for the United States are presented, disaggregated by end-use and by fuel type, and they are related to energy price changes (both in inflating and in real dollars). Projections for the future are suggested to emphasize the need for more efficient utilization of energy.

The second chapter shows how to calculate the life cycle cost of energy systems; it is well placed at the beginning of the book because it applies equally to all energy technologies.

Chapter Three analyzes the heating load of buildings. Mitchell presents not only the usual ASHRAE recipes for design day (i.e., peak) heating requirements, but he shows how to determine the annual consumption, based on the steady state model with variable base degree days. A formula is given for estimating the number of degree days relative to any balance point temperature.

Cooling is the subject of the next two chapters. The discussion includes such topics as the effect of clothing and of comfort conditions on cooling demand, and the relation between lighting and cooling loads. Mitchell also describes the different cooling systems of commercial buildings and shows why they can have a large effect on heating and cooling loads.

Chapter Six presents a clear analysis of furnace performance, both steady state and seasonal. Opportunities for improvements are highlighted, and recent developments are mentioned such as the highly efficient pulse-combustion furnace. This is followed by a comprehensive chapter on heat pumps; it includes a simplified method for finding the seasonal average COP.

The discussion of power generation, Chapter Eight, is centered around the concept of availability. In keeping with the emphasis on conservation, Mitchell presents an interesting comparison of conventional power plants with cogeneration and district heating systems. Chapter Nine develops gas-fired heat pumps, also based on the availability concept.

The potential for energy savings in industry is illustrated in Chapter Ten with several important examples: the use of insulation, heat recovery, heat pumps, refrigeration, and recycling. The chapter on transportation shows how much power is required for ground friction, air friction, acceleration, etc., and how much could be saved by improved design. The discussion of the 55 mph speed limit in the United States is a good example how Mitchell looks at both costs and benefits. The book concludes with a chapter on renewable energy sources: biomass, wind, and solar.

Mitchell's book combines clarity and conciseness. He has shown good judgment in selecting the topics. The material is very up-to-date. Many examples are given, well integrated with the text. As always when presenting specific numbers for new technologies one is liable to be criticized for being either too optimistic or too pessimistic. I find that in general Mitchell's assumptions are very reasonable; also the analysis is so clearly developed that the reader can readily insert his own favorite numbers.

I find only few and minor points to criticize. The fact that

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