Journal of Solar Energy Engineering

Book Reviews

The Exergy Method of Energy Systems Analysis, John E. Ahern, John Wiley & Sons, Inc., New York, 1980, 295 pages, $27.50

In the introduction to this text, the author states that he initially planned to simply collect translations of Russian papers on exergy analysis, but then decided that a thorough presentation of procedures would encourage a fuller use of the method. This text succeeds in these two goals. The collection of translated Russian papers is unique and very valuable. The methodology of exergy analysis is clearly presented and applied to representative problems. However, the book suffers from repetition in wording of the text and numerous errors in the equations and numerical examples. For example, on page 2, second paragraph, it is stated that "the fundamentals of the exergy method are embodied in the principals of entropy production in the second law of thermodynamics that are well described in thermodynamic textbooks, many of which are listed in the bibliography at the end of this book; however, the application of the second law of thermodynamics has been limited." On page 38, it is stated that "The exergy method of analysis is based on the second law of thermodynamics and the concept of irreversible production of entropy. The fundamentals of the exergy method were laid down by Carnot in 1824 and Clausius in 1865. Although all thermodynamic textbooks have chapters on the second law in entropy, the use of the second law has been very limited." Practically the same words are repeated elsewhere in the text. There are also many other examples of repetitious wording. Some typical examples of errors in the equations appear on page 29. On this page appears the expression $P_2 \div P_1 = V_1 \div V_2 = (P_2 \div P_1)^{1 \div \gamma}$. Obviously, this equation should be:

$$V_1 \div V_2 = (P_2 \div P_1)^{1 \div \gamma}$$

On the same page, the expression

$$V_3 = T_3 \div T_2$$

appears. This should obviously read

$$V_3 \div V_2 = T_3 \div T_2$$

Later on the same page, the expression $Q = WC_P\Delta T$ appears. In the proceeding discussion, and in the nomenclature, W is defined as representing work. This expression should read: $Q = MC_P\Delta T$.

In the first table, on page 76, a column of figures is given under the heading of Entropy, which result from multiplying the two proceeding columns, one by the other. The first line in this table, for example, states that

$$0.72 \times 0.11 = 0.082 \quad \text{as a value of entropy}$$

However,

$$0.72 \times 0.11 = 0.0792.$$

The next line in this table is also incorrect.

There are numerous other examples of errors in equations and numerical errors. All of these examples may be due to poor editing or hasty writing. The effect is to detract greatly from the quality of a book which may in fact be very useful because of its compilation of translated Russian articles and presentation of exergy analysis methodology. This book is not to be recommended for students and others who might have difficulty recognizing the errors and correcting them.

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A New Prosperity: *Building a Sustainable Energy Future*, Henry Kelly and Carl Gawell, Brickhouse Publishing, Andover, Mass., 1981, 462 pages, $19.95

This book is based on a study conducted by the Solar Energy Research Institute. In late 1979, SERI was approached by John Sawhill, then the Deputy Secretary of the Department of Energy (DOE), to investigate the possibilities for saving energy through the year 2000 by applying available conservation methods and alternate energy technologies. The purpose of the study was to identify scenarios that were technically feasible and to use the results to help formulate a federal energy policy.

The project was organized into task forces to consider the major areas of energy demand. These were: buildings, industry, transportation, and utilities. The group was to solicit opinions, information, and review and evaluation from a large pool of experts in technology, science and industry, and public policy. However, budgetary and time constraints limited the activity to less than thirty researchers, the majority of whom had primary interests and training in conservation methods, economics, and policy issues. Although experts were consulted in alternate energy technologies, the final report puts primary emphasis on economic assessments, policy issues, and conservation measures. Also, the technology of renewable energy resources is often given a superficial or cursory treatment. The report lacks cohesiveness, and the various energy demand sectors are handled unevenly. For example, buildings receive the most extensive treatment and the most complete set of supporting engineering data whereas transportation receives the least.

The report is divided into four chapters, one for each energy demand sector, and nine appendices. An appendix is provided for baseline assumptions, and eight additional appendices are given delineating analytical details for the tables and figures used in the four chapters. In essence, the report sets out to answer three questions: What is technically possible? What will it cost? Why isn't it being used now? For the methodology, an economic baseline is assigned to the twenty-year period, available research and development data are used to determine the amount of energy saved by using a particular technology, the value of the energy saved and the cost of the technology applied is determined, and a cost/value ratio is calculated to determine the cost effectiveness. Where results are cost-effective, an evaluation is made of what factors acted to keep the market from responding naturally to cost-effectiveness, and methods are explored to encourage greater efficiency.

Buildings. The task force for this energy demand sector was led by Arthur Rosenfeld (University of California, Berkeley) and Joseph Desinger (an architectural consultant from Washington, D.C.). The study is written in six sections, and provides by far the most complete treatment for both residential and commercial buildings. It also gives the most extensive empirical data to support its findings, in spite of the fact that the available data base is fragmented, incomplete, and poorly documented. The major end-use areas evaluated include: heating and cooling, appliance performance, and water heating. About 200 individual technical improvements were evaluated for these end-use areas, the cost-per-unit of energy conserved for each improvement was calculated and the results rank ordered. The most dramatic change in the use of energy shown in the analysis was found in residential appliances, where efficiency improvements are shown to reduce appliance demand by nearly 3 quads-per-year from the baseline case. Because of the inherent diversity, the impact of such improvements, however, is difficult to calculate.

The results of the buildings' analyses indicates a reduction in demand potential of 18 quads, out of a projected use in the year 2000 of 35 quads. Of this 18-quad reduction, solar heating and hot water contribute 2 quads, small wind turbines 1.0 quad, photovoltaics, 0.5 quads, and wood usage 1.0 quad. The relatively low value of residential woodburning is attributed to more efficient stoves and competition for methanol production from woody biomass. Elaborate policy options are then provided for the government's role in achieving these potentials, which include information dissemination, demonstrations, financial incentives, and buildings standards.

Industry. The industry task force was led by M. Ross and Robert H. Williams of Princeton. The Industry chapter is written in four sections, one of which is devoted to solar technologies. Unfortunately, the latter appears more as an appendage to the analysis than as a coherent part of the total picture. Goals for industrial energy use were developed by examining cost effective efficiency improvements for each major category of energy service, e.g., mechanical drive, process heat, etc. Demand for each category of energy service was projected to the year 2000 using appropriate growth indicators; and efficiency improvement target was developed subject to specific policy changes. An important consideration for the industrial goals is the observation that recent growth trends have shifted demand from manufactured goods to services. Energy demand potentials for industry show only a slight increase for the 20-year period, despite an 80 percent projected increase in GNP. Using cost effective investments and increasing industrial efficiency would almost exactly offset growth. For the use of renewables in industry, attention is focused on biomass and to the direct use of solar energy to provide industrial process heat. For example, it is estimated that in an aggressive program solar process heat could contribute 1.4 quads of energy if its present cost is reduced by half. Enhanced capital formation, reduction of corporate taxes, improved industrial research, and a government subsidized "scrap and build" program for plant modernization are among the report's major policy suggestions.

Transportation. The transportation task group was led by C. L. Gray, Jr. (EPA) and F. von Hippel (Princeton). Their findings are presented in four sections. Starting with an overview, which includes public policy alternatives, the discussion centers around increasing energy efficiency both in the near term, mid-term, and long term. Although better organized than the Industry chapter, the overall treatment is shorter and lacks the analytical depth of the previous two chapters (Buildings and Industry). Fifteen technology-based initiatives or changes are evaluated and found to be cost effective, based on the value of fuel saved. Calculations show that it is possible to raise the fleet average for cars from the 1978 level of 14.8 mi/gal to a potential range 45-55 mi/gal by the year 2000. In addition, using DOE developed efficiency ratings for trains, buses, cars, and planes, it is found that the largest savings are effected by shifting freight from trucks and planes to rail. The final section deals with transportation energy from renewable resources. The bulk of the analysis is devoted to alcohol fuels with secondary emphasis on electric vehicles and the use of hydrogen. Methanol and other alcohol fuels derived from biomass are expected to deliver up to 25–45 percent of the fuel needed to operate the national transportation system by 2000. After comparing distribution costs, actual efficiency at end-use, and potential availability of synthetic fuels with methanol (either from biomass, coal, or natural gas), it is concluded that methanol is more cost-effective in terms of overall energy yield. The main constraint on developing methanol is how quickly older cars can be replaced with a new fleet that uses pure methanol.

Utilities. The utilities task force was led by H. Kelly and T. Flaim of SERI. Uncertainties about future energy demands are shown to have already complicated the investment strategies of gas and electric utilities. The analysis presented in the four section that comprise the Utilities chapter suggests that the ambiguity about future electric demand is likely to increase rather than diminish. The study is based on the thesis that the best response to such ambiguity is to move in the direction of deregulation: for example, allowing nonregulated companies greater access to markets heretofore reserved to utility monopolies. Under these conditions, the role of solar electric-generating devices becomes difficult to anticipate. Solar technologies are examined in the study to determine whether they can be economically preferred techniques for displacing existing oil and gas-burning capacity. It it shown that the largest contributions from renewable resources are likely to come from the nation's hydroelectric capacity and from wind turbines, with the latter offering flexibility in modular growth, to offset the uncertainties in utility demand projections.

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