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Abstract

This paper concerns the University's role in a statewide energy program being developed in Montana. Using the facilities and expertise available in the Montana State University System, a program of research, education and information activities will be enacted which will encourage energy conservation and the use of alternate energy devices. In this way the University will realize its full public service potential.

1. INTRODUCTION

For the last 50 years the citizens of Montana, like citizens of the other 49 states, have had available to them seemingly unlimited quantities of inexpensive energy-producing products (i.e., petroleum, hydroelectric, natural gas, coal and wood). These products have heated their homes, run their agricultural machinery, industries and commerce, and allowed for unlimited vehicle travel. However, an abrupt change in this life style will occur within the next ten years with the drastic reduction of available petroleum and natural gas. These energy sources will not only become scarce in the next 10 years, but will also become proportionately more expensive as the continuing depletion occurs. People will have to spend a larger portion of their income in the future in any attempt to maintain the past inexpensive, energy-intensive life style. Attempts to maintain this life style will result in a rapid extraction of our most abundant (but finite) alternative fossil fuel energy source -- coal; it will utilize increasing amounts of alternative energy sources; and it will require significant efforts in energy conservation.

While all regions of the United States face a common energy crisis, Montana must contend with particular problems. The use of energy in Montana is more intensive than most other states because of the extreme winters, the high energy requirements of the metal reduction industry, the vast distances to be covered in interurban transportation and the increasing requirements for fertilizer, mechanization and irrigation in the agriculture industry.

Much of Montana's energy comes from outside her borders, despite the large coal reserves in the state. Figure 1 illustrates several aspects of Montana's energy supplies. Large coal deposits are evident in the Eastern half of the state. However, only small, known oil and gas fields exist, particularly in Northern Montana. Since Montana depends heavily on natural gas for home heating, it is necessary to import natural gas from Canada. The Canadian government has recently decided to phase out this delivery of natural gas to Montana, accelerating the energy crisis in the state.

Also evident from Fig. 1 is the dependence of Western Montana on hydroelectric power. Under normal conditions, this is an inexpensive reliable supply of energy. However, drought conditions, such as those encountered in 1977, can reduce this potential greatly. Much of Montana's population of 750,000, as shown in Fig. 2, resides in the mountainous Western regions of the state. Hence, the threat of reduced hydroelectric power in 1977 has accentuated the need for energy conservation in Montana. It is also shown in Fig. 2 that Montana has a low population density, which complicates efforts to disseminate energy information to the population in an effective manner. An additional complication arises due to the shortage of performance data on alternate energy systems and new devices in Montana's severe climate and diverse topography.

The problems thus outlined emphasize the need for a coordinated energy program in

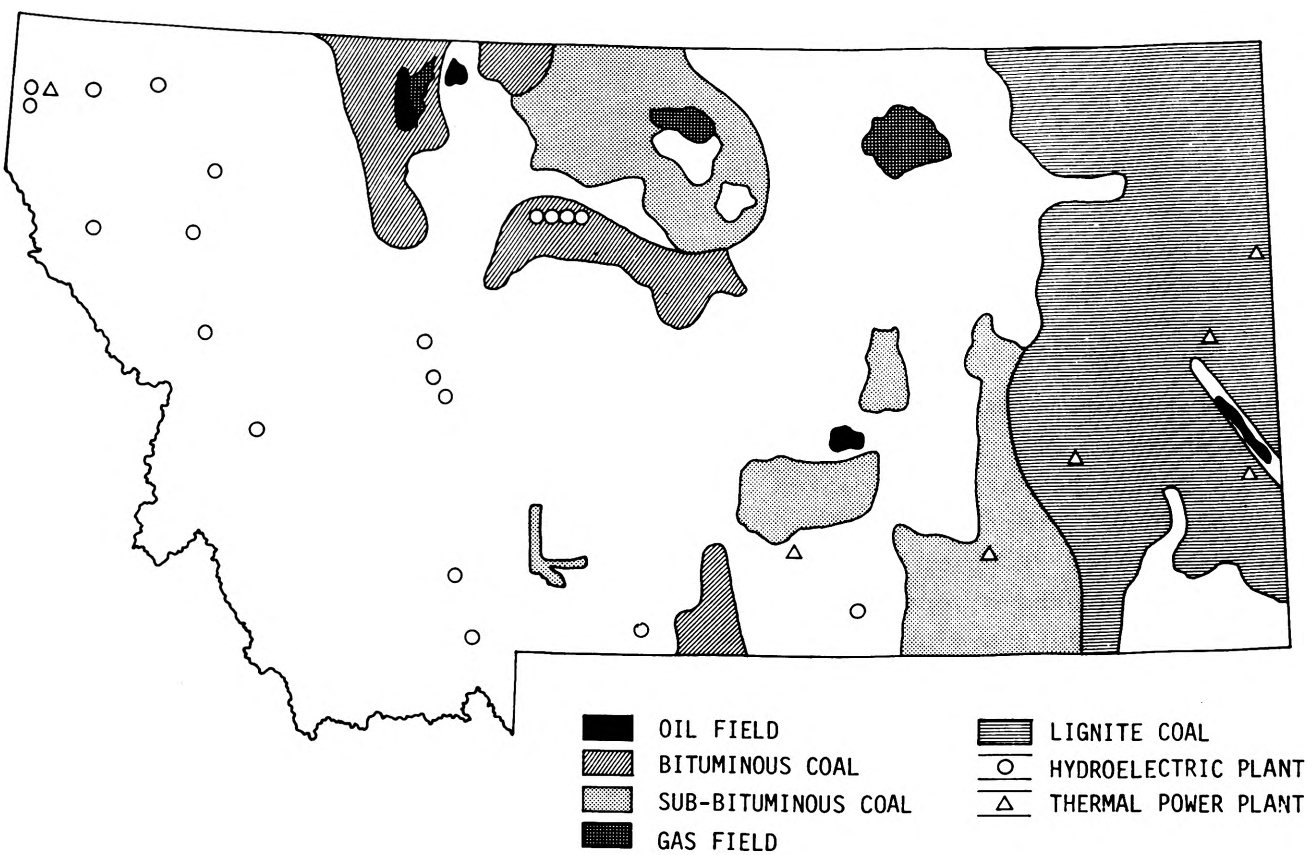

Figure 1. Energy Resources in Montana

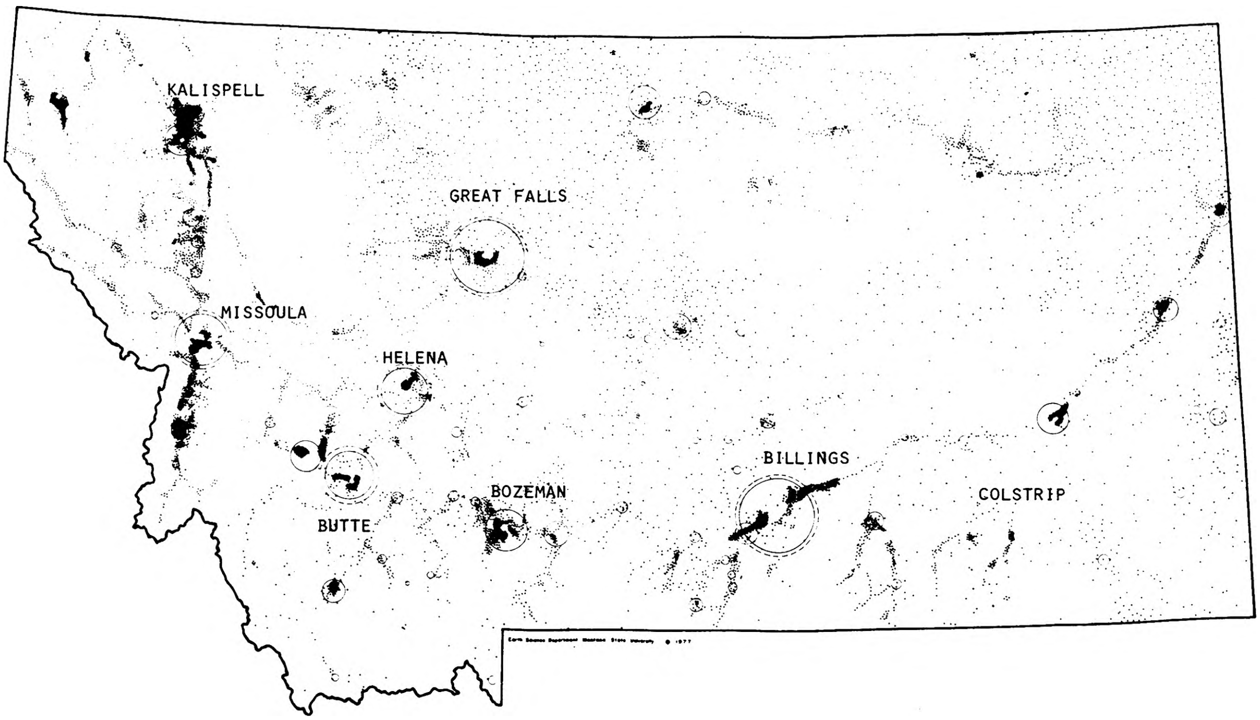

Figure 2. Montana Population Density

Montana. It is believed that the higher education system is the organization best suited to enact such a program. It is in direct response to the described needs that the state energy program described below was formulated.

2. PROGRAM OVERVIEW

A diagram of the state energy program for Montana is shown in Fig. 3. Included are indications of the primary information flows and external interactions both statewide and nationally. Each of the three large blocks represents a separate component. These components are Data Acquisition, Information Dissemination and Extension Services. Each of these will be described in detail below.

In their integrated form, the components are designed to fulfill several specific objectives, deemed important in Montana. These objectives are:

(1) Evaluate existing and proposed energy systems and components on all levels for use in Montana's diverse climatic and topographical regions.

(2) Develop energy simulation models suitable for Montana for use in the residential, commercial and industrial sectors.

(3) Apply the above to develop integrated energy models for use at the community, regional and state levels.

(4) Utilize these models to evaluate cost-effectiveness, energy efficiency and environmental-social impact of different energy systems and programs.

(5) Identify realistic energy and conservation policies for the people and government of Montana.

(6) Make energy information available

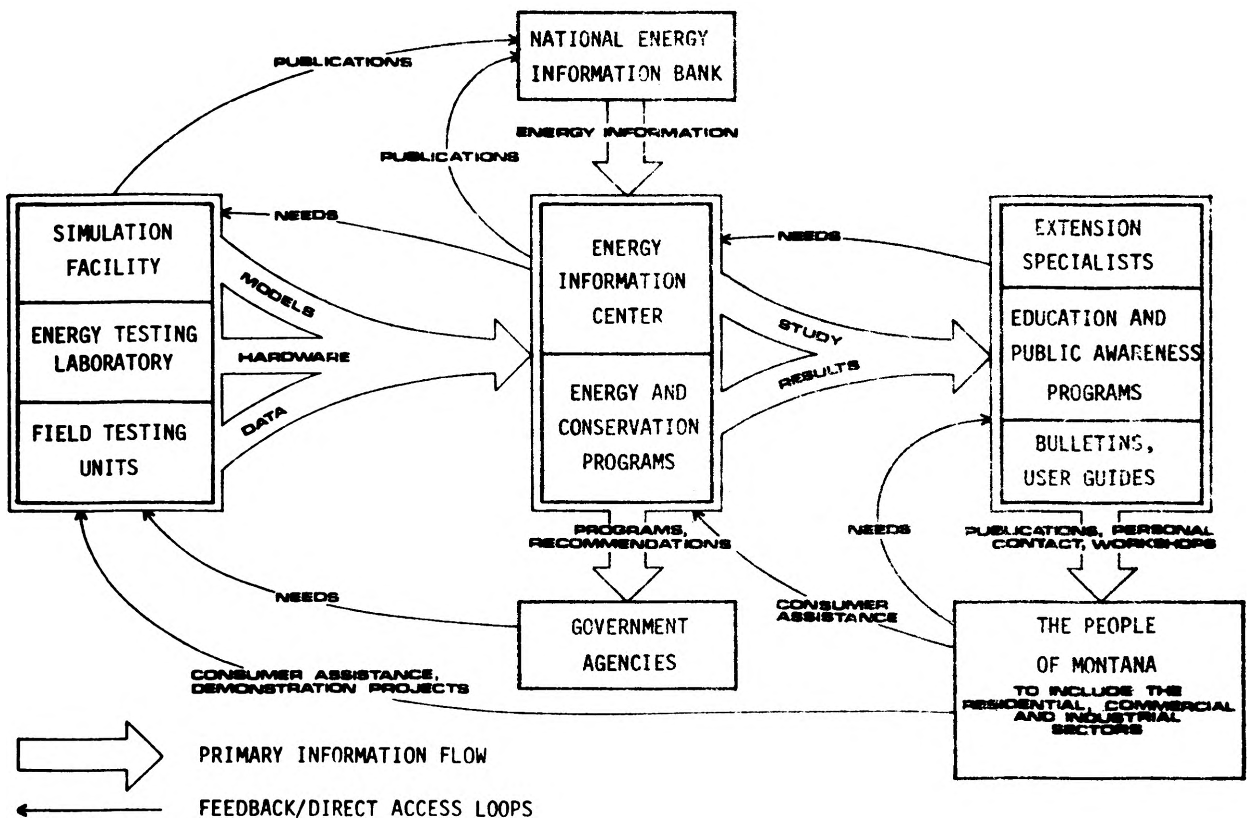

Figure 3. Program Structure

to all citizens of Montana through the establishment of an Energy Information Center and Energy Extension Service.

(7) Promote public awareness of Montana's present and future energy status, develop an energy education program and encourage energy conservation in the state.

The above objectives are intended to benefit the State and citizens of Montana through the establishment of a unified, unbiased and technically qualified program.

Several aspects of this program have received funding and are currently active. Other funding is being sought through various federal and state agencies, and private companies. The University System is also contributing substantially through faculty and staff time and the use of existing facilities.

3. PROGRAM COMPONENTS

3.1 DATA ACQUISITION

One of the three major components of the state energy program for Montana is Data Acquisition, illustrated in Fig. 3. This component will be particularly useful in obtaining objectives (1) through (4) listed in Section 2 previously. As seen in Fig. 3, the Data Acquisition component is made up primarily of simulation and testing activities.

The purpose of the Energy Testing Laboratory will be to provide the facilities and technical support necessary to test and evaluate the performance of various energy systems and components for use in Montana. The lab will consist of fully-instrumented facilities which will allow for testing energy-related devices under conditions of environment and load similar to those encountered in Montana. Data acquisition will be accomplished using a Systems Engineering Laboratories Model 32/55 computer currently operating in the College of Engineering at Montana State University. Additional data will be taken using various microprocessor devices as necessary. An interface with the Simulation Facility will allow the performance of entire systems to be evaluated while testing specific components only.

The Testing Laboratory will be useful in evaluating such specific applications as solar space heating and water heating, solar cooling applications, small-scale remote wind energy systems, and components of more conventional systems. Problems peculiar to Montana's environment, such as icing of solar systems, snow removal from solar systems, and frosting of heat pump coils, will be studied. In addition, because of the large amount of wood heating in Montana, the efficiencies of wood burning stoves and fireplaces will be measured. Other specific problems needing attention will be studied as they become apparent. The laboratory will be open to the public, and will be used to answer questions posed by the public if possible.

A second major activity within the Data Acquisition component will be Field Testing. A limited amount of field test data is available for alternate energy system performance in Montana. It is critical that this data be collected, since weather conditions and topography change greatly across the state. Fortunately, a program exists which will expedite the collection of this data. The Montana Department of Natural Resources (DNR) sponsors an ongoing program of Renewable Alternate Energy grants. These grants are available to the general public (by proposal) to research and employ alternate energy devices throughout the state. The vast majority of these grants are used for solar energy systems. Thus, there will soon exist a network of "field testing sites" in Montana, which will be used in the Data Acquisition component to provide the needed information. Grantees are required to monitor system performance under the DNR program. An important function of the Field Testing activity will be to standardize and compile this performance data.

The final part of the Data Acquisition component is the Simulation Facility. Here accurate simulations of energy consumption, supply and demand in a large class of problems will be made. Individual dwellings will be simulated, as will state-wide programs. Some standard models will be employed, while other models will be developed specifically for Montana. The backbone of the Simulation Facility will be a computer system capable of digital, analog or hybrid operation. A wide variety of problems can be attacked with this system. Interfaces with the Testing Laboratory will allow real-time simulations to be performed while testing or controlling various parts of energy systems. Data collected in the Testing Laboratory and Field Testing activities will be used to develop the simulation models and update them as necessary.

3.2 INFORMATION DISSEMINATION

The second component of this program is Information Dissemination. Results from the Data Acquisition component will be fed continuously to this component in the form of model and hardware testing results, and field testing data. The purpose of the Information Dissemination component will be to provide a clearinghouse for energy information, particularly as it pertains to Montana. This energy information will be supplied by the national energy information bank and the Data Acquisition activities as noted. All information will be available to the public and all governmental agencies, and will serve as the basis for most Extension Services, as seen in Fig. 3.

Two major activities comprise the Information Dissemination component. One of these is an Energy Information Center. This Center will actually be an energy library, staffed by a full-time librarian. The information contained in the Center will be categorized both by subject matter and technical level. This is necessary since the Energy Information Center will be open for public use to aid them in making energy-related decisions. An Interlibrary Loan policy will be established with community libraries throughout Montana to make this information available to greater numbers of people. The Energy Information Center will also be responsible for overseeing the publication of data from models and tests, which will become part of the national energy information bank. Needs discovered through interactions with the public will be conveyed to the Testing Laboratory for study.

Also included in the Information Dissemination component will be Energy and Conservation Programs. This activity will integrate testing results, simulation models, and information from the Energy Information Center to formulate recommendations and energy-related programs. These programs will consider all levels from individual dwellings to regional plans. Socio-economic considerations will be included in each study. The results will go both to the public and to governmental agencies. Some special cases can be included in this activity. For example, a contingency plan for Montana in the case of a severe unexpected energy interruption could be formulated. The effect of different large-scale power generation system options such as nuclear power, MHD, and solar power could be included in these plans.

3.3 EXTENSION SERVICES

Perhaps the most important component of the Montana State Energy Program is Extension Services, for it is this component which actively conducts informational and educational activities throughout the state. As shown in Fig. 3, one aspect of this component will be the Energy Extension Specialist. Like his counterpart in Agricultural Extension Services, these individuals will be the active liaison between the public and the Energy Program. Extension Specialists will conduct public energy education workshops, be available to help individuals with problems, and help prepare bulletins and users guides. In addition to these activities, the specialists will work in the Energy Testing Laboratory and Simulation Facility. Thus, they will remain up-to-date on new devices, energy systems and information through personal involvement. The Extension Specialists will also be the primary means of feedback of needs, problems and ideas to the remainder of the program. Since agriculture is a major industry in Montana, it is envisioned that at least one Energy Extension Specialist will come directly from the Agriculture Experiment Station at Montana State University to be used as the main disseminator of information to farmers and the feedback mechanism on Montana agricultural energy problems.

Education and public awareness programs constitute an important activity of the Extension Services component. Various levels of activity are planned, and some are currently funded. Short workshops will be conducted in specific areas (conservation, solar energy, etc.) at a low techical level for groups of all sizes. More general topics may also be covered. In these workshops, practical suggestions for energy conservation will be stressed. Such programs will be suitable for schools, civic organizations and large industrial groups.

For those wishing to obtain a deeper understanding of energy and energy problems, longer education programs will be offered. These will be approximately 15 to 20 hours long, and will be offered for either Continuing Education or college credit. Two such courses are being developed currently at Montana State University. One is to be offered to state building contractors who are engaged in small-scale residence construction. The emphasis of this 20-hour course will be on building for energy conservation in new structures and on the use of alternate energy systems. The concepts of designing for retrofit of advanced systems will be covered. A second course will be conducted for state high school science teachers. While the subject matter will be similar to that discussed above, a more general coverage will be given. A requirement of the course will be that each participant conduct public energy workshops in his local community. In this manner, such a workshop will be made available to each citizen of Montana through the high school system. It is also anticipated that the information gained in this course will aid the high school teachers in their respective schools.

The final activity of the Extension Services will be the publication of bulletins and users guides. These are expected to cover a broad range of topics, both in general and for specific topics. The strength of these publications will be the inclusion of data and recommendations pertinent to Montana's problems. The bulletins and users guides will be distributed throughout the state by the Extension Specialists and the Energy Information Center.

4. CONCLUSIONS

It is clear that existing energy use patterns must be modified in the near future due to increasing costs of energy and supply problems with traditional energy sources. Some alternative energy systems are available which might be used to alleviate the anticipated problems. However, careful study is needed to ascertain which systems and components are best suited to climatic and economic conditions in Montana. The State Energy Program described herein is designed to be a unified effort to meet Montana's energy problems head-on by using an existing state resource: the University System. By taking advantage of the expertise and facilities already assembled in the system, this program can be enacted at a minimum expense and with a high probability of success.

The components of Data Acquisition, Information Dissemination and Extension Services are complementary and will integrate to provide all the necessary functions for achieving a more balanced and stable energy situation in Montana in the years ahead. Research, testing, simulating, planning and educating activities will result in a better informed public with increased energy awareness and better understood options in the future.

Although this program was tailored to meet some problems peculiar to Montana, the concepts expressed are equally applicable to all states. Similar programs, perhaps based at land-grant universities, could be enacted throughout the nation. Each could address specific areas of local concern. A national effort of coordination between programs would certainly be beneficial to all participants through the exchange of information and personnel. The effect on the national energy situation could be significant, and could be achieved in a highly cost-effective manner through the nation's colleges and universities.

BIOGRAPHIES

JOHN A. CHARLES, Assistant Professor of Mechanical Engineering at Montana State University, received his B.S. degree in Aerospace Engineering from the University of Texas at Arlington in 1970. He completed Master's and Doctoral work at the University of Oklahoma in 1976, after which he joined the faculty at Montana State University.

Dr. Charles is currently involved in various research projects. His interests in energy studies include education programs simulation, and climatic testing. He is also conducting research in the areas of material behavior and fatigue.

ROBERT O. WARRINGTON, JR., Assistant Professor of Mechanical Engineering at Montana State University, received his B.S. degree in Aerospace Engineering from Virginia Polytechnic Institute and State University at Blacksburg, Virginia in 1968. He completed his Master's work in Mechanical Engineering at the University of Texas at El Paso in 1971. He received his Ph.D. from Montana State University in 1975 whereupon he joined the faculty.