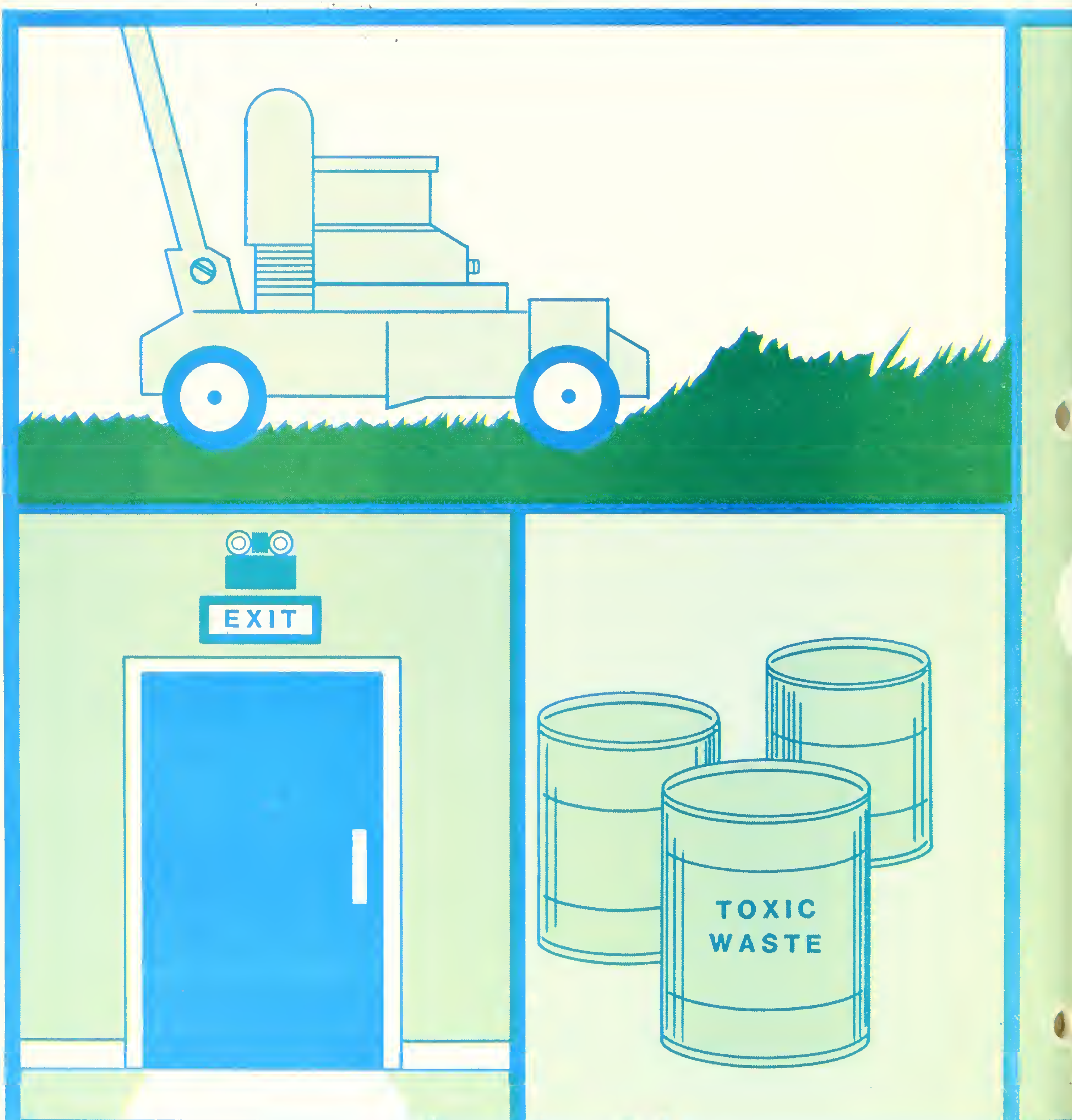
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National Park Service
U.S. Department of the Interior
and
National Recreation
and Park Association

Trends

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Trends in Energy Management

Contents

Trends in Energy Management

Trends

A PUBLICATION OF THE PARK PRACTICE PROGRAM

The Park Practice Program is a cooperative effort of the National Park Service and the National Recreation and Park Association.

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1957 PARK • PRACTICE • PROGRAM 1982
Twenty-Fifth Anniversary

Message from the Director

by Russell E. Dickenson

The "energy crisis" is over, right? Not quite!

The rhetoric and hype of "energy" has eased somewhat, and we seldom wait in line for $1.50 per gallon gasoline. In that sense, the "crisis" may have a smaller dimension. On the other hand, everyone in the park and recreation community knows what energy costs are doing to operational budgets.

While the big debates continue about nuclear energy, energy development, deregulation, and air quality standards, the managers of parks are more likely to be concerned about next month's energy bills. How big a bite will recent rate increases take out of operating budgets? What do we cut out next in order to relieve the pressure on fixed (or shrinking) budgets?

At this point, energy conservation becomes a matter of operational survival, not just something that is "nice to show we are concerned" or "makes management happy."

Park and recreation areas may experience a record level of public use in 1982. With reduced resources, we must be willing to innovate. We will be called upon to do more with less. We must get the most out of budgeted energy dollars. This means taking a look at what we do, asking whether the activity contributes to basic purposes, and selecting the most energy-efficient way to get the job done.

It has been observed that the price of energy will foster energy conservation. That is a true statement. But the price of fuel alone will not assure that the most beneficial and worthy projects and programs will be done. We now live in a time where the cost of "energy intensive" services may have to be provided in different ways or not at all. This means a closer look will be taken by program managers at all levels to determine the most cost-effective and energy-efficient ways to meet organizational objectives.

There are a number of basics to keep in mind when dealing with the energy management business. The first one is best reflected in Sir Joseph Stamp's observation as head of the Internal Revenue Department (England) at the turn of this century.

> "The Government is very keen on amassing statistics. They collect them, add them, raise them to the Nth power, take the cube root and prepare wonderful diagrams. But you must never forget that every one of these figures comes in the first instance, from the village watchman, who just puts down what he damn pleases."

Baseline energy consumption and cost data are absolutely essential in determining efficiency because of the need to measure cost and consumption against a reliable base. Such may be difficult to obtain and keep current but there is no substitute for integrity of such basic information. Once established and validated, one has a basis to defend claims of accomplishment.

Measuring accomplishments, reporting in an understandable way and feeding back results to those doing the work is necessary medicine. It is not as rewarding, perhaps, as working projects, but without it one cannot evaluate cost-effectiveness of projects or, indeed, decide on appropriate energy-saving solutions.

There are no quick fixes or easy answers. Energy conservation/management is accomplished in the trenches by maintenance and operations staff. Plans and intentions do not result in energy savings. Much can be accomplished by doing low cost/no cost options, but some up-front funding is necessary.

The bottom line is cost-avoidance. Consequently, the means to achieve that bottom line should be "cost-effective."

There are many ways to approach energy management. Choose strategy to fit the organization and resources. The best approach for one organization may be unsuccessful in another. Basic to all, however, is INFORMATION, revealing where the greatest energy usage occurs, what can be done to reduce that usage, how much it will cost, and finally, what priority should be given the many options.

Introduction

by John Duran

In 1975, Congress passed the Energy Policy and Conservation Act which required each Federal agency, including the National Park Service (NPS), to develop a Ten-Year Plan for improving energy efficiency, covering fiscal years 1975 to 1985.

In 1977, President Carter issued Executive Order 12003, which required Federal agencies to:

1) reduce the British thermal units/Gross Square Feet (Btu/GSF) energy consumption in existing buildings by 20% by 1985,
2) reduce Btu/GSF energy consumption in new buildings by 45% by 1985,
3) achieve an average mile-per-gallon fuel economy in newly acquired sedans of 4 mpg above that required for the automobile industry.

Lastly, in 1978, Congress passed the National Energy Conservation Policy Act, by which each agency was required to:

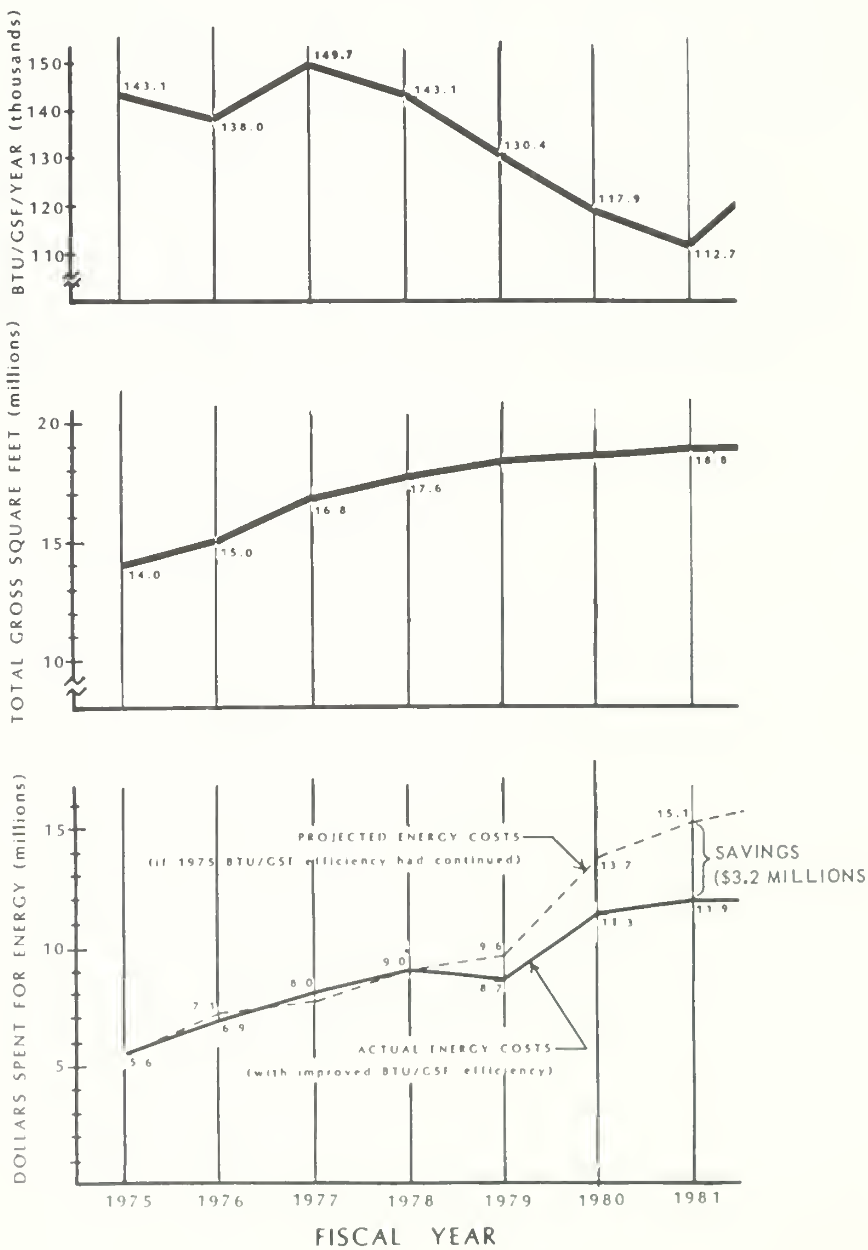
1) conduct preliminary energy audits of all federally-owned buildings,
2) retrofit by 1990 all owned buildings over 1000 GSF in size,
3) give preference in leasing buildings to those that use renewable energy sources,
4) implement life-cycle-costing analysis for all new buildings,
5) identify funds for energy conservation in a separate budget line item,
6) demonstrate the application of solar thermal and solar photovoltaic systems.

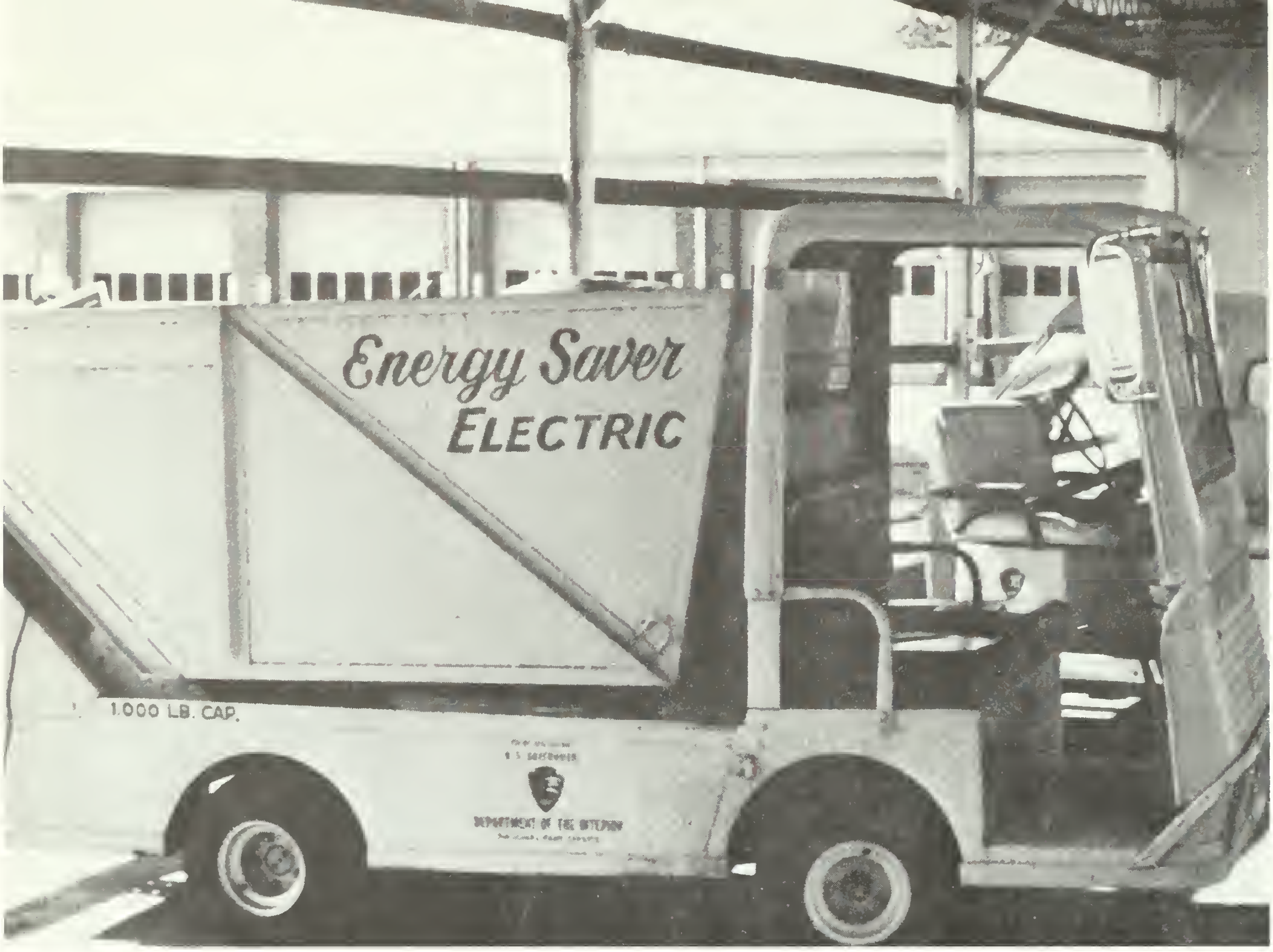
When the National Park Service initiated its energy program in 1978, the main function was to collect energy usage reports from each region and aggregate them into a Servicewide report for the Department of the Interior.

In Fiscal 1979, the first full year of operation, the NPS energy program was funded for $6.2 million. A building survey manual was developed for identifying retrofit measures in NPS buildings, and a site planning guideline was developed to help each park/site develop a plan for achieving improved energy efficiency.

National Park Service

ENERGY MANAGEMENT HISTORY





National Park Service

The National Park Service is trying electric vehicles, such as this trash hauler, as a means of reducing use of petroleum fuels.

Special Initiative

More importantly, a "special initiative" effort was undertaken in six parks to demonstrate and test the operation of the full program. The parks chosen were: Grand Canyon NP and Shenandoah NP (large parks); Colonial NHP and Independence NHP (medium-sized parks); and Colorado NM and Ft. Sumter NM (small parks).

This special initiative included:

1) Washington and contractor personnel traveling to the six parks to teach park staff to conduct Level I (non-technical) energy surveys of buildings, including the inspections and the pencil-and-paper calculations of savings.
2) The funding of cost-effectiveness retrofits in all the buildings surveyed.
3) The writing of site energy plans for improving all phases of park operations, including vehicles' efficiency, public awareness, and employee awareness.

At Colorado NM, a solar greenhouse was installed on the visitor's center in cooperation with the state of Colorado and local volunteers. Also, several moped motor scooters were bought for local personnel transportation.

Also in 1979, alternative energy resources projects were funded for other parks as follows:

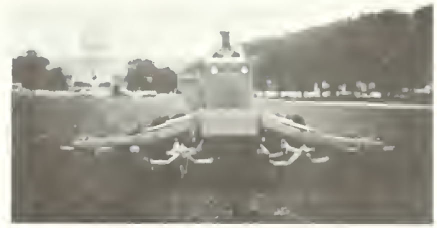
	No. Projects	Funding
Solar Thermal	7	$572,900
Solar Photovoltaic	5	30,570
Wind	3	20,000

On April 10, 1979, President Carter issued an order to reduce our use of automotive fuels by 10% for the twelve months following that date versus the twelve months preceding it. The National Park Service was able to achieve that goal through reduced use of vehicles, and considerable sacrifice by the parks.

1980 Energy Initiatives

In 1980, the NPS Energy program was funded for $1.5 million and initiated major efforts in all areas of energy impact. It accomplished the following:

- saved the National Park Service $2,655,500 by avoiding projected energy costs in both building and vehicle usage,
- completed preliminary energy audits of all owned buildings,
- contracted for development of computer systems to handle energy data from reports, audits, and surveys,
- contracted for energy surveys of 2,600 buildings and 5.7 million square feet of facilities in 104 parks,
- conducted an inventory of buildings leased to the National



National Park Service

Equipment with small engines, such as mowers and chain saws, are run on 100% alcohol in the area around the nation's capital.

Park Service,
- established target design efficiencies for new buildings,
- Contracted for a study of NPS vehicle fleet management practices,
- obtained Department of Energy funding for 720 solar thermal projects worth $3,875,522,
- obtained Department of Energy funding of $3,040,200 for 2 photovoltaic projects, one of which was the world's largest photovoltaic installation at Natural Bridges National Monument, Utah,
- contracted with the Solar Energy Research Institute to have exhibits on renewable energy sources designed for 18 parks, and
- compiled quarterly reports of energy consumption for the entire National Park Service and monitored energy savings.

In February, 1980, President Carter ordered that all agencies reduce by 10% the mileage driven during February and March of 1980 versus February and March of 1979. Again, through special effort, the Park Service achieved a 17% reduction.

FY 81 Energy Initiatives

In FY 1981, with funding of $3.5 million, the NPS energy program continued the initiatives it had begun earlier:

- saved the National Park Service $3,468,600 by avoiding costs of energy in both buildings and vehicle usage,
- contracted with the Student Conservation Association to survey 3117 buildings and 5.6 million square feet in 73 parks at a cost of about $.04/square foot,
- funded 5,175 retrofits in 2,300 buildings at a cost of $1,992,000 with an estimated savings of $1,589,965 per year. The average simple payback was 1.25 years,
- obtained DOE funding of $2,090,000 and added $154,000 of NPS funds to implement 540 solar thermal projects,
- obtained DOE funding of over $232,000 for 5 solar photovoltaic projects,
- completed the study of NPS vehicle fleet management practices, which indicated a need for standards and direction to assure management attention and consistency in monitoring NPS vehicle usage and efficiency,
- presented orientation sessions to NPS employees on the purpose and benefits of the energy conservation program and its dependence on employee support,
- established energy information centers: one for films in the Pacific Northwest Region, and a second for printed material in the Rocky Mountain Region,
- developed computer systems to ease the paperwork of energy-use reporting and to perform the calculations for energy surveys.

1982 Initiatives

In 1982, the program is funded for $3.5 million, and the Service plans to complete many of the activities from previous years. The Level I surveys of buildings has been completed in 7 out of 10 regions, and the remainder will be completed in 1982. The retrofits identified by 1981 surveys will be installed, and Level II (architect/engineer, technical) surveys will be conducted. Only a few solar and special demonstration projects will be funded, but several projects to reduce NPS use of petroleum-based fuels will be implemented. More attention will be given to vehicle management improvements. With the threatened dissolution of the Department of Energy, the National Park Service energy program will become an NPS-designed program to save the parks operating dollars, instead of an effort to meet DOE regulations.

In 1983 the program is funded for $533,000 and will be managed largely by the NPS Regional Offices as they identify needs and funds for implementing projects.

State and Local Park Assistance

The Recreation Resource Development Division of the National Park Service has developed an *Energy Planning and Management* system for state and local park and recreation agencies with a grant from the U.S. Department of Energy and a contract with the University of Michigan's Architectural Research Laboratory. (See "An Energy Management Plan that Really Works" elsewhere in this issue.) The system is designed to assist managers in making rational decisions as to where energy conservation efforts can most effectively be applied.

The Division's staff offers one-day workshops, usually conducted in joint sponsorship with organizations or state societies, which provide training for administrators, planners, and site managers in this process for planning and managing energy usage.

To learn more about the system or to arrange for a workshop, contact the Recreation Resource Development staff in one of the National Park Service Regional Offices (see "Who Can You Turn To?").

John Duran is the Servicewide Energy Coordinator for the National Park Service.

Energy: Wild Card of the 80's

by Susan V. Allen

America's long-standing love affair with her parks is headed for a mid-life crisis in the 1980's, precipitated by changing governmental roles and economic uncertainty. Nowhere is this crisis more evident than on Main Street, USA.

Faced with taxpayer revolts, loss of federal funding and skyrocketing inflation, many local administrators are contemplating the grim prospect of closing down facilities and reducing services precisely at the time when the demand, and need, for them is increasing. Given these pressures, it is perhaps not surprising that the beleaguered manager is overheard mumbling, "who has time to think about energy now?" After all, for the immediate future at least, an ample supply of oil is predicted and the initial high cost of active solar systems to supply large facilities has effectively placed this technology out of reach.

Nevertheless, trouble always seems to come in pairs, and to overlook the underlying role of energy in this mid-life crisis could be a costly miscue. So, as our somewhat jaded lovers sit down to deal out the cards for the coming decade, it is tempting to prophesy that energy will be the trump card. However, a more realistic prediction is that energy will be the wild card to be played strategically in many hands. Keeping in mind that energy management is directly related to other critical management decisions regarding funding, manpower, facility planning and operations, let's deal the cards...

Costs

Unquestionably, the overriding concerns of the 1980's will be economic ones. Even if the annual inflation rate can be held to ten percent, we face a staggering 100 percent increase in the cost of delivering park and recreation services by the end of the decade. These increases will occur even without the addition of any new facilities.

Energy costs are already the second highest line item in the operating budgets of local agencies and are likely to remain so for many years to come. The impact of energy costs on park and recreation agencies will vary regionally, depending on the character of their facilities, climatic conditions, and fuel sources. In the northern and eastern sections of the country, oil-fired generators have generally imposed higher energy costs per kilowatt hour. Conceivably, deregulation of natural gas and the decline of the nuclear power industry could double or triple heating and lighting costs elsewhere by 1990. Agencies which operate older buildings and antiquated outdoor lighting systems will be particularly hard hit.

Regardless of regional influences, energy costs are destined to rise in proportion to other operational expenditures for a number of reasons which have long-term implications for park and recreation management.

Recreation Demand

Energy use and costs are closely linked to changing recreation patterns. In recent years the trend has been toward development of more energy intensive facilities in response to the demand for opportunities to pursue favorite recreation activities not only year-round, but virtually round-the-clock. The operation of indoor swimming pools, gymnasiums, racquetball courts, and ice rinks is a particularly energy intensive venture where climatic conditions require nonstop heating and air conditioning. Furthermore, more flexible work hours, the emphasis on physical fitness, and burgeoning adult sports leagues will continue to increase the demand for extended hours of operation. That means more lighted outdoor facilities as well, if we are to remain responsive to changing life styles.

Revenue

Another long-term implication of rising energy costs concerns the "balance of payments." In the wake of actual or anticipated budget cuts, many agencies are seeking to make up deficits by expanding revenue-producing operations and to make facilities self-sustaining through fees and charges. In some areas of the country, fees are now being pegged to the Consumer Price Index.

However, there are two Catch 22's involved in the assumption that revenues can keep pace indefinitely with operating costs. First, common sense says there is a limit to how much fees and charges can be raised before users elect to channel their disposable income elsewhere. When that happens, revenues will decline but costs may not unless services are reduced, thereby further reducing revenues. The constraints on disposable income are a factor too often overlooked. Will we eventually find ourselves providing park and recreation services only to those who can afford to pay ever more for them?

Secondly, the facilities with the greatest potential for generating revenues—swimming pools, ice rinks, indoor courts, etc.—are also the most energy intensive. For example, in FY 1981 the three indoor recreation facilities operated by the Fairfax County Park Authority (FCPA), Virginia, accounted for 63 percent of the utility costs for the entire 14,000 acre park system.

Energy costs are particularly critical in enterprise operations because they require a direct trade-off of revenue dollars for operations and maintenance versus programming services. The greater the anticipated role of fees and charges in sustaining system-wide operations, the higher the priority which should be given to reducing energy costs at revenue facilities.

New Priorities for the 80's

The combination of budget cuts, inflationary costs, increasing demand and revenue limits suggests three clear priorities for the 1980's: greater operating efficiency, more cost-effective planning, and more active public involvement. Energy management is integral to all three.

Operating Efficiency: More for Less

By definition, increased efficiency is undertaken to *satisfy* demand at a lower cost. The significance of energy costs is that they can be curtailed without decreasing services. Reducing energy costs in the interests of greater operating efficiency will require:

—*more accurate accounting of energy costs and targeting of priorities for reducing those costs:* The Energy Planning and Management methodology described elsewhere in this issue is designed specifically for this purpose.

—*more staff time allocated for training in energy conservation procedures:* This is an example of how personnel decisions are closely related to energy management.

—*more preventative maintenance:* These procedures are essential in older facilities to combat deterioration of equipment beyond the point of no return. They are increasingly important in modern facilities with sophisticated equipment where there are more things to go wrong which are very, very costly to repair. Proper monitoring and maintenance of HVAC (heating, ventilating and air conditioning) systems can reduce energy consumption by 10–15 percent and effect significant savings system-wide.

—*more technically competent personnel:* Knowledge of waste heat recovery and solar systems, computerized building operations, and maintenance scheduling will be important.

East Bay Regional Park District

Chevron Oil Company funded a natural science laboratory at the Tilden Regional Park Nature Area in Berkeley (CA).

Energy management will also increasingly interact with programming policies. In some instances, a significant portion of facility energy costs may be intractable, e.g., in older, inherently energy-inefficient buildings where funding is simply not available for retrofitting to increase operating efficiency. Other energy related choices may also be fixed. Where cuts in maintenance personnel are mandated, managers have little choice but to put available crews on the road, shuttling between sites located miles apart, thereby increasing transportation costs.

In these cases, administrators will have to offset "embedded" energy costs with alternatives to the traditional means of delivering park and recreation services. Cooperative sponsorship of public recreation programs with established user groups in exchange for use of facilities is being actively pursued by the Los Angeles County Parks and Recreation Department. "Adopt-A-Park" programs such as those instituted by the Champaign (Illinois) Park District shift a major part of neighborhood parks' maintenance to local citizens, and can actually upgrade the appearance of these parks through the planting of donated landscaping materials. In addition to offsetting fixed energy and operational costs, community involvement programs can generate much needed public support when budget appropriation and bond referendum times roll around.

Facility Planning: To Build or Not to Build

More leisure time in the 80's will intensify the demand for a broad diversity of park and recreation services. We cannot, therefore, simply stop developing facilities. But we *can* stop building monstrous energy consumers. The technical knowledge to design energy-efficient facilities is widely available within the architectural and building community, but a preoccupation with front-end costs often precludes it from being incorporated into construction specifications. Passive solar design techniques are not significantly more expensive than traditional building methods. Proper site orientation, insulation, energy efficient lighting and landscaping should not be considered "bid alternates." They are the bottom line when one considers that initial acquisition and development costs represent only 10 percent of the life-cycle costs of a facility. Maintenance impact statements and energy analyses must become integral tools for park planning. If we can't afford to build energy efficient facilities, then we can't afford to build them—period!

More refined needs assessments will also have to be undertaken in the interest of cost-effective operations. Proctor and Gamble wouldn't dream of putting out a new toothpaste without conducting an in-depth marketing survey. Can we afford to do less in planning future facilities and programs? Many factors such as recreation preferences, site location, and public transportation access have energy related implications which should be considered in feasibility studies.

Funding: The New Look

We began this card game with a deck of economic concerns. If operating efficiency is the Ace of Spades and cost-effective planning is the King of Diamonds, then funding is most assuredly the Queen of Hearts. Both the hearts and minds of administrators, elected officials and the public will have to be educated to the need for supporting parks and recreation in new and innovative ways. Whereas, in the past, capital improvement programs have been channeled exclusively toward the expansion of facilities, new priorities are indicated.

Fairfax County Park Authority

There is an increasing demand for year round indoor recreation facilities such as this racquetball court at the Providence Recreation Center in Fairfax County, Virginia.

The Fairfax County Park Authority voted unanimously to include $400,000 for energy retrofitting of existing facilities in its proposed 1983–87 Capital Improvement Program, and additional funds are earmarked for specified energy conservation features in new facilities. FCPA administrators are banking on the willingness of political leaders and voters to support a program designed to improved operating efficiency throughout the park system. Few topics are as popular these days as reducing the tax burden, and energy funding is an effective means of doing so.

On the opposite side of the continent the East Bay (California) Regional Park District is finessing the dealer—the energy companies. More than $17,000 have been donated to date by the Chevron Oil Company to underwrite the costs of educational facilities and interpretive programs. Land for the recently dedicated San Leandro Regional Park is being leased, in part, from the East Bay Municipal Utility Department and the Pacific Gas and Electric Company. This San Francisco Bay area park system has been cited by the National Recreation and Park Association as the most outstanding example of public/private partnerships for the creation of recreational areas. The message from out west is: make the New Federalism work for you!

We play for high stakes in the 1980's. We must begin now to be significantly more streamlined in our operations, more cost-effective in our planning, and more creative in our delivery of services. When every hand has the potential for winning or losing, you've got to "know when to hold 'em and know when to fold 'em," and know when to play the wild card.

Author's note: I am indebted to the many colleagues who shared their insights for the preparation of this article, especially Louis Cable, Assistant Director and Bill Beckner, Chief Naturalist, Fairfax County Park Authority; Ralph Cryder, Director, Los Angeles County Parks and Recreation Department; David O. Laidlaw, Director, Huron-Clinton (Michigan) Metroparks; Christian Nelson, Chief of Parks and Interpretation, East Bay Regional Park District; and Robert Toalson, General Manager, Champaign Park District.

Susan V. Allen is District Naturalist and Chairman of the Fairfax County Park Authority's Energy Task Force in Virginia.

An Energy Management Plan That Really Works

by Susan V. Allen and Frank Pezzorello

These days it seems that one seldom gets exactly what one wants and asks for; some cynics would say it happens even more rarely in government circles. But the Energy Planning and Management program developed by the Department of the Interior's former Heritage Conservation and Recreation Service (HCRS) is exactly what local park and recreation administrators began asking for in 1979.

At that time rising energy costs were beginning to have a significant impact on current operating budgets, and were threatening to reduce the capability to meet projected demands for leisure services. Many agencies lacked the resources to conduct comprehensive energy audits, and information about the energy characteristics of park and recreation operations was difficult to obtain. There was a critical need in both the public and private sector for an in-house capability to assess energy usage and to determine the most cost-effective strategies for reducing energy costs.

In response to this challenge, key resources were marshalled to develop an energy planning and management program designed to meet the requirements of park and recreation agencies at the local, regional and state levels. The Department of Energy committed a $60,000 grant for program development and in June, 1980, the University of Michigan's Planning Research Laboratory was awarded a contract to design the planning methodology. In July a cooperative agreement was negotiated with the Fairfax County (Virginia) Park Authority to provide the necessary perspective of a local agency.

The program objectives were to develop:

1) a simplified, non-technical method to inventory, quantify and compare energy use and costs in a variety of recreation facilities,
2) a method for setting priorities for energy conservation in capital improvement, operations and maintenance,
3) an easily accessible source of appropriate energy strategies, and
4) a means of determining their relative effectiveness prior to committing limited manpower and financial resources.

Planning Methodology

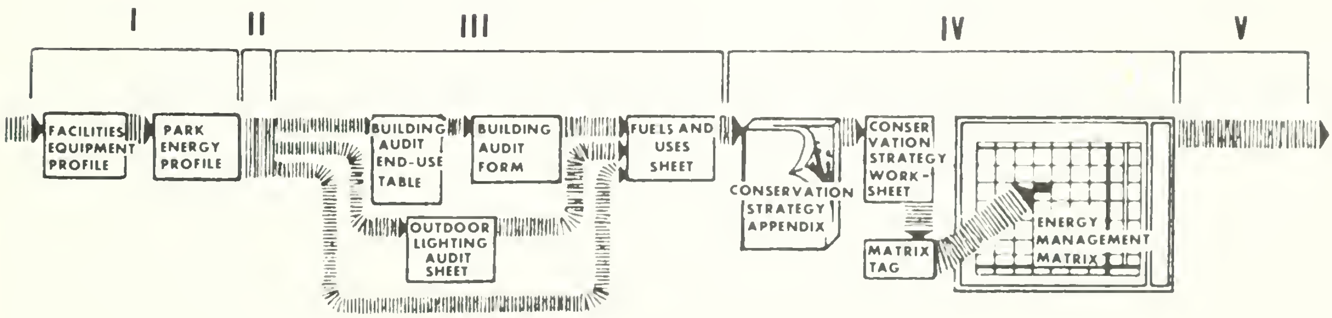
The planning methodology designed by University of Michigan professors Alan Feldt, Mitchell Rycus and Mark Hassett meets these objectives and more. It is elegant in its simplicity and decision-making power. In contrast to traditional engineering approaches which require a time-consuming and highly technical audit of the physical characteristics of all facilities, this methodology begins with the "big picture" and is intended primarily to provide the basis for making rational management decisions. Consequently, the amount and type of data required, and therefore the staff time involved in data collection, is significantly reduced.

The methodology works equally well when applied to individual sites or the park and recreation system as a whole. In either case:

—individual facilities can be ranked in terms of energy costs and consumption, regardless of size or diversity.

—priorities for reducing energy use can be determined by comparing the relative costs and energy intensiveness of various end uses and fuel types. (In other words, it *is* possible to compare apples and oranges or, for example, vehicle fleets and ballfield lighting.)

—the relative effectiveness of various energy conservation strategies can be evaluated on the basis of individual park system energy uses. Thus, a "shotgun" ap-




Fairfax County Park Authority

Waste heat from ice rink compressors is used to heat adjacent pool.

proach is avoided and efforts can be concentrated where they will have the greatest impact.

The energy conservation strategies, researched from many governmental and private sector sources, are directly applicable to park and recreation facilities such as swimming pools, ice rinks, and campgrounds. The quantitative information generated by this planning process can be effectively used to justify operating budget requests, changes in operational policies, and capital improvement recommendations both for the design of new facilities and retrofitting of existing ones. The end result is an Energy Management Plan specifically tailored to the needs of individual organizations which will be responsive over time to the changing political, economic, institutional and future planning climates.

From the outset of program development, the Energy Planning and Management program was tailored to user needs. Park and recreation professionals helped to refine the program materials in a series of test workshops held in Michigan, South Carolina, Colorado and California. Throughout the year-long development phase the FCPA, located in the suburbs of Washington, DC, provided the "real world" environment, field expertise, and program information necessary to design, test, and evaluate the effectiveness of the planning process.

The Energy Planning and Management program materials are presented in a four-part handbook and planning matrix chart that easily fit into a briefcase. The planning process can be most efficiently undertaken within the format of one-day training workshops offered through the NPS Regional Offices, but, with some additional study, it is possible to work through the handbook independently. The handbook provides step-by-step procedures for inventorying energy use, auditing facilities, selecting conservation strategies, and evaluating their feasibility. The planning methodology is outlined in the flow chart below.

How it Works

An awareness of the magnitude and costs of energy is the essential first step in developing an energy plan. Section I of the handbook includes an overview of the planning process and two "park profiles" for assessing energy use and costs. The basic information required to complete these profiles can be obtained through the agency's billing department or local utility companies.

- The Facilities/Equipment Profile consists of a checklist of park and recreation facilities with their associated fuel types and end uses.

- The Park Energy Profile Sheet (PEPS) summarizes all fuel billings and converts all fuel quantities into comparable units of energy. (Regardless of the energy source, all fuels can be measured in British Thermal Units. But you don't need a slide rule to figure it out; a simple multiplying factor is given for converting kilowatt hours, gallons, cubic feet, et al., into million BTU per year.)

Section I is mailed to pre-registered training workshop participants a month in advance of a workshop, together with instructions for gathering as much detailed information as possible for a selected site. Workshop participants are thus able to utilize their own energy data in learning the planning process under the guidance of experienced trainers.

Sections II through V of the handbook detail the remainder of the planning methodology. An example of a typical small park illustrates the purpose of the various worksheets and their relationship to each other. The engineering mystique of an energy audit is dispelled once and for all as the authors explain that audits are merely "procedures that take inventoried information and assign values and magnitudes to them." The audits follow three paths: building, outdoor lighting, and a third path used primarily for vehicle fleets. In each case, the auditing procedure consists of "disaggregating," or separating out, consumption and costs by facility/equipment and fuel types. The results of this simplified auditing process is a clear picture of the proportionate amounts of energy use and costs being allocated for purposes throughout the site or park system.

Where the requisite information is available from operational records, it is plugged in directly. In other cases, specialized forms have been designed to generate the required data. For example, the Building End Use Audit Table (BEUAT) breaks out the average percentages of fuel expended for each end use in specified facilities (living quarters, indoor ice rinks, recreation center, etc).

The Fuels and Uses Sheets order the amount and dollar costs for each end use, by facility and fuel type, and calculate their percentage of total costs and consumption. It is at this point that the dawn begins to break!

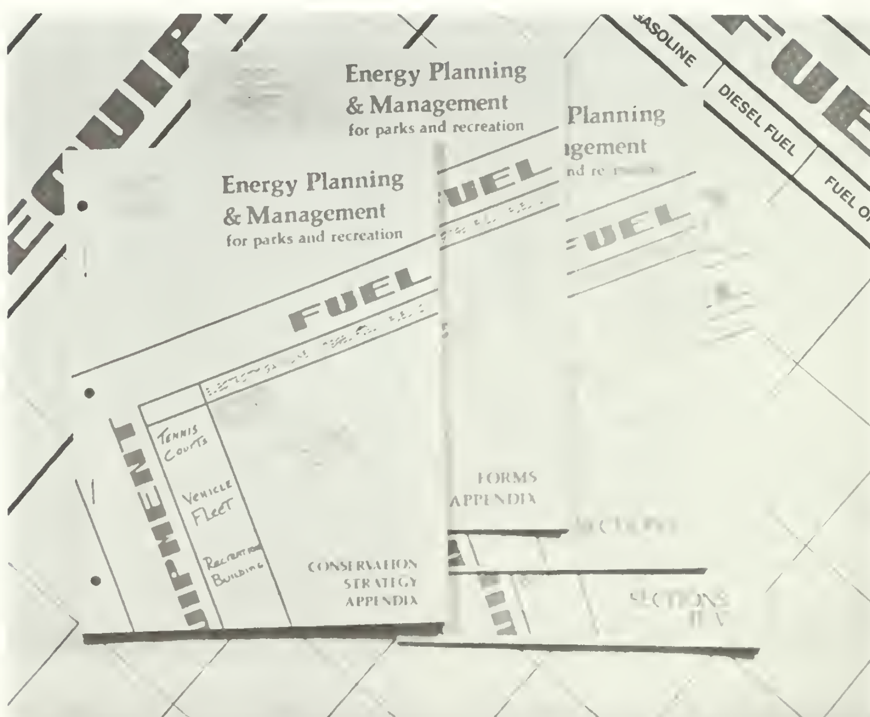
Section IV provides the tools for management decision-making. The Conservation Strategy Appendix is the "supermarket of energy savings." It contains over 100 options including low-cost/no-cost operational strategies, vehicle performance comparisons and facility design and retrofitting alternatives. The worksheet combines information given for individual strategies with park-specific data to generate estimated initial costs, first-year energy and cost savings, and level of effort required to implement each strategy. Those strategies selected for consideration are then arrayed on the Energy Planning Matrix where various combinations of options can be assessed.

Conclusion

As any administrator knows, there are a host of intangible as well as tangible management factors that must be considered in policy making including economic, political and institutional barriers (or opportunities) and the future needs of the park system. These considerations are discussed in Section V. Strategies that would incur significant costs or changes in operational policies would then, of course, be subjected to more detailed analyses. But these efforts would only be undertaken if a given strategy had a high potential for reducing costs.

The energy plan that emerges is an iterative and continuous process for setting priorities based on available resources at any given time. When consistently integrated into an agency's decision-making policy, the Energy Planning and Management program becomes a powerful management tool for increasing operating efficiency and reducing long-term costs. For further information about this program contact the Recreation Resource Development Division, National Park Service, Washington, DC 20240.

Susan V. Allen is District Naturalist and Chairman of the Fairfax County Park Authority's (VA) Energy Task Force. Ms. Allen served as Technical Project Officer for the Energy Planning and Management program while she was on an Intergovernmental Personnel Act assignment with HCRS. Frank Pezzorello is an Outdoor Recreation Planner with the National Park Service's Recreation Resource Development Division.



Walter Smalling, NPS

Using the Energy Planning and Management System

by Bill Graham

We have tested the *Energy Planning and Management* system for parks and recreation developed by the former Heritage Conservation and Recreation Service (see "An Energy Management Plan That Really Works") through test workshops and against already known results from various energy conservation projects that have been implemented in Rockford, Illinois. Initially, we utilized engineering consultants, help from local energy companies, and sometimes intuition, to decide what projects to implement. The projects have involved new facility design, retrofits, and day-to-day management policy changes.

This system will identify strategies, priorities, and estimated savings with very good accuracy. All of this, of course, without the aid and cost of consultants. Obviously, there is some point in the audit procedures where consultative help will probably be needed. However, the system will enable you to hold the costs of that help to a minimum.

The implementation of the planning system does require additional work on your staff's behalf. It seems worthwhile to mention some of the more important advantages and disadvantages of becoming involved with the system.

ADVANTAGES

Cost Reductions

You will see immediate and significant reduction in operating costs if the proper strategies are selected and implemented. Many reductions in energy costs will have no negative impact on program delivery.

Energy Resource Conservation

Reducing uses on non-renewable energy sources will benefit us all in the long run. We need time to develop alternative sources.

Interpretation

Most of us are involved in nature/conservation education. How many of us have expanded those programs to tell the public what we are doing in energy conservation?

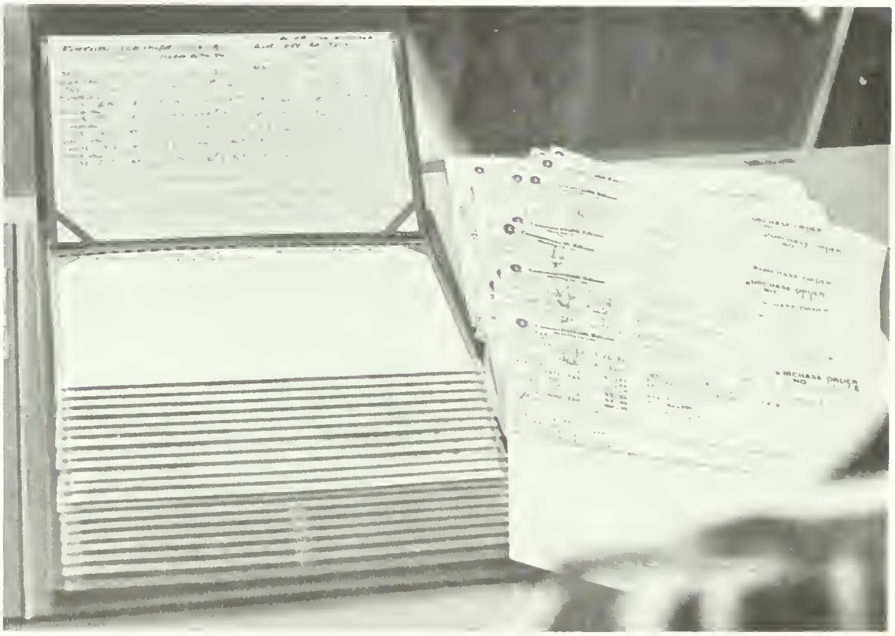
Build Your Organizational Image

This is perhaps the most important advantage to be gained!

"Tooting our own horn" has not been our strong suit. Many of us assume that if we do our jobs well, the public knows about it. Tain't necessarily so! The public frequently doesn't know, or care, who provides the services he or she uses.

There has been a period of relative prosperity in the last 20 or so years. For the most part, the dollars have been available and we have expanded. During this period, most of us have been busy with that expansion and not much concerned with public recognition of our agencies' part in delivery of programs and facilities. Now, with a potentially long and difficult period of economic and financial adjustment ahead, we are being forced to face very different decisions and justify every dollar sought.

Reviewing electric bills for the log book is an important process in the energy management plan.



Vance Barrie, Rockford Park District

Vance Barrie, Rockford Park District

This earth berm against the walls of the Rockford Park District Ice House provides excellent insulation against heat gain within the building.

Polls say that most people think "we" (the government) are too big, too wasteful, too inefficient. What are we going to do about this? If it's true, we'd better change—or someone else will change us! If we are *not* too big, wasteful, and inefficient, then we had better make sure the public knows that! If we approach the next few years properly and positively, we will emerge stronger. The rules are changing in this ever-increasingly competitive game for a portion of the tax dollar. In order to compete, we must improve our images. We must prove that our services are needed and are provided responsively and efficiently.

DISADVANTAGES/ PROBLEMS

Data Collection

Someone has to begin shuffling through old energy bills and logging the base data needed, facility by facility. Your computer, if you have one, may be able to do this for you. Most of the data you need is on the bill.

You may want to subscribe to the weather data service from your local National Oceanic and Atmospheric Administration (NOAA) weather station. This will provide you with needed degree-day data. This report, published monthly, provides hourly and daily weather data that is also helpful in understanding what happened to your outdoor facilities and programs due to weather factors!

Capital Costs/Justification

Differences of opinion are likely to surface about what is a justifiable capital cost repayment period when you consider energy-saving new construction alternatives or retrofits. We are still thinking of the dollar spent for construction or retrofit as being the same as a dollar spent to buy a unit of energy that is not replaceable!

Since our primary goal is to provide recreation opportunities for our patrons, is it not equally important to consider what is the end result of building improperly, or not retrofitting, when it results in operational cost escalations that force us to close facilities or price ourselves out of the market?

Examples:

A. What action should be taken for the 2.5 million dollar facility whose energy bills are "eating you alive"? Do we:

1. Allow fees to escalate to the point where the public no longer uses it, and thereby "waste" the investment?

2. Partially support its operation with taxes (increasingly!) in recognition that it is a needed recreational facility?

3. Spend the capital to retrofit and reduce operational costs, even though the payback period is longer than we would like?

B. New construction of an ice rink.

1. Do we build an ice rink as a metal prefab for minimum initial cost?

2. Build three walls in reinforced concrete and earth berm to get maximum "R" factors?

Action—How to Get It!

Every organization needs to have an energy "czar," although the federal government is doing away with such things (remember, the action is shifting to the local level). The goal is to have one person with the *authority* to see that:

a. Energy concerns are considered in new construction.
b. Retrofit opportunities are evaluated on existing buildings.
c. Operations—whether maintenance, administrative, or program—are run with energy conservation in mind.

This person need not be another staff member, just a specific assignment for an existing staffer.

This seems to be a good opportunity for an interdepartmental committee, comprised of persons from all areas and levels of your organization. Perhaps most importantly, you will get super ideas from the folks at the bottom of your organization—the sort of common sense ideas that tend not to occur to management! Many of the potential benefits of an energy conservation program accrue only as staff awareness is sharpened. If *all* employees understand that energy conservation *is policy*, energy and money will be saved.

Public Acceptance—Before You Do It

Everyone knows of organizations that decide to change something, and then just do it! They then catch hell from the public, even if the change was needed and justified. The end result is that they have to explain why they did it anyhow, but the public is left with a bad taste in their mouths. This is a lesson in how to establish a bad reputation!

Examples:

A. You decide that your organization can no longer afford the "Golf Course Syndrome" that calls for grass to be mowed frequently, whether or not the use of the area requires it.

People resist change, unless they understand (preferably beforehand) why it's necessary. Before you begin to implement no-mow areas or skip-mowing, explain the energy and cost savings. Perhaps planting the proposed no-mow area in wildflowers is the key to gaining acceptance!

B. Before you reduce the indoor temperature in your public facility, explain why it is necessary to your users and suggest that they will want to be prepared to change the way they dress. Publicize the alternatives: more taxes or higher user fees.

Conclusion

In summary, you should be involved in an energy conservation program and should consider using the *Energy Planning and Management* system for parks and recreation.

Take this system and implement it. Tell the public why and how they can conserve energy and dollars. "Toot your horn" about your successes and build your image within your community as a responsive and efficiently-run agency. In the battle for the tax dollar, you not only need the cost savings this program can provide, you need the improved public image!

Bill Graham is Deputy Director for the Rockford Park District in Illinois.

Passive Solar Design

by Claude Thompson, Jr.

R. A. Underwood

Bachman Therapeutic Recreation Center, Dallas, TX.

Basically, a comfortable internal building environment can be achieved in only two ways: either the active method of using costly refined fuels to mechanically heat, cool, and illuminate the space; or the passive method of utilizing the free energy forces of nature to achieve the same results.

Obviously then, the key to energy-efficient management in any building is to balance the requirements of this man-made environment for light and air temperatures with the natural patterns of the localized climate. This is called passive solar design, and although the concept has attained significant recent popularity, its roots were actually developed in the climate-responsive construction techniques which evolved decades ago, before cheap fossil fuel energy and the use of mechanical climate controls became widespread.

Actually, passive solar design should not be thought of as an alternative energy resource. It should be considered the basic energy strategy regardless of the type and extent of lighting, heating, cooling, and air handling system used. Expensive refined energy resources and mechanical systems are only required when the natural energies provided by the microclimate of a particular site are insufficient for, or contrary to, the energy requirements of the use proposed for that site.

Man's perception of a comfortable environment in which to play as well as work is affected by a combination of temperature, humidity, and wind, and these in turn are directly affected by the sun. Therefore, climatic aspects, and especially the sun and solar patterns, affect the amount of energy used by park and recreational facilities more than any other single factor. If the passive energy potential of a building is maximized, the need for artificial energy will be significantly reduced.

Park and recreation applications are especially good candidates for passive solar design due to the character of both their location and their activities. Parks normally provide the flexibility required for efficient climate orientation, better than do more confining commercial and residential building sites. Furthermore, recreational activities generally require less critical levels of heating, cooling, and lighting than do the more sedate commercial activities.

Similarly, recreational personnel are usually more inclined and better scheduled to provide the passive controls necessary to replace automated mechanical systems than are occupants of office and manufacturing buildings. Of course, passive solar designs also fully complement the role of park agencies as environmental stewards and lend themselves well to environmental education and natural history interpretation. For these reasons, perhaps even more so than the proven economic savings, energy-efficient passive solar designs are becoming increasingly common in parks and recreation settings.

Technically, passive solar systems are those which heat, cool, and distribute air by natural, non-mechanical means only. Regardless of how efficient a passive energy system may operate, it is still dependent completely on somewhat variable climate conditions. Therefore, in common practice today, features of passive solar construction systems are combined with elements of conventional mechanical systems.

All passive solar systems perform four essential functions: collect and convert the sun's rays into usable heat energy; store this energy for periods during which collection is not occurring; distribute it to interior spaces as needed; and control undesirable energy losses and gains.

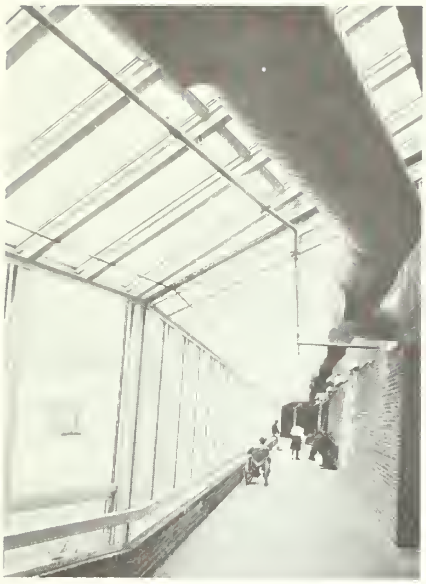
Passive Solar Heating Concepts

In passive solar applications, the building envelope itself, or some structural part of it, acts as the collector. The most common passive collector device is simply a south-facing glass or translucent plastic wall or window. Glass is most often used for solar collection because of its comparative low cost, wide availability, durability and added insulating value.

The most common forms of passive solar storage materials are water and masonry such as concrete or brick. Because of their high density, these materials can soak up and retain tremendous amounts of heat energy without getting excessively hot themselves, and hold it for extended periods of time.

Energy flows and air distribution in passive solar systems are by natural means such as direct radiation, conduction from storage mass, or air convection. Since heat always moves from areas of higher temperature to areas of lower temperature, this natural circulation pattern assists in both the generation and use cycles of passive solar systems. Yet, because it is perhaps the least dependable aspect of totally passive solar systems, the natural energy distribution element is also that most often supplemented by mechanical systems such as fans and heat pumps.

Since the building space itself also serves as the collector and storage element, passive solar structures can both overheat when the sun is unusually clear and lose their cap-


R. A. Underwood

The glass gallery along the front serves as a passive solar energy system.

tured heat energy at night and during inclement weather. Control devices are, therefore, a critical aspect of passive solar design. Such controls include both the stationary insulation of the building walls, floor, and ceiling (discussed elsewhere in this issue of *Trends*), and movable insulation used to cover the collector and storage spaces when heat loss may occur.

Another important type of passive control is the overhang of rooflines or trees which shade the collectors from the longer exposure of the high angle summer sun but allow the low angle winter sun through unobstructed. Vents which exhaust any undesirable heat buildup, and which catch and direct desirable cooling breezes are also valuable control techniques in passive solar building design.

Passive Solar Cooling Techniques

Most passive solar systems also provide some aspect for cooling interior spaces during warm weather. While it is impractical, and perhaps in some climates impossible, to achieve levels of cooling which are obtainable and which have been made popular by mechanical air conditioning, natural cooling is nevertheless a practical technique.

In space cooling for human comfort, as in heating, it is the differential temperature between that which exists and that which is desired that must be provided, and not the entire temperature. Therefore, any amount of cooling which can be provided by passive design techniques assists in reducing the need for mechanical systems by at least an equivalent amount.

Basically, the storage and control media described for passive heating, including insulating against heat loss and shading off or venting away excess heat buildup, serve also to reduce the cooling temperature differential. A related passive cooling technique consists of cooling outside air down to ground temperature, which is normally much cooler than air temperature, by passing it through tubes buried in the earth. Still another passive cooling method is the thermal chimney which produces a draft by allowing appropriate collector and storage spaces to overheat and be vented from the structure, thus augmenting natural ventilation and drawing warmer air out of the building spaces.

Passive Design Strategies

While each passive solar design is uniquely different due to site and layout specifics, they may be grouped generally into one of three strategies, depending on the relationship of the collector to the space being heated. These three strategies include direct gain systems which operate largely by radiation, indirect gain systems which combine collection and storage in a single unit and transfer the energy for use elsewhere through conduction, and isolated gain systems in which solar energy is collected outside of the building space and distributed by means of natural convection. Since passive solar design strategies incorporate the building itself and fit most contemporary architecture, they require little, if any, adjustment of the building configuration.

Direct Gain Systems are the simplest and most common strategy for passive solar design systems. Such techniques merely open the interior building space to the direct radiation of the sun. This is accomplished through south-facing glass which collects the heat energy. Energy is stored in the interior masonry floor and walls, and furniture and other objects for later release when collection is no longer occurring. Circulation in a direct gain system is limited to natural convection, and its benefits are largely limited to a single room. An important consideration in direct gain systems is ventilation, since even in winter interior spaces can overheat. In the cooling mode, direct gain systems use convection to draw cooler air into the space from lower vents and exhaust hot air through the higher collector.

The Ridgewood Neighborhood Recreation Center in Dallas, Texas, is a showcase of direct gain passive design features. Skylights and clerestories not only serve as solar heat collectors to reduce the heating demands on a conventional HVAC system, but also provide natural lighting which supplements electrical lighting in the offices, activity rooms, and gymnasium. Internal circulation throughout the 14,000 square feet building is aided by a natural air convection loop system encouraged by openings in the walls between rooms.

Excess heat buildup in the ceiling spaces is exhausted by exterior wall vents, helping to keep the rooms beneath cooler in summer. The low, wide overhang of the roofline shades the external walls and windows from excessive heat, and darkly-tinted, double pane thermal glass windows insulate the structure against excessive heat gains. In cooler climates, adjustable shades could be added to insulate the skylights against heat loss at night.

Another example of direct gain passive solar heating is the indoor swimming pool of the San Antonio Independent School District. Instead of a metal or masonry skinned building which would absorb solar radiation and thus insulate a cool interior as well as require artificial lighting, the 50-meter instructional and competitive pool is housed in a standard commercially-manufactured greenhouse which gathers both the sun's heat and light. Natural convection currents maintain fairly even temperatures throughout the interior. To avoid overheating and excessive humidity during summer months, hotter air is naturally exhausted from roof vents, drawing cooler air in through lower vents and doors. Conventional electric space heaters with blowers provide backup during inclement weather when solar radiation is not sufficient.

Isolated Gain Systems collect solar energy in a separate sunspace, apart from the location where the heat is actually to be used, and hence the term isolated gain. The attached greenhouse is the most common form of isolated gain system. Because the greenhouse itself serves only as a solar collector and is not used as a work space as is the case in direct gain systems, it can collect and store significant amounts of heat and energy and its temperatures can be allowed to remain quite high during the daylight heating periods and become rather low at night. Normally, the attached solar collector sunspace is insulated from the host structure and heat transfers occur only as needed through openings such as doors, windows, or vents. The isolated gain principle is also one of the best passive solar techniques for retrofitting to an existing structure.

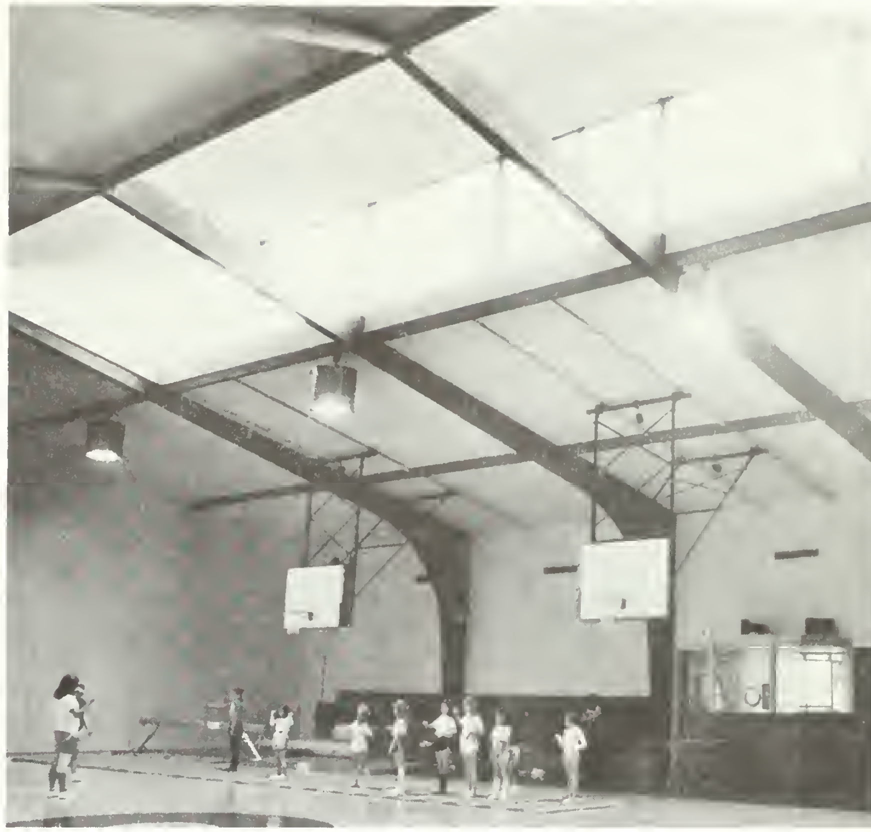
The Dallas Park and Recreation Department (TX) has incorporated a 3,500 square foot greenhouse type isolated gain solar collector into the original planning and construction of the Bachman Therapeutic Recreation Center to augment conventional mechanical heating and cooling. The 10-foot-wide greenhouse serves as a distinctive gallery along the entire front of the 37,000 square feet building, but also transmits heat directly into adjoining office and activity spaces. The interior brick wall and dark-colored tile floor of the sunspace help store the sun's heat for later use.

To prevent both heat loss during the winter and heat gain in the summer, an airlock vestibule entry and double-pane glass is used. The ducts of the mechanical HVAC system are located along the ridge of the greenhouse where they obtain additional warmth through direct gain principles. Mature deciduous trees shade the greenhouse against overheating in summer, but allow the warming sun through to heat the sunspace in winter.

Standard greenhouse ventilation techniques which draw cooler air through lower vents and exhaust hot air from roof vents serve both to cool the sunspace from overheating and can also serve as a thermal chimney cooling system by closing these lower outside vents and drawing air instead from the work spaces for exhaust through the upper vents. Additional heat storage devices such as water tanks would be advisable in colder climates with shorter solar heating days.

The National Park Service has installed attached greenhouses to existing visitor centers at the Mount Rushmore National Memorial in South Dakota and the Theodore Roosevelt National Park in North Dakota to provide natural heat to these buildings and reduce the loss of more expensive conventional energies.

Indirect Gain Systems are a modern variation of the direct gain system. Instead of heating the room directly, the sun's energy heats a storage wall placed a few inches behind the glass collector as well as the air between the wall and the glass. Convection is used to circulate this heated air through vents in the wall. Heat is also radiated from the storage wall directly into the room. The



R. A. Underwood

Clerestory windows, or vertical skylights, not only provide natural lighting but also help to heat and cool the Ridgewood Recreation Center in Dallas (TX).

storage walls are normally made of masonry and called Trombe walls after the designer of the system, or consist of metal tanks filled with water. This indirect gain method offers significantly increased thermal storage capacity over historical direct gain principles, but has the disadvantage of blocking the natural sun light from the interior room space and requires more critical design calculations and specialized construction.

Solar Pond Systems

Solar ponds are non-flowing, saline water bodies which provide yet another efficient passive solar energy strategy. The solar pond collects the sun's heat energy just as do the glass walls of a direct gain building system and stores it for use elsewhere as do the air spaces, masonry walls, and water tanks of isolated gain systems. However, since the pond is not a structural part of the building, this technique does not risk the overheating problems generally accompanying attached systems. Unlike fresh water ponds in which the heat rises to the surface and is lost to the atmosphere, salt water solar ponds naturally draw the hotter temperatures to the bottom where they are more effectively stored and drawn off for use elsewhere.

Solar ponds are also quite adaptable to existing developments, often cost substantially less to construct than other solar alternatives, and routine maintenance is minimal. Due to the reverse heat flow, solar ponds, in effect, insulate themselves and therefore work equally well in colder weather. However, the major attraction of this concept is that once the salt water reaches a steady state, both attainable temperatures and storage time significantly exceed other passive solar techniques, making the solar pond extremely stable and nearly unaffected by daily climatic variations.

The largest operational salt-gradient solar pond in the United States is in Miamisburg Community Park in Ohio which provides winter heating for an adjacent recreation center and warm water for the 50-meter outdoor swimming pool during the summer. The half-acre solar pond was designed and built along with the recreation center following the evaluation and rejection of several other alternative supplemental energy concepts. Heat transfer is through conventional mechanical heat exchanges and blowers, although the system will operate with natural convection circulation only.

Earth Sheltered Structures

Covering buildings with earth is an effective and economical passive construction technique, and complements the need of passive solar design strategies for insulation. Since soil temperatures a few feet below the surface remain nearly constant throughout the year, earth coverings insulate buildings against unwanted heat gains and losses better than most manufactured materials. Earth sheltering is also a very feasible passive cooling technique, as these subsurface temperatures are normally substantially cooler than surface air temperatures.

But earth shelters provide other economic benefits as well, including reduced maintenance costs, extended building life, noise reduction, enhanced security against fire and storm damage, and saving of limited site surface for other uses. The only real disadvantage of earth sheltered structures is the difficulties of adding space later.

The Shenandoah Community Recreation Center in Shenandoah, Georgia, is an excellent example of the energy-saving value of earth sheltering. This 58,000 square feet two-story center is covered to the roof on three sides by a thick blanket of earth. This insulation protects the building interior from heat gains during summer, thereby providing free natural cooling. During the winter, interior heat generated by building occupancy, lighting, and mechanical operations is retained by this insulating cover and redistributed to help heat other interior spaces as needed.

Summary

Passive solar design is not a panacea for the energy crisis but it does offer a very positive alternative. One of the major limiting problems of passive systems is the insufficient technical data on their performance for use in both design and economic analysis, although proper sizing of these systems is even more critical than with mechanical systems. However, if the tradeoffs can be properly balanced, passive solar design can provide a sound economic alternative to conventional fuel consumption and mechanical systems. Park and recreation facility planners have learned over the years to plan with the natural drainage characteristics of a site to avoid the wasteful consequences of flooding. In a similar manner, planners must today learn to plan with the energy forces of the natural climate, or continue to suffer the consequences of costly operation and maintenance of inefficient mechanical energy systems.

Claude Thompson is Senior Park Planner with the Dallas, Texas, Park and Recreation Department. He has spoken on energy-sensitive park and recreation planning at several professional meetings.

ALTERNATIVE ENERGY RESOURCES

I. Two Approaches for Small Scale Solar Systems

by Richard Simmons and Richard D. Davis

Yes, the National Park Service is involved in solar space heating and cooling of buildings, and with the solar heating of domestic hot water. Our experience dates back over a decade, beginning with the construction of new buildings and major retrofit projects by the Denver Service Center. Over the last few years, the number of projects has climbed dramatically, though the average project has been on a smaller scale.

Early Systems

Generally, the first solar thermal projects were built as quasi-demonstration projects when solar was still very much of a novelty. At that time, economic return on solar was still questionable due to lack of precedent, and it was considered more important to demonstrate that solar could actually heat and cool a building. Examples of projects completed then were: the solar heated Lovell Visitor Center at Bighorn Canyon National Recreation Area (WY), which was constructed as a new building, and the solar heating and cooling system retrofitted to the Visitor Center at Mount Rushmore National Memorial (SD).

As would be expected, there were "bugs" in these early systems. For the most part, the troubles resulted from contractors being unfamiliar with solar systems and occurred during construction. Design problems were usually minor. It's a credit to both park staffs and the Denver Service Center that most of the "bugs" were eliminated as soon as they were detected, and that the units have functioned so well. The vast majority are now operating at an acceptable efficiency, and as the price of conventional energy rises, they are proving solar to be a viable economic alternative.

There were numerous situations where members of the park staff would volunteer their labor after hours and build solar heating systems using scrap materials. The solar heater used on the asphalt storage tank at Wind Cave National Park (SD) is an excellent example of this type of effort. This unit was built out of sheet plastic, scrap plywood, and old soft drink cans. It is used to heat road oil in the tank to a point where it will flow into distributor trucks. The unit largely replaces an electric heating element powered by a gasoline generator.

Special Demonstration Park Program

With the advent of the National Park Service Energy Program, the number of small-scale solar thermal projects increased substantially. Solar domestic hot water heaters that showed an attractive payback period were funded from the Special Energy Demonstration Park Program at Colorado National Monument (CO).

One of the most interesting aspects of the NPS Special Demonstration Park Program has been the opportunity to install passive units in cooperation with the Colorado State Energy Office. The most recent example of this cooperation has been the installation of a Trombe wall on the Visitor Center of Great Sand Dunes National Monument in southwestern Colorado. Like a previously completed solar greenhouse at Colorado National Monument, the state provided the design and the supervision of the volunteer construction crews while the National Park Service provided the materials and some of the labor. We have found these cooperative efforts to be one of the most enjoyable parts of the entire energy program, and it has proven to be very effective in terms of cost, expertise, and public relations.


Micki Hellickson, NPS

Solar domestic hot water system on residence in Theodore Roosevelt NP (ND).

Energy Grants

Within the last 2 years, the Park Service has received funds from the Department of Energy (DOE) for a substantial number of solar thermal projects. The funds were granted under the Solar in Federal Buildings Program which was designed to demonstrate the practicality of solar thermal systems to the general public through their operation on federal buildings.

Through the efforts of its Denver Service Center, the National Park Service received funding for a number of large solar space-heating projects under the DOE program, including projects in the Southwest Region at Navajo National Monument (AZ) and Carlsbad Caverns National Park (NM). There was also an active solar space-heating system for the Visitor Center at Colorado National Monument in the Rocky Mountain Region and two projects at Fire Island National Seashore (NY) and one at Gateway National Recreation Area (NY-NJ) in the North Atlantic Region.

The NPS also requested funding for a large number of solar domestic hot water heater projects. The NPS Western Region received approval for 325 systems at 26 parks, the Rocky Mountain Region has 201 systems approved for 15 parks, and the Pacific Northwest Region has 7 systems approved for Craters of the Moon National Monument in Idaho.

National Park Service

These panels power a solar domestic hot water system at Great Sand Dunes NM (CO) which was funded by the DOE Solar in Federal Buildings Program.

Although these systems did not constitute the major portion of DOE's total funding, they did represent the majority of the projects, and were the first projects in the program to have their funds transferred to the benefitting agency and obligated.

Contracting for Projects

Interestingly, the Western and Rocky Mountain Regions decided to take different tacks in contracting for their respective projects. The Western Region followed the Request for Proposals (RFP) procedure, while the Rocky Mountain Region followed the more familiar Invitation for Bid (IFB) method. This allowed us an excellent opportunity to compare both procedures for use with small-scale solar systems.

Under the RFP procedure used in the Western Region, interested bidders were asked to submit packages detailing how they would meet the requirements for systems stated in a *general* set of specifications provided by the Regional Office. These packages were then reviewed for technical aspects of the bid, the quality of the material, and the proposed price. A contract was then awarded considering all of these areas. The actual installation of the systems in the Western Region was provided by contract in some of the park areas and by park forces in others. Under the IFB procedure used in the Rocky Mountain Region, interested bidders were given a *detailed* set of specifications outlining the minimum acceptable requirements for the systems. Having met these minimum requirements, the successful bidder was then selected on a lowest-bid-price basis. The installation of the units in the Rocky Mountain Region was part of the contract and included in the bid price.

Contracting Comparisons

The advantage of the RFP was that a large number of systems could be reviewed for engineering quality and efficiency and the best system selected, whereas only one type of system (in this case flat plate liquid systems) could be specified under the IFB process. The IFB procedure was advantageous in that once the specifications were completed, there was not a great deal of time spent in engineering review except for checking the qualifications of the successful bidder. Depending on the number of submittals, the amount of man-days spent on a detailed review under the RFP can be substantial.

Both the RFP and IFB opened the regions up to the threats of protests by manufacturers or installers. In the Rocky Mountain Region a number of manufacturers were upset because they did not meet our specifications which required a flat plate liquid collector system. Research has shown that this type of system constituted at least 80 percent of the solar domestic hot-water heating market. We therefore reasoned that we would be able to obtain the best price for this type of system. Also, getting replacement parts and performing maintenance would be easier.

We received phone calls, letters, and two Congressional inquiries because of questions from manufacturers of other types of systems. "Evacuated tube" system manufacturers were very concerned about not being able to meet our specifications, but the subsequent bidding showed that their price might range up to twice that of the standard flat plate system. We received a number of inquiries from "tracking concentrator" system firms. We felt well justified in not considering those systems because of both the cost and potential maintenance problems.

Concern was also expressed by a number of flat plate, air collector firms. The liquid systems offered much greater efficiency. The liquid-liquid heat exchanger is far superior to an air-liquid exchanger. Also, for the same efficiency, the liquid collector is smaller than its air counterpart, resulting in fewer aesthetic, wind, and roof-loading problems.

Strangely, the variations in the RFP and IFB procedures made little difference in the long run. The primary difference between the equipment installed in the two regions was that the liquid for the solar loop in the Western Region's systems was an oil liquid, whereas it was an anti-freeze and water solution in the Rocky Mountain Region.

Specifications

The specifications for the Rocky Mountain Region were drafted by Tom Meagher of the Midwest/Rocky Mountain Team of the Denver Service Center. The specifications received high praise from the National Aeronautics and Space Administration at Huntsville, Alabama, which served as review authority for DOE

Workers install trombe wall on visitor center at Great Sand Dunes NM (CO).

National Park Service

on this program. In fact, the specifications were used as a model for other agencies by NASA.

Besides specifying a flat plate liquid collector for the Rocky Mountain Region systems, the size of the collector was specified by means of the common "F" chart method which bases size upon hot water requirements and geographical location. The heat exchanger for the system turned out to be an internal exchanger in a stone-lined, insulated storage tank. Backup heating requirements were met by electric heating elements.

The Rocky Mountain Region was divided into five areas for the sake of issuing IFBs that would be large enough to obtain a good price for the government while not being so large as to preclude relatively small companies from the bidding. Even with this arrangement, several contractors complained about the contracts, which ranged in size from approximately 30 systems to a little over 50 which were too large for their small firms to bid on. We learned that the solar market is primarily composed of very small firms that are used in installing only a handful of systems per month. Despite the complaints, we got strong interest from solar dealers.

A number of firms saw an opportunity to display their products to the public visiting the national parks. The idea of placing their products in the positive, ecological setting of a national park was very attractive to a number of manufacturers, and probably was a factor in the relatively low bid price that we received.

Comments on the NPS Western Region's Approach

During April 1981 the solar system manufacturer provided the materials and labor to install the original five systems, including one in Hawaii, two at Grand Canyon, and one each at Point Reyes National Seashore (CA) and Sequoia-Kings Canyon National Parks, (CA). Immediately after completion of installation each of these systems was instrumented. A one-day efficiency test was conducted by personnel of the Marshall Space Flight Center—National Aeronautics and Space Administration. The test showed a low of 44% and a high of 60%—excellent results for active flat plate solar domestic hot water heating systems.

The remaining 320 units were to be installed as follows: 47 by park forces, 16 contracted by the park; and the remaining 257 were contracted to a Small Business Minority (8a) contractor. By the end of December 1981 more than 100 systems have been installed and are operational. All systems are scheduled for completion by May 1982.

The systems as installed will provide 60–80% of the yearly hot water required for a family of four in each building. These systems will reduce the use of fossil fuels and will enable our areas to promote the use of an alternative source of energy to park personnel and visitors.

Minor Problems Encountered

There have been some minor problems with the contracts, largely in the area of installation. A few of the solar hot-water storage tanks leaked, and there have also been a number of areas where the installation crews left off the required insulation for the pipes. These have been, for the size of the contracts, minor items. Good inspection by the parks and the Denver Service Center people and, a generally very cooperative attitude on the part of the contractors have kept potentially troublesome problems at a minimum.

Some problems arose from our lack of manpower to check all the sites before the bids, but these were usually easily solved. A few areas we thought had existing electric hot water heaters turned out to have liquified-petroleum gas instead. One area had some trouble with the floor loading for the heavy, stone-lined hot water storage tanks that were installed. Space problems in National Park Service residences were solved, in most cases, by installing single instead of double tank systems.

The single tank systems caused some problems where large families needed more than the standard 30 to 40 gallons of hot water provided immediately by the back-up unit in the 80-gallon tanks that we installed in the residences. A few families had some difficulty adjusting to the solar living style, such as using most of their hot water after the sun had been out long enough to heat the water in the tank.

We would recommend to anyone interested in contracting for solar domestic hot-water systems that they include in their original contract units to recharge the solar fluid in their systems. Only one such system per area is required.

The anti-freeze type liquid in the solar loop needs to be recharged once every 3 years. We would also recommend a user manual on solar life-style as well as the standard maintenance manual that should come with each system.

The parks, in general, are very pleased with their systems. Results have been positive, especially in those areas that had systems installed in time to take advantage of the late summer and early fall sun.

Richard Simmons is the National Park Service's Rocky Mountain Regional Energy Coordinator and Richard D. Davis is the NPS Western Regional Energy Coordinator.

II. Solar Electric Projects

by Addison Hulse

The first demonstration of direct conversion of sunlight to electricity by means of the photovoltaic effect occurred in 1839. In 1954, the effect was demonstrated in a semiconductor junction and this opened the way for practical commercial application. Initially, the silicon solar cell was used on spacecraft to provide an endless supply of electrical energy. Numerous terrestrial applications were soon found as the cost of the solar cells began to decline. Today solar photovoltaic panels and systems are commonplace in both government and private installations.

Photovoltaic Solar Panels

The National Park Service (NPS) has been using photovoltaic solar panels since 1965 as electrical power supplies for remote radio repeater stations. The NPS currently has over 51 photovoltaic systems in daily service. These systems range in size from a few watts, providing power to a single radio repeater to 100,000 watts, providing power to an entire remote community. The systems have proven very reliable. Several are providing power during the winter seasons at locations where power previously was not available year round.

Figure 1 shows the construction of a typical silicon solar cell. Silicon solar cells are made by doping pure silicon crystals with other chemical elements. The solar panel can be expected to last for 20 years or more in constant use. As the only cost of solar photovoltaic systems is the initial cost for installation and occasional maintenance, they can easily be cost-effective over their lifetime.

Additional benefits of solar panels are the elimination of refueling, battery charging, and periodic equipment overhauling. Occasional drawbacks are vandalism, theft of panels, and low electrical capacity if too many cloudy days in a row occur.

National Park Service

A photovoltaic system provides power for communications at a fire lookout tower at Isle Royale NP (MI).

Determining Cost-Effectiveness

To determine the cost-effectiveness of a solar photovoltaic system, the total cost of a system over its useful life must be compared to the life cycle cost of a conventional system. If the solar system is to be a replacement for an existing conventional system, such as a gasoline powered generator, only the operating and maintenance cost of the conventional system should be considered in its life cycle cost unless a replacement would be required during the time period selected for analysis.

The easiest way to compare systems uses the simple payback analysis. If a solar system can be shown to be cost-effective for a 20-year period or less using this method, it should be considered for installation. If it is not cost-effective using simple payback, a life cycle cost comparison of the solar system and several alternative systems should be made. The life cycle cost procedures are shown in 10 CFR Part 436 Subpart A and published in the Federal Register. These procedures contain recommended discount (interest) rates, study periods and marginal fuel costs to use in an analysis.

Photovoltaic systems are generally most cost-effective where energy demands are low and distances to the utility are long. Generally, medium-sized systems are not cost-effective when located within one mile of commercial power. Smaller systems might be cost-effective within one mile of a utility, depending on the terrain and application.

Site Location

Locating a suitable site for a photovoltaic system is important. Adequate sunlight must be available year round and potential shading from trees, mountains, buildings, and weather must be evaluated. The aesthetic impact of a solar array on a building or area must be coordinated with the responsible staff so an unwanted visual intrusion is not installed. Maintenance requirement must be known to maintain accessibility to the system in case of failure or to perform scheduled maintenance. Systems should be placed in areas not subject to vandalism.

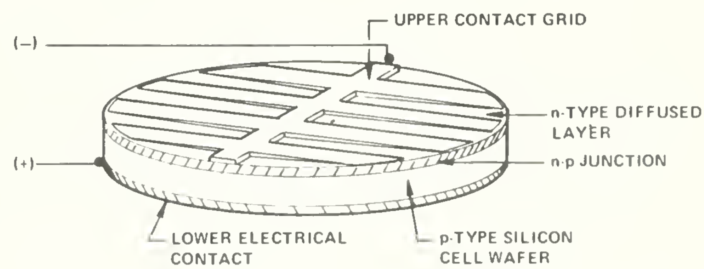


FIGURE 1. TYPICAL TERRESTRIAL SOLAR CELL STRUCTURE

The starting point in the design of a solar system is the amount of sunshine available daily at the site in question. Meteorological records are available for the mean daily solar insolation on many sites. These can be converted to the predicted total solar radiation falling on a particular site by manual calculations or by available computer programs. Approximations must be made for specific locations. The array tilt from horizontal can be selected to give either maximum annual insolation or maximum winter insolation to properly serve the load. Each solar electric system must be individually designed for a particular application and location.

Most solar system suppliers have computer programs available to properly determine the array size and storage battery capacity for a specified location. This insures that the storage battery capacity will meet the system requirements during extended periods of sunless days. The minimum load information required to determine the system size is operating voltage and daily current requirements. Both the load current and the expected percent of "on" time must be averaged over the entire year. Once the array and storage system have been computed, all of the remaining components of the photovoltaic system can be sized.

Equipment Considerations

Consideration should be given to component efficiency and degradation of equipment with time. Since the system is modular, additional array panels or batteries can be added or deleted if necessary after the system is operational. Figure 2 shows a large system in block diagram form.

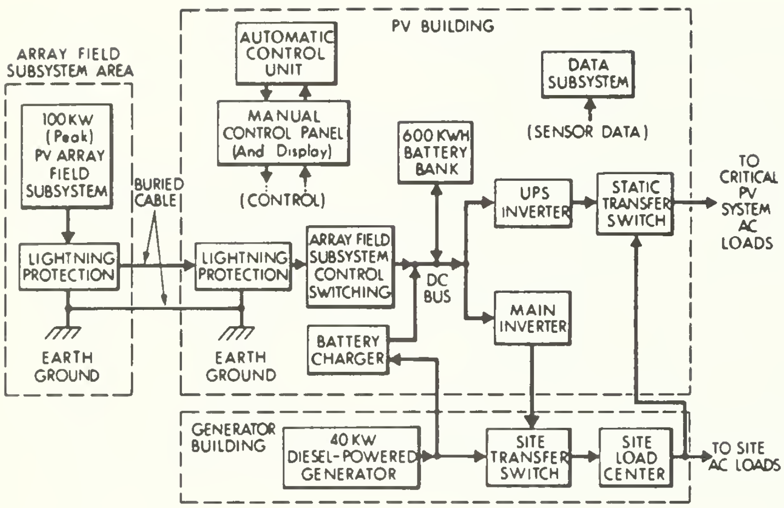


FIGURE 2 SIMPLIFIED PV POWER SYSTEM BLOCK DIAGRAM OF THE NATURAL BRIDGES NM SYSTEM

Several manufacturers provide complete systems including the solar arrays, supports, batteries, controls and interconnecting wiring. These systems should be considered when purchasing a new system as they will be assembled of matched components and the supplier will be responsible for providing an operating, reliable system of proven capabilities.

Safety

Standard safety procedures should be followed with photovoltaic systems both in design and operation. Some of the more important safety considerations are lightning protection, proper battery servicing procedures, disconnecting power sources when working on circuits, covering the array with opaque material when maintenance is performed on live electrical parts, and proper grounding on higher voltage systems. All photovoltaic systems should comply with pertinent articles in the National Electrical Code.

NPS Photovoltaic Projects

The NPS has installed a number of different types of solar photovoltaic systems in the last 16 years. From the first six systems installed in 1965 on six peaks in Sequoia-Kings Canyon National Parks (CA) to the 100 kilowatt system recently installed at Natural Bridges National Monument (UT), reliable electrical power has been generated for remote applications. Performance of virtually all of these systems has been essentially trouble-free. Occasionally a panel or array will be vandalized or stolen, but the solar systems, for the most part, seem to be respected by park visitors and are left alone. These systems provide electrical power for many important functions in the parks. Some of the applications are:

- —remote radio repeaters
- —communication battery chargers
- —central station community power
- —comfort stations
- —lighting
- —refrigerators
- —weather stations
- —cathodic protection
- —charge electric vehicle batteries
- —traffic lights
- —interpretive audio stations
- —travelers' information stations

The National Park Service has notable photovoltaic installations at the following sites:

Natural Bridges National Monument, Utah
Isle Royale National Park, Michigan
Rocky Mountain National Park comfort stations
Mount Rainier National Park, Washington

Summary

Our experience with photovoltaic systems in the NPS has been very encouraging, and future uses of these power systems should prove very satisfactory. As the rapid technological advance of photovoltaic equipment and systems continues, the products will become even more reliable, and the cost per peak watt will continue to decline. Some day in the future, our children may not have to depend on the public power companies, but will generate all their own electrical power from the sun falling on their roof tops.

Addison Hulse is a mechanical engineer with the National Park Service's Denver Service Center.

ALTERNATIVE ENERGY RESOURCES:

III. Wind Power Development

by Richard D. Davis

Wind is second hand solar energy; its basic driving force is the unequal heating of the earth and atmosphere. It is given characteristic flow patterns by the earth's rotation. Objects on the earth recognize the wind as air in motion, in particular any noticeable natural movement of air parallel to the earth whether of high or low velocity or great or little force.

Work can be accomplished by using the force of the wind to drive a variety of devices including: sails, wind vanes, propellers, etc. The amount of work that can be derived from the wind is dependent upon the velocity and direction in which the wind approaches the device which converts the force of the wind to work.

Power is the time rate of doing work and it is normally expressed in ft.-lbs./hour or horse power. To determine what power output a machine is capable of, it is necessary to determine the average amount of work delivered over a specified period of time.

All of the foregoing principles and definitions have been understood and used throughout time, and the wind has been a viable force used to perform work. Sailing vessels have used the wind for power for thousands of years. There were more than 25,000 windmills in use in Denmark alone during the 1890's; in the United States a million or more small windmills were located on farms during the 1920's. During the period from 1930 through the present, wind continued to be an economic source of power for many Third World nations and isolated areas. However, the more developed nations abandoned the wind for inexpensive fossil and nuclear fuels.

The cost of so-called conventional fuels began escalating with the oil boycott of 1973 and has continued at an almost exponential rate. Because of increasing costs of conventional sources of fuel, alternative sources of energy are now being promoted to reduce the overall impact of economic imbalances caused by the location of the sources of fuels. Wind, which for centuries was a conventional source, is once again being studied as one of the alternative methods of reducing this nation's dependence on fossil and nuclear fuels.

The current emphasis for the development of wind as a source of energy is the conversion of wind power to electrical power through the use of a variety of rotating devices driving an electrical generator. The major consideration in locating these machines is the average wind velocity available at the proposed installation area. Wind machines are very site specific. They must receive wind at a sufficient velocity to generate the power for which they are designed. Although an area may be deemed "windy," the average 24-hour per day velocity may not be sufficient to provide the energy necessary to ensure an efficient cost-effective return on the placement of a wind machine. Therefore, before final placement of a wind machine, it is prudent to conduct a wind feasibility study.

National Park Service

This reconstruction of a turn-of-the-century windmill at John Muir National Historic Site demonstrates the usefulness of cost-free wind energy to pump water for irrigation.

Wind Feasibility Study

A wind feasibility study determines what the average wind velocity is at a specific location and height. Such a study is normally conducted over a prolonged period of time with an anemometer (an instrument that provides wind velocity and directions) located at specific sites and heights to determine where it would be economical to locate a wind generator.

Wind feasibility studies will normally result in information useful to power and design engineers who contemplate siting a wind machine in the area. Currently, technology for a wind generator requires an average velocity of at least 12 miles per hour year round to make the installation of a machine cost-effective.

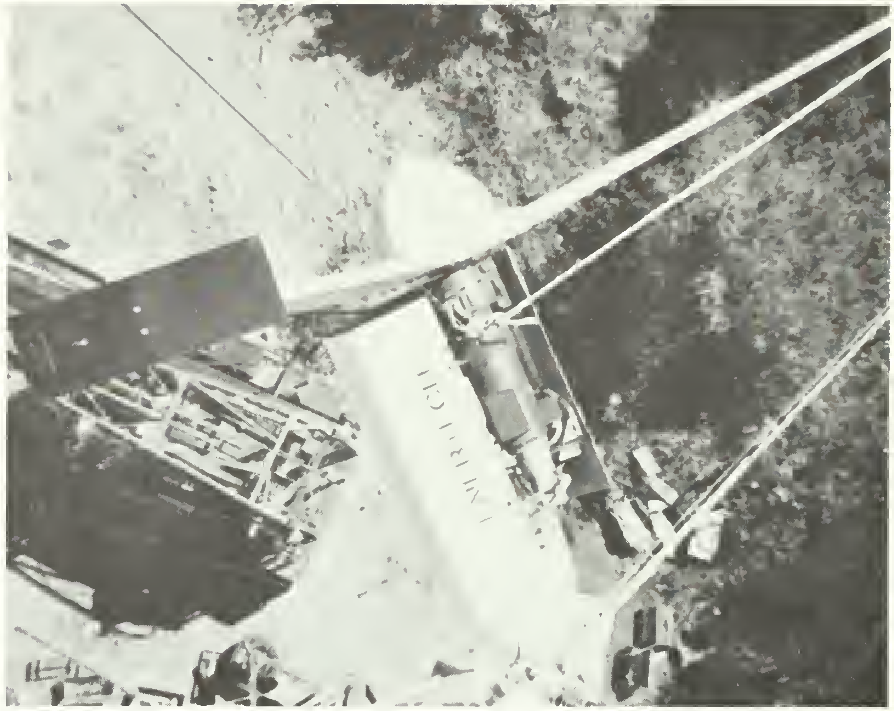
NPS Wind Machine Projects

The National Park Service has installed nine noteworthy wind machine projects. Two of them have been unsuccessful because of harsh weather. The others are functioning successfully. Included in these experiences are:

(1) A small aero-motor type wind machine for pumping water at the Eisenhower Farm in Get-

W. Swalling

Dr. M. S. Manalis demonstrates the quality control procedures used to calibrate the field microcomputers that will test for wind power feasibility.



National Park Service

A wind machine being raised to top of 60' tower at Capulin Mountain NM (NM).

tysburg, Pennsylvania. The machine was not in operation at the time the Park Service acquired the farm and is currently used for interpretive purposes only.

(2) Three small wind machines are used to generate power seasonally in the Midwest Region. Two of the machines are located on Apostle Islands National Lakeshore, Bayfield, Wisconsin and one is located in the Voyageurs National Park, Minnesota.

(3) One wind generator was located at Sandy Hook, New Jersey, in the Gateway National Recreation Area. Installed in 1977, this machine failed because of the severe salt atmosphere and was struck by lightning. The machine was dismantled in 1981.

(4) A wind machine was purchased in 1979 and installed at Theodore Roosevelt National Park in North Dakota. The machine was in operation approximately two months when a structural failure in the mounting occurred. The machine was destroyed.

(5) A 4-KW wind machine has recently been installed at Capulin Mountain National Monument, New Mexico.

(6) A 4.5 KW wind machine has been purchased and is scheduled for installation during the spring or summer of 1982 at Katmai National Park and Preserve, Alaska.

(7) An historic wind machine used for pumping irrigation water is currently in service at John Muir National Historic Site, Martinez, California.

(8) A wind feasibility study is currently being conducted at Anacapa Island, Channel Islands National Park, California. If this study shows that the wind can provide the power for a small electric generator, the funds will be sought for the installation.

Personnel in the Western Region of the National Park Service will continue to pursue development of the wind as an energy resource because it offers an environmentally safe alternative to the fossil fuels currently in use.

Richard D. Davis is Regional Energy Coordinator for the National Park Service's Western Region.

ALTERNATIVE ENERGY RESOURCES:

IV. Micro-Hydro Power

by John Teichert

Moving water—the perfect power. It's clean, it's free, and in certain sections of the country, inexhaustible, especially in the Pacific Northwest. To generate electric power, just divert some of this moving water through a pipe or penstock, let it flow down a vertical drop to spin the blades of a turbine, and sit back and watch the power being generated. No air pollution, no OPEC, no waste of water. In fact, it's a steady source of power not dependent on any depletable energy source.

Recently, much attention has been given to hydropower around the nation due to a new Federal law which allows a hydro developer to sell hydroelectric power at a rate comparable to unit costs for new generating facilities. At these rates, called marginal rates, the revenue produced by hydro plants will increase as the cost of depletable energy sources climbs.

Stop you say—we in the National Park Service aren't in the power-generating business. In fact, we are prohibited by law in most areas from developing commercial hydropower facilities. The environmental consequences of damming our streams is too high. The idea of changing the natural setting and altering our natural resources conflicts with our objectives of preservation and protection. All of the above are correct.

However, there are park areas without commercial power where we generate power using depletable energy. The results are high fuel bills, high maintenance, and an environment compromised by generator noise and pollution. Many areas already have small dams and penstocks (pipes) which are used to collect drinking water. Many of these systems are being abandoned because of the new drinking water standards. There are sites where a partial diversion of a portion of a stream would cause no environmental consequences. In fact, if we could turn off a generator, we would improve the environment. The cost of the fuel oil or liquified-petroleum gas needed for a generator is rising astronomically. If the same power could be generated by a free energy source, the saved funds could be better applied to our job of preservation and protection. There are also sites where old hydropower facilities have been abandoned because of cheap electrical rates. Again, all of the above are true.


National Park Service

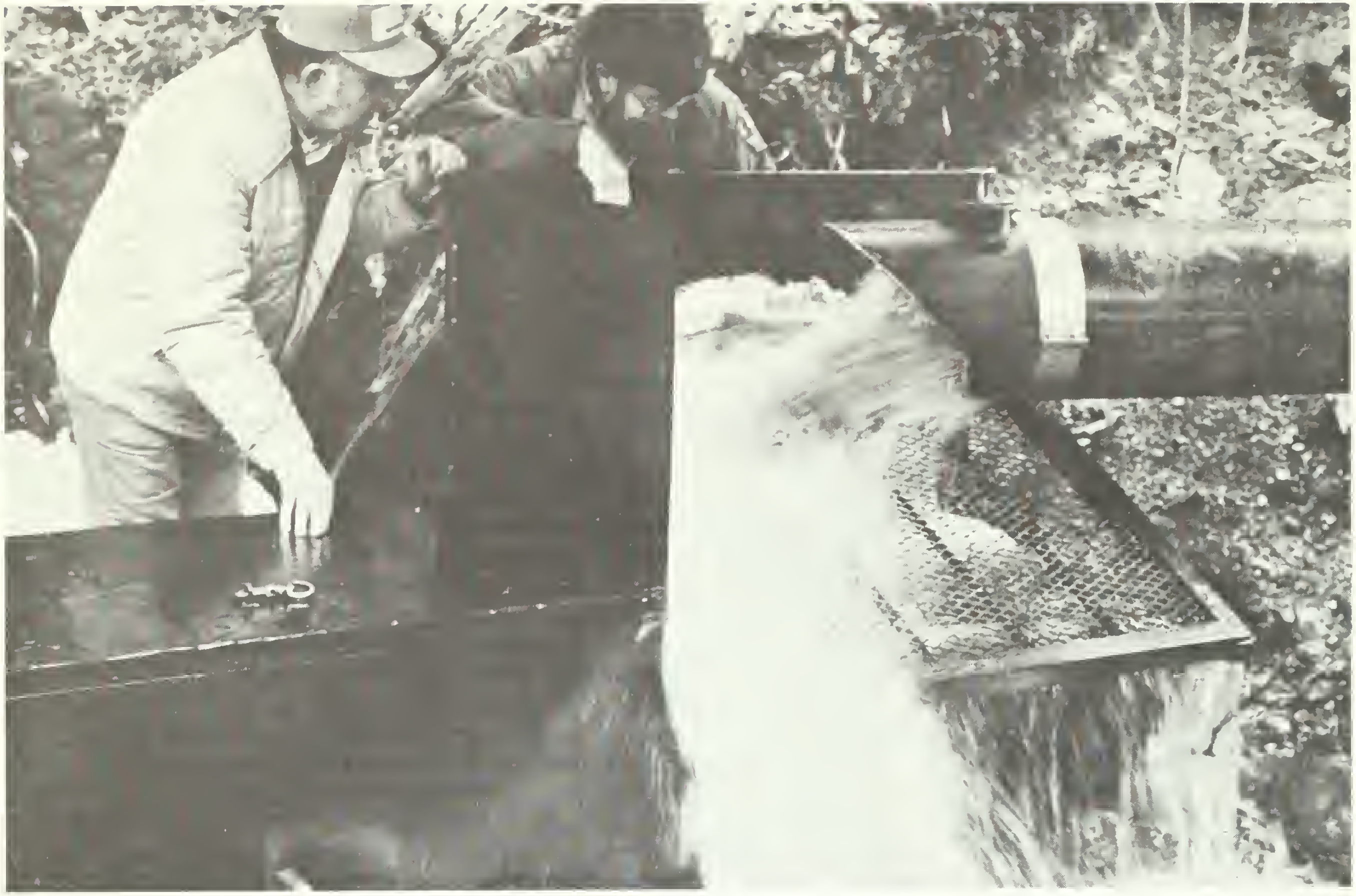
City of Tacoma (WA) hydro facility with generation station and penstock.

Hydropower Potential for Parks

Now consider hydropower. What are the advantages of such a system if installed in our parks? Free energy source, quiet operation, lower maintenance than self-generating, and possible use of abandoned systems at lower costs. The most important advantage besides cost is the self-sufficiency feeling of not being dependent upon outside, high-cost depletable sources.

Of course, there must be disadvantages. First will be installation cost—where does one get the dollars? In addition, there could be environmental impacts; or the potential stream flows might not correspond with our energy demands. In general, though, the advantages far outweigh the disadvantages. Remember, these are not large megawatt systems. The hydro *most* adaptable for our use is titled *micro-hydro*, that is, plants with generating capabilities less than 100 kw, mostly under 25 kw.

It is vital that a project to install a hydro system have the full commitment of the people involved, from the on-site maintenance and management people to the park headquarters and regional personnel.



National Park Service

A pipe from the stream intake structure at Olympic NP (WA) feeds into the settling structure while the filter screen separates large obstructions.

The following steps outline the process of determining the potential of a hydro project. Each step must be satisfied in order to conclude that a hydro project might be feasible.

STEP 1: Is water available?
Obviously, without it you're out of business.

STEP 2: Can you use the resources? What, if any, restrictions are evident, from the environmental considerations to no vertical rise to lack of flow?
In most cases, licenses and/or permits are not required but it's still a good idea to check with the appropriate state or local offices.

STEP 3: Determine the characteristics of the potential system. What is the usable flow of water, what is the head, how long is the penstock, what is the power that can be generated, and does this match your power needs?
This is a fairly simple process with minimal engineering requirements.

$$Pth = \text{Theoretical Power} = \frac{Q \times H}{709}$$

Useful Power = (Pth) × (efficiency of equipment)

STEP 4: What is the costs of the system?
Determine who the equipment suppliers are for your type of water source and find out the costs of their equipment. Most equipment suppliers will be able to give you a rough estimate if you can supply them with the following information: head, usable flow, length of penstock from intake to generator location, power demand, and whether you want AC or DC (AC is more adaptable to existing systems). Are the costs reasonable?

STEP 5: What are the cost of alternatives to micro-hydro power?
Connection to commercial power, or operation and maintenance costs of existing generating facilities or environmental impacts of the existing site are some of the existing costs of alternatives to hydro. What about electricity?

STEP 6: What is the life-cycle cost of the hydro alternative?
This compares the total costs of installation and operation of the new hydro facility with the alternative methods of providing electricity, including the present method. NPS Regional Energy Coordinators have the procedures for conducting a life-cycle cost analysis.

STEP 7: Do we want to continue?
The critical step towards actual design and construction. This decision may not be based on pure economics but on use of a continuous renewable energy source.

Case Study

Finally, let's walk through the above steps as applied to an actual project done in the Pacific Northwest Region of the National Park Service.
THE SITE: Staircase Area, Olympic National Park (WA). Electricity

generated by a 12 kw diesel generator.

STEP 1: Bear Creek is a free-flowing water source closely situated near the existing electrical distribution system.

STEP 2: The creek is usable since there are no known fish species present. Environmental assessment indicates no major impediments. The proposed site is similar to a hydro site which was an abandoned facility. Contacts were made with the State of Washington and the Federal Energy Regulatory Commission (FERC), and no licenses or permits are required.

STEP 3: Water flow, as measured by an informal weir during extreme low flow season indicated 76 cfm. Head from the proposed intake to the proposed generator site—92 feet; approximate penstock length—400 feet.

Using the formula $Pth = Q \times H/709$, where

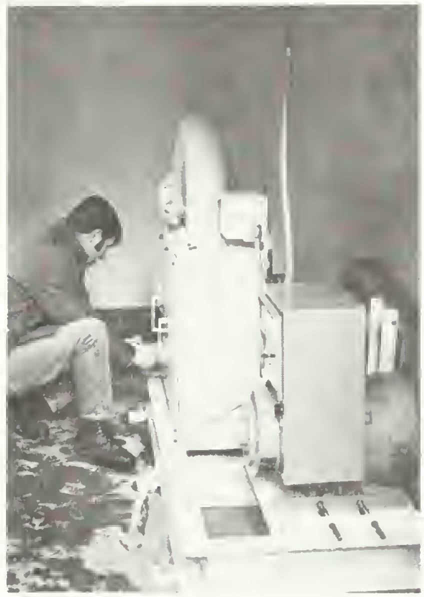
- Pth = theoretical power
- Q = flow rate
- H = vertical head
- $Pth = 76 \times 92/709 = 10$ kw;

Convert this to useful power by using the following hypothetical setup:

- Impulse turbine (pelton wheel) – efficiency of 80 percent
- Single belt drive – efficiency of 95 percent
- Alternator – efficiency of 80 percent

- P = useful power = $Pth \times$ efficiency of equipment
- $P = 10 \times .8$ (turbine) $\times .95$ (belt drive) $\times .8$ (alternator)
- $P = 6$ kw continuous power
- Connected power requirement = 8 kw

Based on a continuous estimated power output during maximum *low* water season of 6 kw, a connected power requirement of 8 kw can be satisfied.



National Park Service

15 KW hydro generation machinery at the Staircase hydro facility, Olympic NP (WA).

STEP 4: Estimated cost of a 6 kw system based upon a quote from a supplier was $45,000.

STEP 5: The connection of commercial power to the site was prohibitive. The cost to operate the existing system was approximately $5,500 per year (5,500 gallons costing $1.00 per gallon) in present diesel fuel costs plus an estimated $500 per year maintenance cost.

STEP 6: For a 25-year life, the life-cycle cost savings anticipated for the hydro system over the present diesel generation system is about $60,000. This corresponds to a simple payback, based on present fuel costs, of 6–7 years and a savings investment ratio of 2.48.

STEP 7: All parties from the staff at Staircase to the headquarters personnel at Olympic, and at the Region were firm supporters of the project and wanted to continue with it.

Funds were obtained during fiscal year 1981 from special demonstration project funds from the Energy Program in the National Park Service's Washington Office. An architect/engineering firm was hired to prepare the contractor documents. Formal bids were advertised and awarded in September 1981. By the time this article is in print, the final plant with a potential of 15 kw of electrical power generation will be on-line and providing a renewable power source to the park.

A publication put out by the National Center for Appropriate Technology in Butte, Montana, entitled *Micro Hydro-Power, Reviewing an Old Concept*, is available from them directly at Post Office Box 3838, Butte, Montana 59701, for $5.25 or from the National Technical Information Service (NTIS) in Springfield, Virginia. It is an excellent publication in all aspects of micro-hydro information.

Many other publications are available, as listed in the Micro Power book, from your state energy offices, Regional Energy Coordinators, or local libraries.

Summary

Where applicable, micro-hydro generation facilities can provide economical, environmentally-clean energy. Not all areas will have the potential, desire, or support to develop a system. At Staircase, the site characteristics were good. For them, they now have the "perfect power."

John Teichert is the National Park Service's Pacific Northwest Regional Energy Coordinator.

V. Geothermal Potential

by D.M. Aughenbaugh

The earth's core, a molten mass of iron and nickel, is the source of geothermal energy better known as "earth heat"; heat generated by the radioactive decay of rocks is trapped under immense pressure, creating temperatures up to 7,000°C. Surrounding the core is the mantle, a layer of semi-molten or solid rock, and an outer layer, the crust, which is only 15–30 miles (24–28 kilometers) thick.

Generally, scientists believe that the earth's crust is not one continuous sheet of rock but a series of plates floating on the mantle, which move against each other. At thin spots or where two or more plates meet, hot rock or magna can come quite close to the surface, where it may transfer heat to aquifers, underground water reservoirs, and oil and gas reserves.

Figure 1, Geothermal Gradient Map of the United States, shows where the geothermal gradient is high indicating "earth heat" is close to the surface. Occasionally the magma breaks through the surface to form a volcano. Except for geysers, hot springs, or volcanic activity, the surface of our planet gives little hint of the awesome heat and energy contained within the earth.

Some experts estimate that up to 32 million quads of energy are simmering within 6 miles (10 kilometers) of the surface of the United States. About 80 quads are used in the United States per year. One quad is equal to 1,000 trillion BTU's with a BTU being the energy required to raise one pound of water 1° F.

Geothermal Resource Development

At a time when fossil fuels are becoming increasingly scarce and expensive, and when nuclear power faces an uncertain future, such a prodigious energy source cannot be ignored. At present, a number of nations—led by Italy, Japan, and New Zealand—have begun tapping this resource to heat homes, produce electricity, and fill many other industrial and agricultural needs. In the United States, the known sources of geothermal energy available with current technology far exceed the underground supplies of coal, gas, and oil. Figure 2 gives us a picture of the present worldwide geothermal energy resource development.

Geothermal resources can be classified into five types as shown in the accompanying table. Of these, only the first three (thermal springs, vapor-dominated, and liquid-dominated) are developed commercially today. Methods of tapping hot dry rock and geopressured resources are presently being tested. The development and refinement of the hot dry rock process is now the most promising method of making geothermal energy economically competitive with conventional sources of energy.

Thermal Springs

Thermal springs, geysers, and shallow wells have been utilized for various purposes since ancient times. At temperatures lower than 212° F (100° C), geothermal water is not suitable for electric generation but can be used for heating, cooling, medical purposes, agricultural processing, fish farming, and other industrial applications. A good example of large-scale application of geothermal energy is a system in

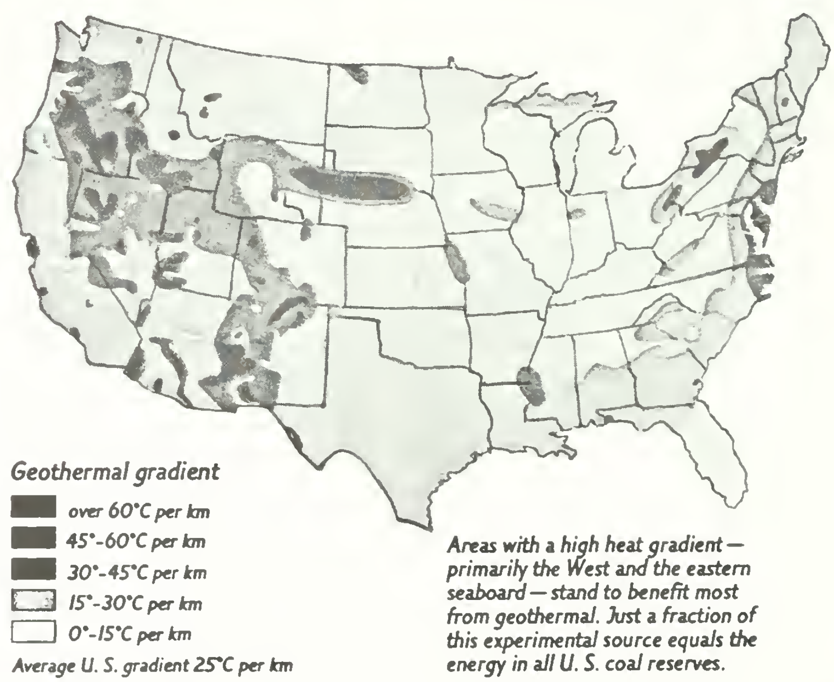


FIG. 1 GEOTHERMAL GRADIENT MAP OF THE UNITED STATES

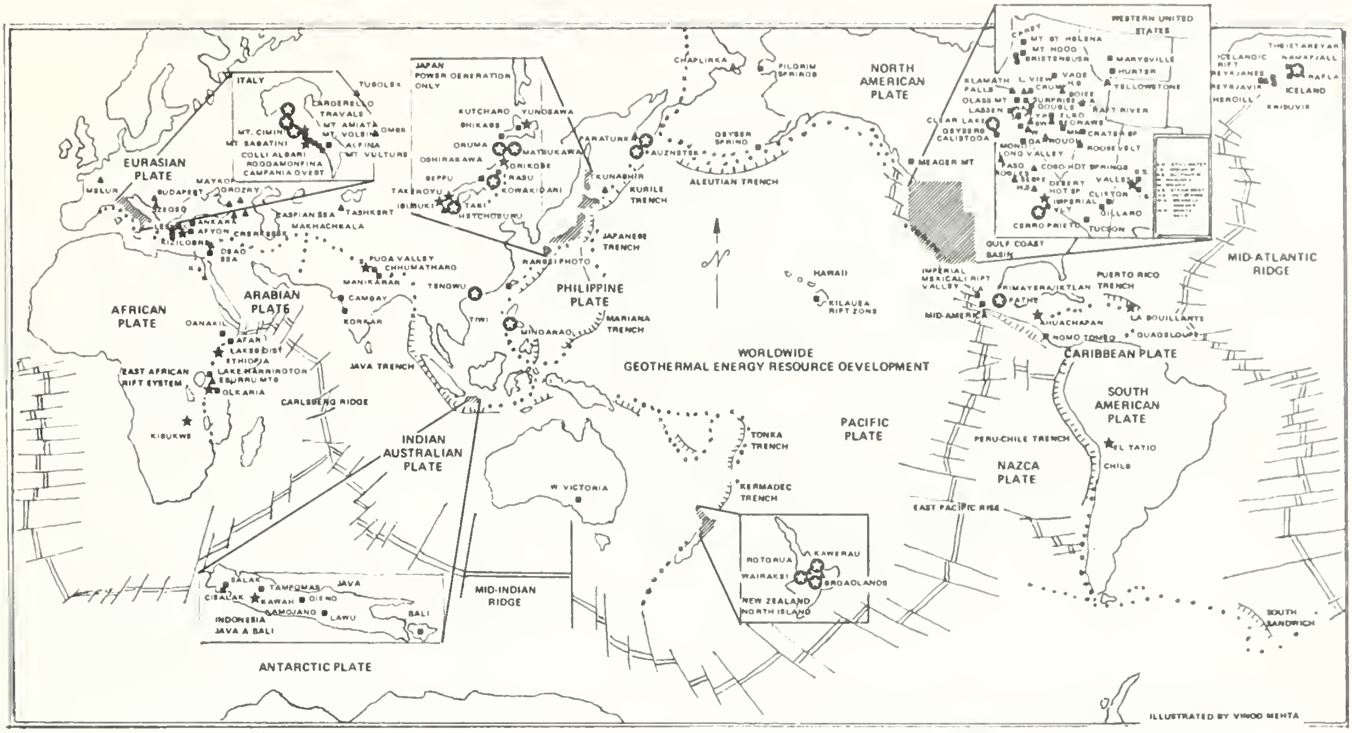


FIGURE 2

Worldwide Geothermal Energy Resource Development

MAP BY
Prem K. Saint and Abel Jasso
California State University at Fullerton

LEGEND

- Existing Geothermal Power Production
- Geothermal Power Under Test or Construction
- Non-Electric Uses of Geothermal Energy
- Ongoing Geothermal Exploration or Known Geothermal Resource Areas (KGRA)

- Mid-Oceanic Ridge/Rifts
- Ocean Trench
- Plate Boundary

Table 1: Classification of Geothermal Resources

RESOURCE TYPE	TEMPERATURE(°F)	SALINITY (%)	FIRST COMMERCIAL OPERATION	COST MILL/KWH
Thermal Springs (Warm Water)	80–200	Up to 20	200 AD	Vary by project
Vapor Dominated	340–385	—	1913	20-30
Liquid Dominated	300–600	0.1–26	1958	28–75
Hot Dry Rock	300–550	—	1958 (Est.)	20-40 (Est.) Test Wells
Geopressured	300–400	4–10	1986 (Est.)	20-30 (Est.)

*Costs do not reflect income from pressurized brine and methane gas by-products.

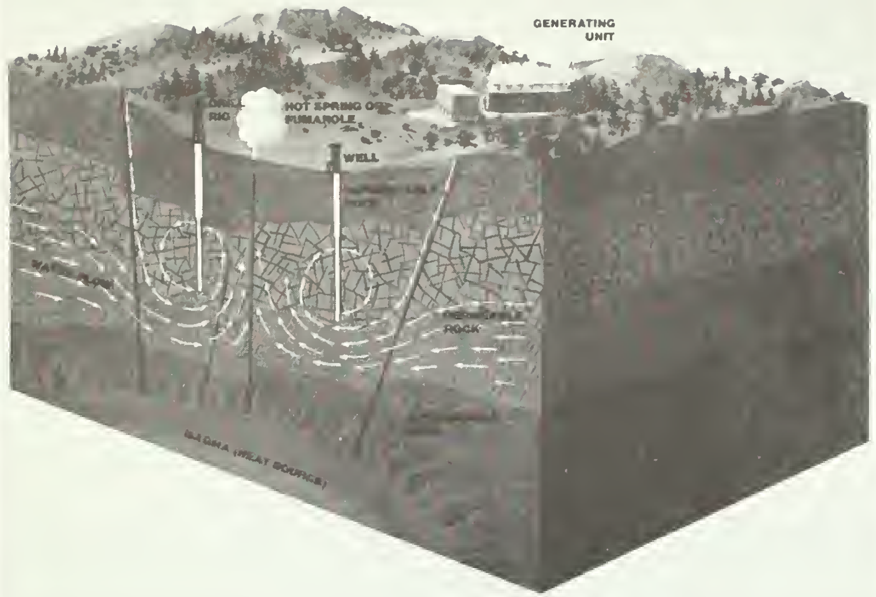


FIGURE 3 – THE GEYSERS DRY STEAM SYSTEM

Klamath Falls, Oregon, which heats a college, a hospital, and an apartment complex. The cost of using geothermal energy is estimated at 10 percent of the cost of retaining the original oil heat.

Within the National Park System, warm water from the springs at Hot Springs National Park (AR) has been used for heating as well as therapeutic bathing. A geothermal system utilizing hot water coils installed within the existing forced air system of the 5,460 square foot NPS administration building has been so successful that plans are now underway to use surplus thermal water to heat the nearby 11,250 square foot Physical Medical Center building.

Vapor-Dominated

To date, by far the simplest and cheapest way of acquiring geothermal energy is to tap aquifers and porous rocks where hot water is under great pressure. Steam with temperatures approaching 400° F (205° C) is obtained by drilling into the aquifer of porous strata to release the pressure and allow the water to boil. Unfortunately, the process can be applied in only a few places in the United States.

The Geysers in northern California, about 90 miles north of San Francisco, is the only commercial geothermal electric power plant in the United States. Northwest Wyoming has been identified as another potential vapor-dominated geothermal source. The first unit of The Geysers plant was put into commercial operation by Pacific Gas & Electric Company on September 25, 1980 and already produces enough electricity to meet 25 percent of the electric demand for the San Francisco Bay area.

More than 200 wells have been drilled up to 2 miles deep averaging 8,500 feet. Before reaching the turbines, the dry steam from these wells is cleansed in a centrifugal separator to remove tiny particles of rock that could damage turbine blades. After passing through the turbines, the steam is cooled to become water and is then reinjected (Figure 3) into the hot aquifer and permeable rock to retain the underground water supply. Hydrogen sulfide gas and other impurities such as boric acid and rock dust are produced as a part of the process but are almost completely removed. This type of installation costs less to build than a conventional fossil fuel or nuclear power plant, and the overall operating cost of electric production is less than other sources of electric power in California. Figure 4 gives a total cost comparison with other generic sources.

Liquid-Dominated

The liquid-dominated or wet steam systems, in which thermal energy is extracted from hot brine brought up from the earth, are more universally applicable than the systems previously mentioned, and consequently offer greater potential for development. Depending on temperature variations and on problems of dissolved solids and corrosion associated with the brine solution, different methods are used. Figure 5 includes a schematic drawing of the prominent power cycles used to produce electricity.

In the flashed steam cycle concept, steam and water are produced from wells at pressures usually less than 100 pounds per square inch and with temperatures between 350° F and 600° F. The steam is separated from the hot water and fed to the turbines. The steam condensates from the turbines and the hot water brine is then returned by reinjection wells to the aquifer.

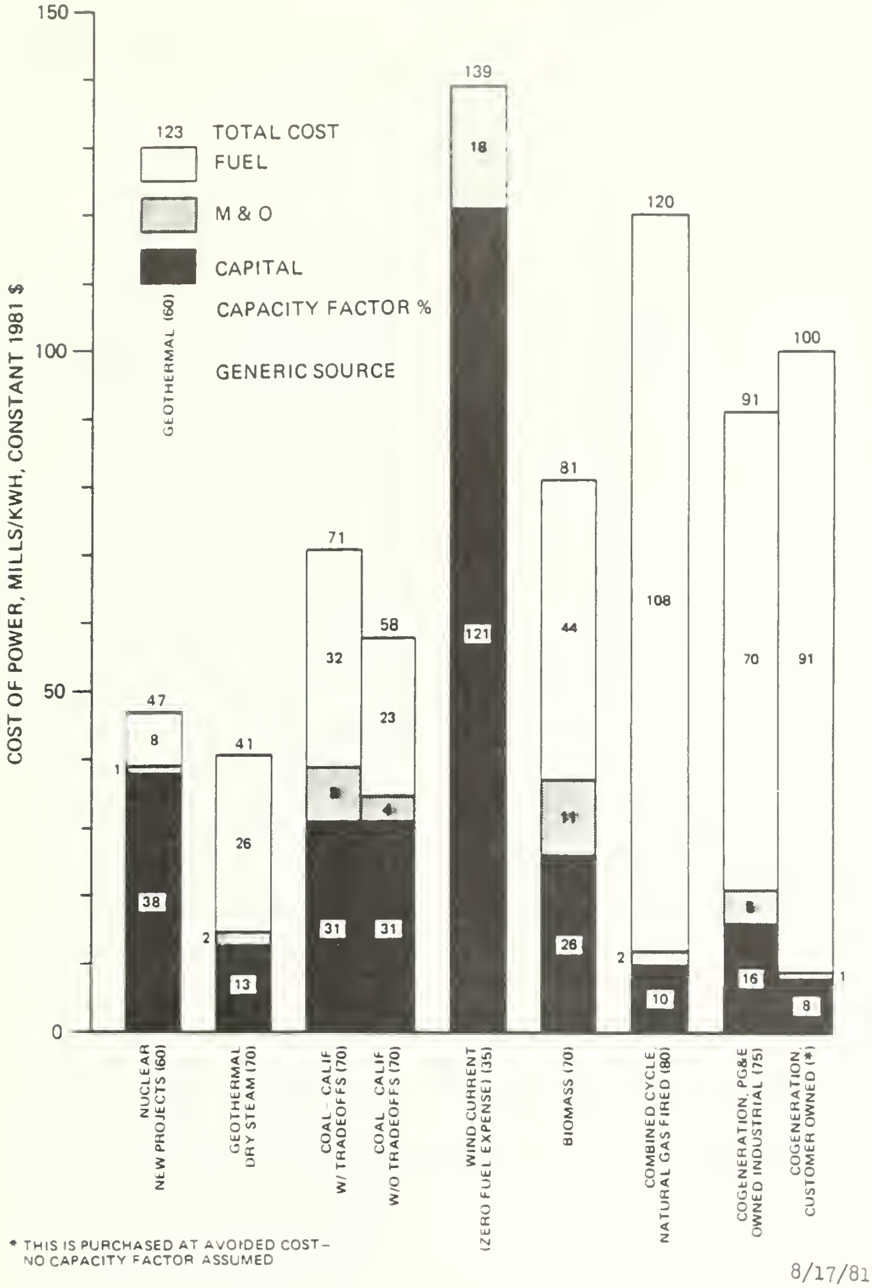
The binary cycle concept utilizes geothermal water with temperatures between 212° F and 380° F. The hot water or brine circulates through a heat exchanger, transferring its heat to another fluid with a low boiling point, which then drives a binary turbine. The brine does not come into contact with the turbines or condensers. The geothermal water from the heat exchanger is returned to the aquifer.

Hot Dry Rock

The hot dry rock process is a new idea which may be one of the greatest discoveries not only in geothermal

COSTS OF CURRENTLY AVAILABLE
GENERIC SOURCES OF ELECTRIC GENERATION

FIGURE 4



resources but in the whole field of energy. The other processes utilize water and steam that have been naturally heated by contact with hot underground rock formations. Now the Los Alamos National Laboratory has created a system using hot rock which has not come into contact with underground aquifers. A very deep hole—10,000–16,000 feet in the test systems—is drilled into a hot dry rock formation, and the rock at the bottom of the hole is fractured with pressurized water. Then a second hole is drilled to intersect the fractured rock. Water with no undesirable minerals is pumped down the first hole, heated by its passage through the fractures, and recovered from the second hole for use in producing electricity. The estimated heat recovery is about 85 percent. Additional experimental work needs to be done, especially in determining how long a particular system will continue to supply heat before the rock cools.

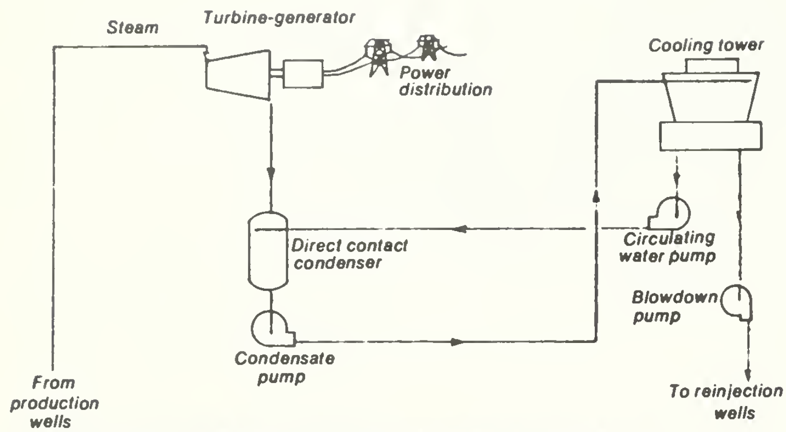
Geopressured Zones

Buried under deep sedimentary rocks along the Texas and Louisiana Gulf Coast are large aquifers of hot brine and dissolved natural gas. The brine is contained under very high pressures of 5,000–20,000 pounds per square inch and has both thermal and mechanical potential to power turbines and generate electricity. Studies are being made to determine if it is economically feasible to capture not only the heat energy but also natural gas and hydraulic energy.

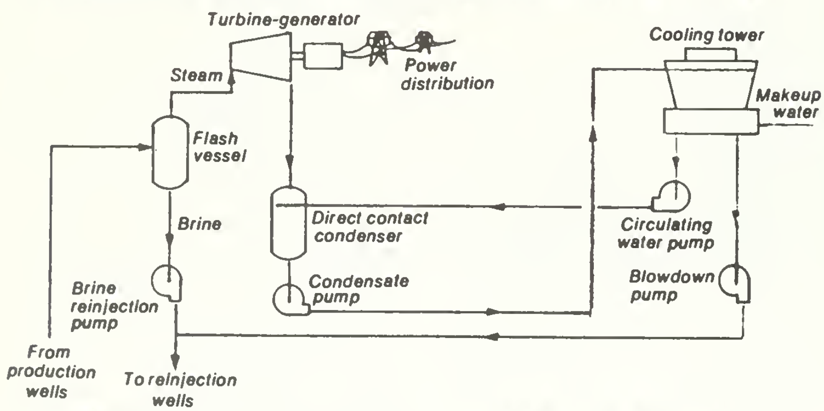
As prices for other forms of energy rise, the extraction of geopressured water and gas may become economically profitable if technical and environmental obstacles are solved involving corrosion, scaling, and disposal of hot saline fluids. Estimates indicate that the potential of this thermal energy could be as much as 115,000 megawatts of electricity generated annually for 30 years, with an equal amount of power obtained from the methane gas.

Environmental Aspects

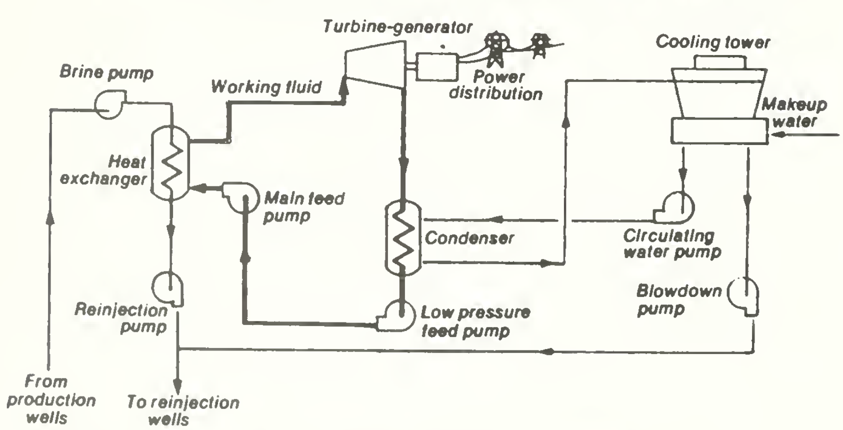
Compared with conventional methods of producing electricity—using coal, oil, gas, and nuclear fuel—geothermal energy has many advantages. It produces relatively little atmospheric pollution and only small amounts of solid waste. The only serious problems involve annoying or toxic gases and the corrosion problems associated with hot brine. These problems can be controlled or eliminated with appropriate controls and present technology.



Methods for power generation from geothermal deposits include a vapor-dominated system (above) where dry steam is conducted from well to turbine



In the flash process, steam is separated from hot water and then fed to a turbine



The binary process uses an organic Rankine cycle to produce electricity

FIGURE 5

The new rock system can also eliminate many of these difficulties. Since hot rock can be easily found, locations can be chosen to minimize environmental impacts. Also, this method produces neither liquid nor gaseous emissions and presents no corrosion problems. Since the water used was pumped into the well during the process, only heat is taken from the rocks and subsidence is not expected to occur.

However, any power plant will have an impact on its surroundings, especially as additional commercial and industrial development begins in the area. Of the ten major geyser fields of the world, all but three have been destroyed or adversely affected by the drilling of wells and subsequent development. The Beowawe geyser field of Nevada, which was second only to Yellowstone in North America, was destroyed by geothermal drilling during the 1950's. The sad part of the story is that the wells have not yet been used for energy production; they were never plugged or capped but were permitted to discharge uncontrollably. Fortunately, such incidents could be eliminated or prevented by careful planning and reasonable controls.

Since geothermal resources affect areas containing many states and require large investments for initial development, it is reasonable to ask if an agency similar to the Tennessee Valley Authority could be established for geothermal development. As a practical matter, every geothermal project has to be cost-effective. However, we are today reaching the point where geothermal energy can be developed effectively and economically.

D.M. (Dusty) Aughenbaugh is Regional Energy Coordinator for the National Park Service's Southwest Region.

Micro - computers for Energy Data Processing

by Ted R. Dinkel

The use of computers (micro-, mini-, or mainframe) in energy data processing comes about because of the following characteristics of computer processing of data:

- ability to handle large volumes of data
- capacity to do repetitious operations
- ease of data storage, retrieval and transmission
- ability to aggregate similar types of data

The moving force in the National Park Service's Energy Program to acquire and employ microcomputers was the expected volume of work necessary to complete a thorough survey and analysis of all buildings in the Service which would identify retrofits that would be cost-effective for energy conservation. The Service has roughly 10,000 energy-using buildings in its inventory. Studies done in 1979 identified 50 different types of retrofits that warranted evaluation within each building. Twenty-five of these projects could only be said to appear applicable, needing detailed engineering evaluations; the remaining half required actual calculation of cost savings from the data gathered by a surveying team. These retrofit projects ranged in complexity from installation of water-flow restrictors in faucets to complete installation of wall, floor and ceiling/roof insulation.

The calculations required to determine the length of time necessary to save enough energy to pay back the initial cost of the material and labor to install were similarly varied, depending upon fuel used in the building, the unit cost of that fuel, the size of the building, the climate in which the building was located, etc. Thus, the initial use of "microcomputer calculators" to eliminate repetitive entry of data, calculations and recording results. It is this drudge work that a computer handles so well. The computer, once programmed and thoroughly tested, can perform the same task an endless number of times without fatigue, with no decrease in accuracy. It unconditionally and objectively applies the same tests and operations to each entry applicable.

Equipment Standardization

By standardizing equipment, the programs written in one location can be duplicated and distributed to operate in other locations. This standardization is what allows data in the Energy Program to be entered at the building level, and aggregated at the park, regional, and national levels. This aggregated information can then be disaggregated on another basis, such as fuel type, type of project, climate zone, or building size.

With proper additional equipment, the results of the various automated operations can be printed on paper, stored on one of the various types of magnetic media, such as tape or disk, or transmitted electronically to another computer.

It is now possible to buy a bare-bones microcomputer for $149. For obvious reasons this low-end microcomputer will do only bare-bones type operations. However, the costs of microcomputers are now in the range whereby they can legitimately be considered essential equipment in any office. The total cost of one installation of the Energy Program computer is less than $4500 (including government discount).

The Energy Program selected the Apple II and its microcomputer primarily because of its availability on the GSA Purchasing Schedules. It is, however, a fine microcomputer in its own right, on the basis of features and price. The internal circuitry (the central processing unit) of the micro is essentially the traffic cop of the system, determining the flow of data from one place to another and what operations are to be accomplished upon that data.

Integrated in the computer is the input device, a keyboard, just like a typewriter. A varying amount of "core" memory can also be accommodated within the computer housing, and this CPU memory capacity determines how large a program can reside in the computer and be run, as well as the size of any data bases and variables that the program needs. The standard display device is the Cathode Ray Tube or TV-like monitor.

"Floppy" disks are very much like super-thin 45 rpm records coated with a magnetic substance enclosed in a protective sleeve. These floppy disks can store much more data or programs than the core memory can accommodate and are used for long-term storage of programs and data. Just as it is possible to place a phonograph needle any place on a record, the floppy disks allow random access to the information stored upon the disk. Programs can be loaded and run, and data accessed during an operating session without the need for lengthy waiting periods.

A printer is used to provide any needed hardcopy during operations. A dot matrix printer is one in which the individual letters are formed by a series of separate dots as opposed to the way a typewriter prints letters, each one from a separate key striking the paper. The dot matrix type printer allows for different type sizes and graphics.

The last piece of equipment making up the system is the modem (for Modulator/Demodulator), a device that allows data to be transmitted over the telephone lines from one computer to another. It is wired directly from the computer to the telephone line without a standard telephone instrument in between. This direct connection allows for the program to actually dial the phone, make the connection, establish the proper communications with the remote location and begin transferring the data, all without operator intervention.

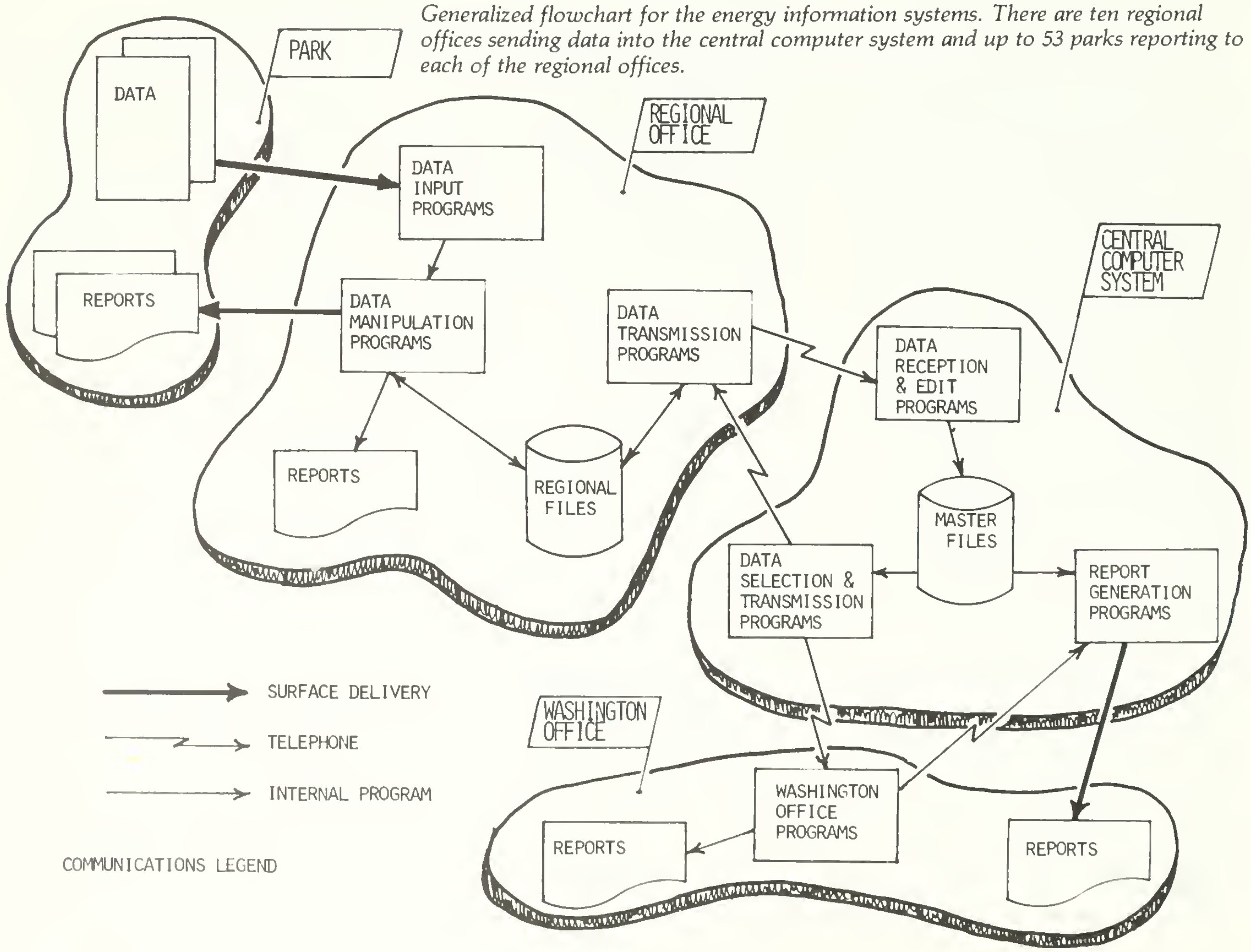
Survey Analysis & Retrofit System (SARS)

The programs of this system accept input on a building-by-building basis within each surveyed park. Look-up tables provide standardized data for each park, eliminating the need to re-enter park level data for each building in that park. The basic data for each building is entered such as building identification, type, size, and fuels usage. Each project or retrofit type can then be entered from the form prepared by the field survey teams. Formatted screens that duplicate the forms as closely as possible lead the operator through each item of entry as needed.

At several steps in the process errors can be corrected before the final calculations are made, and the program can be exited from at any time and started again, picking up where work was stopped. A record of each retrofit calculation result is stored in files on the floppy disks, one file for each park. Printouts of the basic data and data entered for each retrofit can be made to provide a check of the accuracy of input.

Additional programs in the system allow for editing of the retrofit data stored on disk, if necessary, sorting the retrofits by building number or by payback period, printing listings of the sorted retrofits, providing an in-

Generalized flowchart for the energy information systems. There are ten regional offices sending data into the central computer system and up to 53 parks reporting to each of the regional offices.



dication of the source of funding for each project, and transmitting the retrofit data from each regional office to a central computer in Washington. Programs at the central computer allow the aggregation of the retrofits and provide a regional and Servicewide ranking capability.

Quarterly Energy Use Reporting System (QEURS)

In order to properly manage its energy consumption, the National Park Service requires that energy consumption be at the park level for twelve fuel types in both buildings and facilities, and vehicles and equipment. This data is submitted to the regional offices and is totaled to provide a regional summary. This summary in turn is sent to the Washington office to be consolidated into the Servicewide report to the Department of the Interior.

The Quarterly Energy Use Reporting System provides for the entry of park fuel consumption and cost data, and storage of that data on a floppy disk in the regional office. Each park's data is entered as separate entities and can be edited if changes are needed. The data stored on the floppy disk is then transmitted to the central computer in Washington. The records passing the edit checks are then added to a master file of quarterly energy use data going back to 1975, the base year against which current energy consumption is compared.

After the regional personnel feel that the data is correct they can then retrieve a copy of their portion of the master file for the current year, along with the proper portion of the 1975 base year data. Programs on the regional microcomputer provide for the generation of an energy consumption report for each park and a regional summary.

The Washington office then generates the Servicewide report from the park-by-park data in the master file.

Notice that the effort in submitting the regional report consists of only typing it into a computer program, verifying the correctness of the data, and transmitting it to Washington. No paper has to be mailed, no calculations have to be made, and late arriving data can still be added right up to the due day and will still be available for inclusion into the summary reports.

Summary

As stated earlier, computers provide the wherewithal to handle large volumes of data, do repetitious operations, store, retrieve and transmit data easily, and consolidate small data bases into larger ones. Usefully configured computers can be obtained for less than $5,000. Once acquired for one use, microcomputers are easy enough to work with that other uses for them seem to quickly develop from many minds.

However, computers do only what they're told. Programs must be written or purchased to accomplish the required tasks. Changes in procedures or requirements generally require changes in programs, and programs, as with other things, sometimes need maintenance. Equipment does indeed break down. It may be only a sticking key on the keyboard or a broken disk drive. Useful information can only be derived from a data base if correct and current data resides therein.

Lastly, the human element still exists in computer usage. Just as errors are made in manual processes, errors will be made in computer programming and operations. "There's no such thing as a free lunch."

Ted R. Dinkel is the National Park Service's Energy Data Systems Administrator.

Ted Dinkel operates and programs the Energy Program Apple II computer.

John Duran NPS

Retrofitting Historic Structures

by Peter W. Woodbury

In deciding which retrofit should be undertaken in an historic structure, we must first look at the structure with the eye of a preservationist and determine which projects will not impact on its historic nature.

Therefore, historic structures can be divided into two categories; the truly historic, such as the Ford Mansion at Morristown National Historical Park (NJ) and the adaptive reuse historic, such as North Bridge Visitor Center at Minute Man National Historical Park (MA).

Although the projects suggested in this article will work equally well in both, we will slant our discussion to the North Bridge Visitor Center-type historic structure.

First, if you inspect an historic structure from the outside, you will notice, in most cases, that our forefathers have already started the job for us. Note the orientation of the house on the lot and the organization and the placement of the various activities within the house. Sites that would lend themselves to a reasonably dry cellar were chosen. Usually, the front of the house faced in a southerly direction, and the long, sloping roofs faced in a northerly direction.

Windows

As we look at the good things in the historic structure, the first problem area, the windows, confront us. As we should be aware, about 20% of the heat loss from the structure flows out through the windows. In analyzing the windows, we realize that windows leak heat in several ways:

* *Infiltration:*
Air leaks through any opening. This includes the area around the glass, the sash, and the frame.

* *Conduction:*
The ability of a material to serve as a medium for heat, electricity, etc. Glass is a very good conductor. Therefore, great amounts of heat escape the structure.

National Park Service

Interior window inserts were used to reduce the heat loss through the windows at the Wayside House at Minute Man NHP (MA).

* *Convection:*
The transfer of heat by the circulation of the heated parts of the air.

Infiltration and conduction losses, by their nature, do not apply solely to windows. There can be infiltration losses around the sill, foundation, moldings, and other cracks. Likewise, conduction can, and does, occur through wood, brick, and other building materials.

The simplest and most effective improvement for windows is to caulk and weatherstrip. Caulking should be applied wherever two different materials or parts of a house meet. It takes no specialized skill to apply, and you need a minimum of tools (screwdriver, caulking gun, and caulk). Caulking compounds come in many different types, and they can be grouped into the following basic types:

- Oil or resin-based caulk are readily available and will bond to most surfaces—wood, masonry and metal. They are not very durable, but are lowest in initial cost for this type of application.

- Latex, butyl, or polyvinyl-based caulk are all readily available and will bond to most surfaces. They are more durable, but more expensive than oil or resin-based caulk.

- Elastomeric caulks are the most durable, but are also the most expensive. They include silicones, polysulfides and polyurethanes.

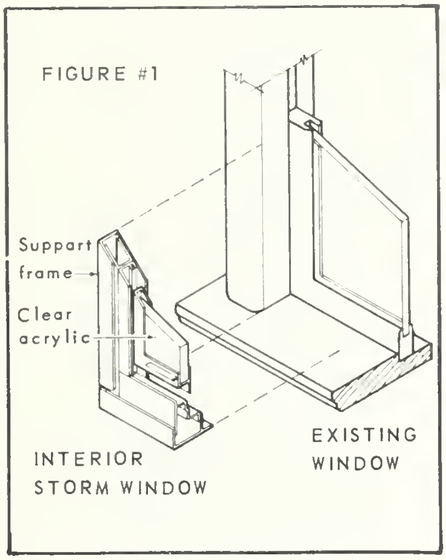
The latex or butyl types seem to work best. They are modest in cost with relatively good durability (5–7 years) and can be painted. Use a filler material such as oakum, caulking cotton, or sponge rubber to fill extra-wide cracks before caulking.

Weatherstripping is needed between two moving parts, or one moving part and one stationary part (i.e., doors and operating windows). When weatherstripping the historic structure, it is best to choose a material that is as invisible as possible. This, of course, limits your choices. The thin-spring metal units are somewhat difficult to install, but virtually invisible.

Storm Windows

The next possible retrofit is the installation of storm windows. In keeping with the preservation of the historic structure, we do not recommend exterior storm windows. The addition of interior storm windows is a possible solution to this problem. Storm windows are designed to reduce air leakage around windows while increasing the R-Value; thus, rightness of the fit is important.

One type of interior storm window is the sash track. The interior sash track type (Figure 1) is very similar to



Glass fibre batts have been installed with the vapor barrier *toward* the living space in the Oliver Farmer House (MA).

the exterior sash track, but is mounted inside the frame.

Removal of window insulation can be utilized for rooms or buildings closed for the winter in which a constant temperature must be maintained. One of the simplest forms is polystyrene cut to size with duct tape protecting the edges. The panel is then placed in a foam gasket and fitted to the window frame. From the outside appearance of the building, it would seem as if the shades were drawn.

There are a number of other good window treatments on the market that can be used in the adaptive reuse type structure, such as insulated curtains and window quilts, roll-down thermal shades and insulating panels and shutters.

Insulation

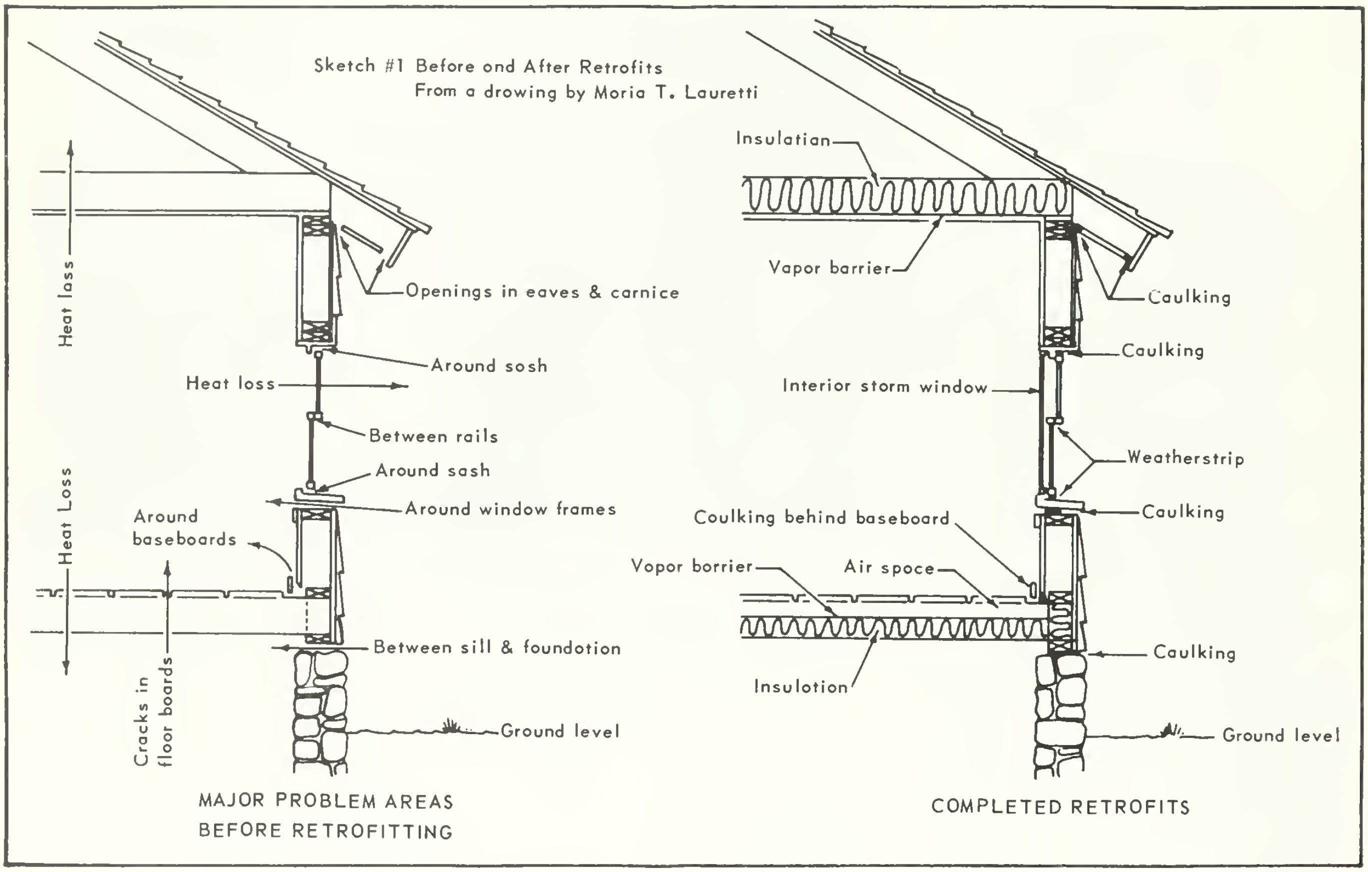
Insulation is the next retrofit option you should consider. When insulating, the best place to start is the attic, which has the most potential for savings. When inspecting the attic, note the condition and how much of the insulation exists. Checking the condition of the existing insulation is important as flat, worn out insulation loses its R-Value as the air spaces are reduced. If the insulation is worn out, remove it.

After deciding how much insulation you need, using one of the charts on R-Values consistent with your area of the country, you are ready to insulate. If there is no insulation on an open-floor attic, I would recommend installing glass fiber batts or blankets with the vapor barrier toward the living space.

If, on the other hand, there is some insulation and you need to add more, do not use a vapor barrier. If you do, you will trap moisture in the old insulation and incur condensation problems.

To finish insulating properly, you must look at the need for ventilation. If there are signs of condensation after one heating season, or there is no vapor barrier, ventilation should be retrofitted through a cross-section of opening equal to about 1/300 to 1/500 of the attic floor area.

The wall cavities are probably the area of most concern in deciding whether or not to insulate. When it comes to historic structures, unless a proper vapor barrier can be added, or the wall cavity ventilated properly, the walls should not be insulated.



Sketch #1 Before and After Retrofits
From a drawing by Maria T. Lauretti

Basement

The last area to review is the basement. When deciding to insulate the basement, a number of questions must be asked: Is the basement wet, or just damp; is it heated; or unheated; is it a usable space, or a crawl space? For the purpose of this discussion, we will assume the basement is dry and unheated.

As always, first inspect the joists and under the floor, checking for problems such as rot or termites. If there are none, measure the spacing of the joists to determine insulation width. Insulation should be purchased with a vapor barrier and installed with the vapor barrier facing up. The insulation should fit rightly at the ends to protect against heat loss, but there should be air space between the vapor barrier and the bottom of the floor. Fortunately, there is insulation on the market designed for this purpose. It has a porous covering with the tabs for stapling to the bottom of the joists. If this type of insulation is not available in your area, use regular insulation supported by wire mesh.

Remember, as with the attic insulation, don't forget about ventilation. Check for condensation, and don't block combustion air intake openings for the furnace. Also, insulate all heating ducts and water pipes in the space.

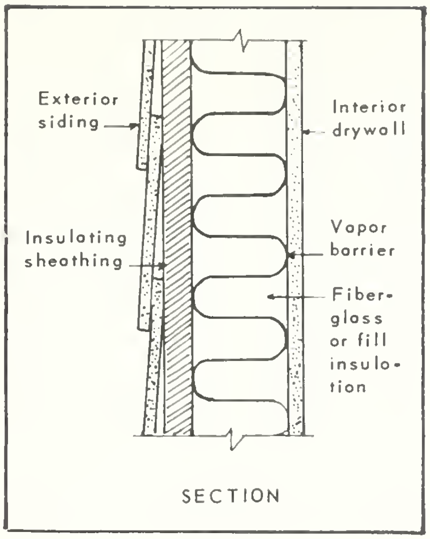
The retrofits outlined above are not the complete picture. One of the most effective ways of obtaining energy savings is not a retrofit at all, but a change in lifestyle and work habits. Is it necessary to live and work at 70° F. or more? Temperature of 65° F. during the day and 60° F. at night will result in impressive savings.

Whatever you do, please use extreme care. Your attention to detail cannot be over emphasized. Do a complete job. Historic buildings are special—please treat them that way.

Peter W. Woodbury is the National Park Service's Regional Coordinator for the North Atlantic Energy Region.

The Insulation of Wood Frame Buildings

by Murray J. Cowan



Section showing proper installation of insulation in a typical exterior stud wall.

Insulating an attic is a relatively simple undertaking if the attic space is accessible and properly ventilated. Insulating a wall, however, is a bit more complicated and requires a good deal more planning.

Whereas in an attic, the insulating materials are limited to loose fill and fiberglass rolls or batts (with the latter being preferred if the attic is accessible), there are a number of different kinds of insulation available for use in (or on) walls. The insulating material chosen must not only provide a cost-effective installation, but must not adversely affect the structure and its appurtenances, nor create potential harm to the people inside the building.

Another consideration is the proper application of moisture protection in the form of a vapor barrier. This is especially critical in walls since, unlike a ventilated attic, a wall is an "enclosed" building component and any accumulation of moisture within the wall might destroy its insulating characteristics and eventually lead to structural damage.

Since moisture migrates from relatively damp areas to dry areas and the moisture content inside a building (especially a residence) is generally higher than it is outside (in winter), provision must be made for some type of vapor barrier on or near the inside surface of the wall to prevent the moisture from entering the wall (see sketch). In predominantly warm climates, the location of the vapor barrier should be reversed, i.e., located near the outside portion of the wall behind the siding or sheathing.

A typical exterior wood-frame wall is constructed of 2x4 framing members with vertical studding at 16-inches on center. Any insulation installed *within* this framework is limited to about 3½ inches in total thickness, the approximate depth of a 2x4. If this space is already insulated, additional insulation can only be provided by applying a rigid insulating board to the interior or exterior wall surface. However, with the possible exception of Alaska and the northern-most areas of the lower forty-eight, it is probably not yet cost-effective to increase existing stud wall insulation from R-11 (assuming 3½ inches of existing fiberglass) to R-19 or higher.

Uninsulated Walls

There is no doubt though, that retrofitting an uninsulated stud wall is cost beneficial. Unfortunately, it is no simple task to retrofit an uninsulated wall with fiberglass batts since this involves the removal and reinstallation of the interior wall surface. The most common method for installing insulation between the studding of an existing frame wall is to remove a row of exterior shingles (near the ceiling), drill holes in the exterior sheathing between the studs, and fill each 3½ x 15 cavity with a poured-in type of insulation.

In retrofitting a wall in this manner, several insulating materials are available . These materials are usually blown or pumped into the wall cavities. However, since a wall cavity filled with any of the loose fill materials does not contain a vapor barrier, it may be necessary to "paint a vapor barrier" onto the inside surface of the wall being insulated. This is most effectively done with an aluminum paint or with a product such as InsulAid, by Glidden. Of course, these coatings should then be covered with a finish coat of interior wall paint.

Now a word of caution concerning two of the typical insulating materials.

Cellulose

The first type, cellulose, is manufactured from ground-up paper or wood products and is inherently a fire hazard. Today, however, most manufacturers treat their products with fire retardant chemicals to make it *less* flammable. However, if too much of the fire retardants are added, the insulation may be corrosive to metal switch and outlet boxes. To ensure compliance with Federal flammability and corrosiveness standards, cellulose manufacturers are now required to label each container of insulation with the following statement:

> "This product meets the amended Consumer Product Safety Commission standard for flame resistance and corrosiveness of cellulose insulation."

In addition, cellulose manufacturers are required to label their products with information concerning the proper installation of the material to avoid potential fire hazards.

Urea-formaldehyde Foam

The second type of insulation in question is urea-formaldehyde (UF) foam, a field-mixed material that is pumped wet into wall cavities. This material was developed in Germany in the 1930's, and has been used in this country since the 1950's. It is used in several northern European countries today in hollow masonry construction. In the last several years the material has seen increased usage in frame construction in the United

National Park Service

Gable louvre for attic ventilation above the insulation, usually 1/300 of attic floor area.

States, with mixed results. The problems associated with the material are as follows:

Shrinkage: One of the major advertised advantages of UF foam is its relatively high insulating value compared with other types of insulation. Since the material is installed wet, shrinkage occurs at a constant rate. In a National Bureau of Standards (NBS) test, the shrinkage rate was 8% after 26 months and showed no indication of leveling off. Hence, as curing occurs, the resulting loss in R-value due to shrinkage may reduce the effective insulating value of the material to or *below* that of mineral fiber insulation.

Structural Damage: Since urea-formaldehyde foam insulation is installed wet in wall cavities, contact with adjacent materials can result in the warping of wood framing and the bulging of drywall or deterioration of plaster. Moreover, after shrinkage occurs, condensation may appear in the voided areas resulting in the formation of a rot-inducing fungus. Rotting of wood siding and sheathing can also occur in UF foamed walls since the NBS-sponsored test indicated that the moisture content of these building elements was approximately twice the normal value.

Deterioration/Collapse: One effect of high temperature and humidity on UF foam is the disintegration of the material. Tests conducted by the National Bureau of Standards indicate that three out of four specimens disintegrated after fourteen weeks at a temperature of 104°F and 92% relative humidity. While these test conditions are admittedly extreme, they nevertheless suggest that the material may be unstable under combined conditions of high temperature and humidity.

Noxious Odors: A serious problem that may develop after the installation of urea-formaldehyde foam is the release of formaldehyde gas, a potentially toxic substance that may cause nausea, vomiting, headaches and respiratory difficulties. In addition, formaldehyde gas has been identified as a suspected carcinogen. Additional tests are being conducted to determine the validity of its suspected carcinogenity.

In February, 1982, a Consumer Product Safety Commission (CPSC) panel voted to ban the future manufacture and installation of the material. The ban will reportedly take effect in late summer. However, the decision is subject to review by Congress and will almost certainly be contested in court by the industry. In view of the action taken by the CPSC panel, as well as the information above, the author recommends avoiding this material whether or not the insulation industry's suit is successful.

For new construction, a total insulating value of about R-19 (6 inches of fiberglass) is now generally recommended for frame walls in most parts of the country. R-11 (3½ inches) should suffice for predominantly warm climates.

Additional Insulation

If it is determined that additional insulation is required, an alternate to filling the cavities between the studs with loose insulating material is to install rigid insulation board on the exterior or interior of the wall.

The preferred method of installing the insulating board is to apply it to the outside of the wall by first removing the existing siding, and then reinstalling the siding over the new insulation. It is possible, however, to install the insulation directly over the existing siding if new siding is to be installed on the building. If the old siding is wood, however, it should be removed since the accumulation of moisture within the wall could conceivably result in rot.

If the exterior wall has a brick facing and a small loss of living space is not critical, another procedure is to attach the rigid insulation directly to the interior drywall (or to furring strips attached to the drywall). The insulation, in turn, must then be covered with drywall for fire protection. If the wall being insulated contains water piping, it would be wise to cut out the existing drywall and leave an uninsulated area about 6 inches on either side of each pipe to prevent freezing.

Conclusion

As mentioned earlier, reinsulating a wall is both expensive and somewhat complicated. Moreover, because a wall is an enclosed building component, the addition of insulation (especially on the interior wall surface) may increase the possibility of moisture condensing inside the wall. If this occurs, venting the wall from the exterior (between studs) will be necessary.

The intent of the author is to demonstrate that insulation cannot be indiscriminately "loaded" into a building without regard to its type or without considering how it might affect the performance of other building elements or the well-being of the people inside the building. Insulation should be thought of as a building (or architectural) component and, as such, the way it impacts other areas of the structure, as well as the interior environment of the building, must be carefully considered.

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Safety in Wood Heating

by Linda E. Newman

Since the Arab oil embargo in 1973, there is a growing concern in America toward the development of alternate energy resources, in order to lessen our dependence upon expensive foreign petroleum.

As the cost of heating homes with traditional fuels continues to escalate, wood, a relatively inexpensive renewable resource, has become increasingly popular for domestic heating. Thus, the use of woodburning stoves is becoming increasingly popular.

The increase in the use of wood stoves as home heating systems and supplemental home heating systems has naturally resulted in the refinement and improvement of wood burning stoves. Wood burning stoves today are modern, high quality stoves which provide a convenient, economical, efficient, comfortable, and ecological means of keeping warm. But heating with wood can be very hazardous if necessary precautions in selecting, installing, operating, and maintaining your stove are ignored.

Home heating is now the number one cause of fire incidence in the U.S., and has replaced arson as the number one residential dollar loss in the U.S. Hospital emergency rooms all across the northwest U.S. report that as many as 45 percent of all burn injuries treated were related to wood heating, and most injuries involved children.

If you plan to install a woodburning stove in your home, it is a good idea to educate yourself as to the potential hazards involved and the safeguards you can take to assure safe operation of your new heating system.

I. Plan ahead and start by choosing a safe stove.

- When selecting your stove, check to see if it has been tested and listed by a national testing laboratory. The most common is Underwriters Laboratories (U.L.).

- Check to see what material has gone into the construction of the stove. The life span of the stove is affected by the quality of the material. Cast-iron and steel plate are the safest and most durable materials available. Barrel and sheet metal stoves are less expensive, but will eventually burn through.

- Consider the quality of construction of the stove—check to see what safety features the stove has. Door gaskets should be airtight; all joints should be sealed; firebox should be lined with brick and cast iron; the door latch should be secure; and the stove should have draft control to regulate the fire.

The size of the stove should fit the space to be heated. If the stove is too small it will burn too hot and weaken the stove, and if it is too large the fire will burn too cool which can result in creosote buildup.

II. *Safety consideration when installing a wood stove:*

Check with your local building or Fire Department to find out what the national and local building and safety codes are. National safety codes as well as insurance companies require installation permits. To obtain a permit, your installation must be inspected and approved to insure adherence to local and national building and safety codes. This permit becomes public record and is, therefore, readily obtainable if needed for an insurance fire-loss claim.

Always place your stove at least 36″ clear of all combustible materials, e.g., walls, furniture, draperies, etc.

Set your stove so that the shortest and most direct section of the stove pipe is used to connect the stove to the chimney.

Never hook up more than one stove to a flue, and make certain the flue is unused. More than one heat device hooked up to a flue reduces efficiency and draft. A poor draft causes an increase in creosote buildup and danger of fire.

III. *Operating Your Stove Safely:*

1) When reloading your stove, open the air inlet and damper all the way for a minute to prevent smoke and combustible gases from entering the room. Be sure to keep your face a good distance away whenever opening damper, air inlet or loading door. Sometimes, when the loading door is opened for refueling, the sudden rush of air into the combustion chamber can cause a small, slow explosion called "backpuffing" which could result in serious burns if one is standing too close to the loading door.

2) Don't let your stove overheat. Too strong a draft can cause a dangerously hot fire which could result in a chimney fire.

3) Keep anything that can burn away from the stove:
  a) Don't store your wood near or under your stove.
  b) Don't dry wood on the stove.
  c) Keep curtains, clothing, etc. well away from the stove.

4) Get a smoke detector, install it properly, and keep it in good working condition. Sleep with bedroom doors closed at night. Ninety-seven percent of fire fatalities nationwide were caused by smoke inhalation without ever receiving a burn—64% died in bed, unaware that a fire existed. One-third of these types of

fatalities could have been avoided if the people had slept with their bedroom doors closed.

5) Keep children and pets away from hot stove.

6) Keep fire tools handy: poker, shovel, fireproof gloves, etc.

7) Never use flammable liquids such as gasoline, kerosene, or charcoal starting fluid to start a fire.

8) Keep a dry chemical fire extinguisher handy.

9) Bring fresh air into the room by cracking a window or by using a special vent to prevent suffocation and provide a draft for a better fire.

10) Empty ashes regularly and carefully. Put them in a metal bucket or container with a tight cover and place them outside to cool before throwing away. Never set metal container with hot ashes on any combustible surface.

IV. *Instruct family members about what to do IN CASE OF FIRE:*

1) Make certain everyone knows the warning signs of a chimney fire (sucking sounds, a loud roar, and shaking pipes).

2) Make certain all members know how to operate a fire extinguisher.

3) If you think you have a chimney fire call the Fire Department before doing anything else. (Place Fire Department emergency phone number stickers on all phones in the house.)

4) Cut off the fire's air supply by closing any air intake vents to the fire box.

5) If there is a fire, discharge a fire extinguisher into the fire standing back six to eight feet.

6) Get everyone out of the house. Watch for sparks or signs of fire on the roof or neighboring roofs.

V. *Maintaining your wood stove:*

1) Inspect your system regularly to insure safe and efficient operation:

a) Clean your chimney at least once a season or if it has one quarter inch or more of creosote buildup. If you have an airtight stove it is very important to check it frequently as total blockage has occurred in less than 72 hours after installation.
b) Check stove pipe regularly. Take it apart and scrape inside with a stiff brush.
c) Check for leaks in stove and stovepipe at least once a month. (This procedure is extremely important because all incomplete combustion, such as occuring in wood stoves, oilburning furnaces and automobile engine combustion, produces carbon monoxide gas (CO). Because CO is odorless, tasteless and colorless it gives no forewarning of its presence. Exposure to CO can cause headaches, dizziness, drowsiness, collapse, coma and death. Many instances of illness and asphyxiation due to CO exposure have been reported. Therefore, proper and regular maintenance should always be carried out to avert this potential health hazard.)
d) Check firebox liner and grate. Replace if needed.
e) It is a good idea to check your chimney every 3 to 4 weeks when first installed, to determine buildup rate.

2) If you plan to clean your chimney yourself you will need:

a) Brush—steel bristled or a burlap bag filled with sand.
b) Weight—approximately 20 lbs.
c) Rope—length of chimney plus a few extra feet and strong enough not to break.
d) Ladder.

3) How to clean:

a) Plug up end of stovepipe with rags so soot does not puff out into the room.
b) Tie weight and brush (or burlap bag of sand) to rope and drop it down the flue.
c) Move rope up and down length of chimney scraping creosote and soot off chimney walls.
d) Shovel debris out of ash door or end of stovepipe.

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The Energy Future—Through Rose-Colored Glasses—Darkly

by James W. Stewart

Unless one consults Jean Dixon or an Ouija Board, there are few available sources for predictions of what the future of energy might be. Energy as an "issue" has been recently redefined to be one of development of energy resources. Energy supply, cost and conservation are now considered to be public concerns and will be taken care of in the market place.

So it is necessary to reach back several years to take stock of what the future holds for humanity in relation to energy. Consider this estimate in the Department of Energy's 1977 National Energy Plan.

> "There are physical and economic limits on the world's supply of oil. A widely used geological estimate of total recoverable world oil resources, past and present, is about 2 trillion barrels. More than 360 billion barrels have already been consumed. Current proved crude reserves are 600 billion barrels. World consumption of oil has grown at an average *annual* rate of 6.6 percent since 1940, and it grew by as much as 8 percent annually during the 1960's.
>
> If it could be assumed that world demand for oil would grow at an annual rate of only 3 percent, and if it were possible (which it is not) that production would keep pace with that rate of growth, the world's presently estimated recoverable oil resources would be exhausted before 2020. At a conjectural growth rate of 5 percent, those resources would be exhausted by 2010. Despite some uncertainty about the exact size of recoverable world oil resources, and about the rate of increase of productive capacity, this fundamental fact is clear: *within about four generations, the bulk of the world's supply of oil created over hundreds of millions of years, will have been substantially consumed."*

This estimate is alarming enough by itself but is only one aspect of energy in our complex society. Of more immediate concern to managers is the economics of energy at the consumer level.

The energy future that we, as managers, are likely to be concerned with is still supply, cost, and conservation. This is not because we disregard global concerns and national policy direction, but because these are the realities we must grapple with in day-to-day operations.

The situation we are presented with in each of the areas of concern is as follows.

Supply

1981 was a good year for oil users. American oil demand dropped 5.5%, contributing to a softening of the world oil market that compelled OPEC to drop its crude oil price. New discoveries of oil in the U.S. replaced nearly all of last year's production, and we are told by industry analysts to count on plentiful supplies through 1982. But other big oil users also say that this is a fortuitous but passing phenomenon, and we should not be lulled into a false sense of security. Most industry people anticipate another oil supply disruption within the next five to seven years.

A few years from now a "happy" facilities manager may be one who had the foresight and the funds to install "multi-fueled" boilers. The choice for the rest may be to pay the price of fuel or cut back operations.

Cost

In the market place, of course, the price of energy is tied inextricably to supply. Each energy type (oil, gas, electricity) has its own market conditions in various parts of the country. In 1982, fuel prices are expected to remain stable at about current price levels. But the oil market is still very volatile, and the price per barrel could jump to $50/barrel in a month. Fuels such as oil and coal could also be affected by decontrol of natural gas. If gas prices soar, large users can and will switch to other fuels creating demand pressures on these fuels.

Facilities managers are apt to be confronted with a situation that is bad now and can only get worse with little prospect of improvement. Improvement in this case would be energy price reductions which are more in line with budgets of two or three years ago. Given the fact that this is unlikely to happen, managers will be looking at several options such as closing down portions of their operations, achieving budget increases to cover energy costs, or achieving better conservation and improving energy efficiency.

Conservation

If facilities managers have concluded that all the low-cost/no-cost operational and retrofit measures have been taken that are worthwhile, and/or would not adversely affect mission, and that funds are not available to accomplish more costly but effective retrofits, then there is little choice but to maintain the status quo.

There will be few, if any, federal grants to help defray capital costs. Many utility companies, institutions, and private organizations, however, will provide technical assistance at little or no cost. Such aid must be considered in relation to your own needs and situation.

Energy Future

Our energy future, then, is viewed darkly. But predictions are not facts and nobody really has the answers. The best course is to remain flexible and expect adjustments that will hurt temporarily. The fact we are most likely to bemoan is that funding for the purpose of increasing energy-efficiency and eliminating waste, simply will not be available unless it is squeezed out of other maintenance or operations programs. But even though capital funds will be scarce, you don't have to remain at the mercy of uncontrollable forces and do nothing about it. A prescription for your energy future then might be to:

—Obtain energy consumption data.
—Analyze it to determine where the greatest energy use occurs. (You might be surprised.)
—Do energy audits (surveys) to identify both low-cost/no-cost conservation options and more expensive, but big payback items.
—Implement the retrofit options you can afford now.
—Maintain your retrofit list so that items are given consideration along with other operations/maintenance and facilities rehabilitation and improvement projects.
—Continually maintain energy consumption data so you can measure accomplishment in terms of avoided costs.

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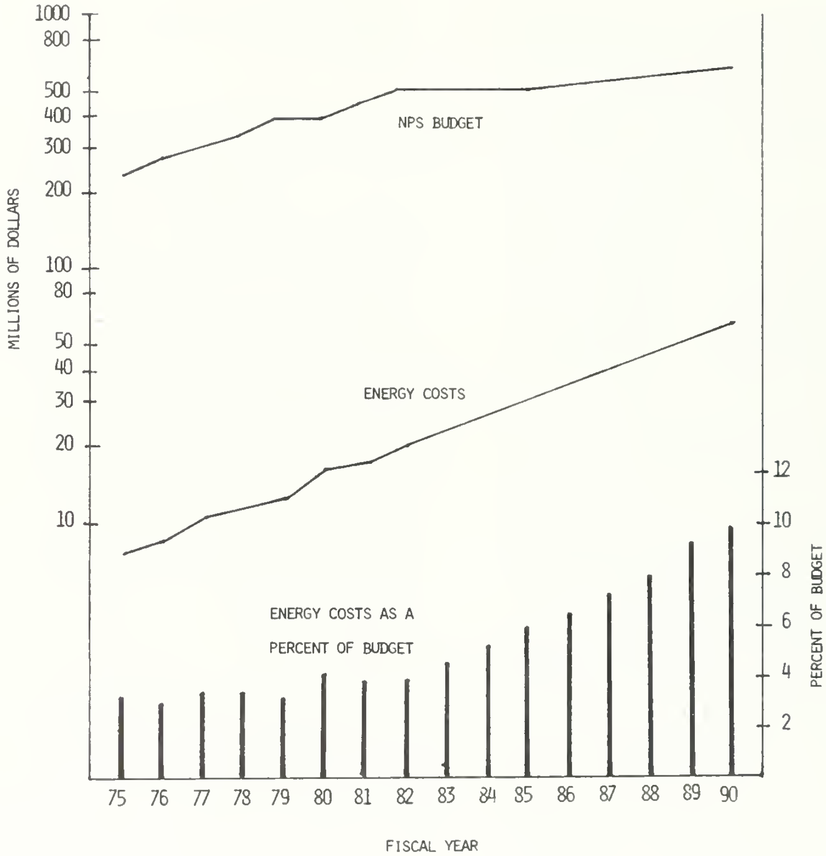

The graph representing NPS budgets are total existing and projected appropriations for operation of the NPS line item. The projection beyond FY 1982 assumes that appropriations will remain at the FY 1982 level through 1985 and then increase at 4% per year through FY 1990. These projections are for the purpose of depicting one possible scenario and do not represent management policy.

Who Can You Turn To?

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Publications

Passive Solar Design

Crowther, R.L. *Sun/Earth: How to Use Solar and Climatic Energies.* New York: Charles Scribner's Sons, 1977.

Duncan, E. & Martin Jaffe: *Site Planning for Solar Access: A Guidebook for Residential Developers and Site Planners.* Chicago: American Planning Association, 1980.

Foster, R.S. *Landscaping That Saves Energy Dollars.* New York: David McKay Company, Inc. 1978.

Geiger, R. *The Climate Near the Ground*, 2nd Edition. Harvard University Press, 1950.

Mazria, E. *Passive Solar Energy Book: A Complete Guide to Passive Solar Home, Greenhouse and Building Design.* Emmaus, Pa.: Rodale Press, 1979.

Moreland, F.L., Ed. *Earth Covered Buildings and Settlements.* Springfield, Va.: National Technical Information Service, 1979.

Olgyay, V.V. *Design With Climate.* New Jersey: Princeton University Press, 1963.

Robinette, G.O., Ed. *Landscape Planning for Energy Conservation.* Reston, Va.: Environmental Design Press, 1977.

Stein, R.G. *Architecture and Energy.* Garden City, New York: Anchor Press/Doubleday, 1977.

Wells, M.B. *Underground Designs.* Brewster, Mass.: Malcolm Wells, 1977.

Wright, D. *Natural Solar Architecture: A Passive Primer.* New York: Van Nostrand Reinhold, Co., 1978.

Insulation

Comparison of the Thermal Peformance of Three Insulating Materials Commonly Used to Retrofit Exterior Frame Walls in Existing Residences. D.H. Burch, C.I. Siu and F.J. Powell, National Bureau of Standards.

Energy Ideas, Number 10, January/February, 1978. National Recreation and Park Association.

Preservation Brief #3, Conserving Energy in Historic Buildings, Baird M. Smith, AIA.

NBS Technical Note 946, *Urea-Formaldehyde Based Foam Insulations: An Assessment of Their Properties and Performance.* U.S. Department of Commerce/National Bureau of Standards.

DOE Facilities Solar Design Handbook, January 1978. U.S. Department of Energy.

News from CPSC, U.S. Consumer Product Safety Commission, August 1, 1979.

Fact Sheet No. 91, U.S. Consumer Product Safety Commission.

In the Bank . . . Or Up the Chimney?
U.S. Department of Housing and Urban Development (HUD)
Available from:
Superintendent of Documents
U.S. Government Printing Office
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SD Cat. No. HHI.6/3:EN2/3

Retrofitting Existing Housing for Energy Conservation: An Economic Analysis
National Bureau of Standards
Building Science Series #64
Available from:
Superintendent of Documents
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SD Cat. No. C13.28/2:64

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Micro Hydro-Power

Micro Hydro-Power-Reviewing an Old Concept. National Center for Appropriate Technology, P.O. Box 3838, Butte (MT) 59701.

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