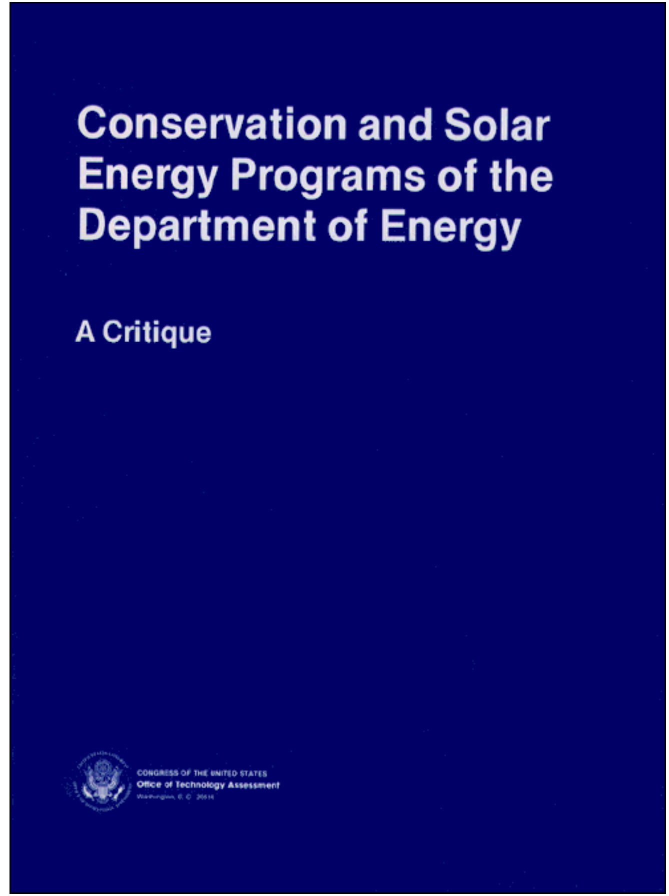
Conservation and Solar Energy Programs of the Department of Energy: A Critique

June 1980

NTIS order #PB80-197759



Library of Congress Catalog Card Number 80-600092

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 Stock No. 052-003-00757-6

Foreword

The Office of Technology Assessment is pleased to present this analysis of the Conservation and Solar Energy Programs of the Department of Energy (DOE). The study, requested by the House Committee on Science and Technology, was conducted in much the same manner as earlier OTA evaluations of the Plan and Program of the Energy Research and Development Administration, and the National Energy Plan of 1977.

The study evaluates the progress and direction of a number of conservation and solar energy programs, in order to provide an overview of the balance and long-range contribution of these efforts, and to discover if the programs are coherently linked to goals set by Congress and the administration. The basis of the work was generated by two advisory panels, assembled to achieve a balance of knowledge and viewpoints. The panelists identified and discussed critical issues. OTA staff prepared this report based on the panel effort, and augmented by review of DOE Conservation and Solar Program Summary Documents, budget material, and discussions with DOE personnel. All responsibility for the accuracy, completeness, and objectivity of the work rests with OTA.

JOHN H. GIBBONS
Director

Analysis of DOE's Conservation and Solar Energy Programs

Advisory Panel #1

J. Thomas Ratchford, Chairman
American Association for the Advancement of Science

Anthony Adler
Muller and Co,

A. J. Arker
General Electric Valley Forge Space Center

John Bame
Shell Oil Co.

Piet Bos
Electric Power Research Institute

Carel DeWinkel
Wisconsin Power and Light

Kirk Marckwald
Off ice of Appropriate Technology
State of California

Henry Marvin
Brunswick Corp.

Eric Stork
Purdue University

Jack Walsh
New England Power Service Co.

Steven Weissman
California Public Utilities Commission

Benjamin Wolff
American Wind Energy Association

Advisory Panel #2

Grant P. Thompson, *Chairman*
The Conservation Foundation

Larry Becker
City University of New York

A. M. Clogston
Bell Telephone Laboratories

Joe Dawson
Grumman Energy Systems

Jim Harding
Friends of the Earth

Eric Hirst
Oak Ridge National Laboratory

Herbert Hunt
Eugene Water and Electric Board

Herbert Kraemer
General Mills

Jonathan Lash
Natural Resources Defense Council

Vivian Loftness
Dubin-Bloome Associates, P.C.

Brian Pardo
American Solar King Corp.

Sandra Rennie
Center for Energy Productivity
Mellon Institute

Joanna Underwood
INFORM

NOTE: The Advisory Panels provided advice, critique, and assistance throughout this assessment, for which the OTA staff is deeply grateful. The Advisory Panels, however, do not necessarily approve, disapprove, or endorse all aspects of this report OTA assumes full responsibility for the report and the accuracy of its content.

Conservation and Solar Energy Programs Project Staff

Lionel S. Johns, *Assistant* **Director, OTA**
Energy, Materials, and International Security Division

Richard E. Rowberg, *Energy Program Manager*

Alan T. Crane, *Project Director*

Nancy Carson Naismith, Project Director

Charles Holland   Robert Olson   Joanne Seder

Administrative Staff

Marian Grochowski   Lisa Jacobson   Lillian Quigg   Yvonne White

Contractors

William U. Chandler   Pamela Deuel

Reviewers

John Andelin, *Consultant*
John Benemann, *Consultant*
Tom Bull, *OTA*
Clark Bullard, *OTA*
Eileen Clifford, New Mexico *Public Service Commission*
Modesto Maidique, *Harvard Business School*

OTA Publishing Staff

John C. Holmes, Publishing *Officer*

Kathie S. Boss   Debra M. Datcher   Joanne Heming

Contents

Contents—continued

List of Tables

List of Figures

Chapter I
OVERVIEW

Chapter I
OVERVIEW

The Conservation and Solar Energy (C&SE) Programs of the Department of Energy (DOE) have had a brief but troubled history. The importance assigned to conservation and solar energy in our national energy thinking has never been as great as it is now. Last year the President announced dramatic goals for solar energy and, by implication, conservation. The budget levels for the programs have never been so high. Public interest and expectations are also ever increasing with conservation and solar investments growing rapidly. Yet disappointment and frustration with the programs are common. A March 1975 OTA report, *An Analysis of the ERDA Plan and Program,* identified many problems that are still painfully relevant today.

This review was undertaken with the **intent** of performing a constructive critique for both Congress and DOE Some of the issues identified in this report suggest how Congress and the Secretary of Energy can set the stage for C&SE to become more effective. Others raise questions over the direction some programs have taken. Finally, some point out where programs are functioning inefficiently, and what might be done to improve them.

This report naturally dwells on C&SE weaknesses because that is where improvements are most likely, but C&SE also has strengths. There are many highly competent, dedicated people working there Some programs are moving forward effectively. The organizational structure of the programs seems improved now with the consolidation of Solar Technology and Solar Applications While efficiency could no doubt be improved by various modifications, an era of stability would probably be more productive. Major reorganizations invariably produce major jurisdictional disputes, seriously detracting from the real business of the office. DOE would be better advised to concentrate on putting the right people into the existing positions and giving programs an opportunity to settle down.

Under the best of operating conditions, however, C&SE will have to overcome some major problems. **A striking conclusion of the panels was that C&SE lacks a clear vision of where it is going and how it will get there.** Some of the programs are doing as well as might be expected, but no coherent theme permeates the entire office and guides the directions and paces of the various programs. Evidently, this deficiency results from the lack of clear direction from DOE management and the lack of a strong analytic capability within C&SE. The Office of Policy, Planning, and Evaluation has only **13** professionals. A staff of this size is entirely inadequate to perform the long-range, in-depth studies required. **C&SE needs to develop the capability to determine what it can accomplish for the country, to make sound policy and program decisions to reach these objectives, and to keep the programs moving steadily toward the goals in the face of pressures to alter course in ways not necessarily in the national interest.** The new Program Summary Documents are encouraging, but the quality of the planning effort needs to be higher if C&SE is to push the country forward to meet its goals. Improved analytical capability will allow for comparisons between conservation and solar technologies and other approaches, such as synthetic fuels. Such comparisons are badly needed.

Another major deficiency is inadequate program evaluation. C&SE must have the capability of determining which programs have wandered off course or become irrelevant, and which might be usefully expanded. Evaluation will become crucial to some programs in controlling costs as they reach the demonstration stage. Widespread implementation of these technologies will largely depend on their costs becoming competitive with other options. For instance, the President's goal for photovoltaics is 1 Quad* in 2000. **At** present, a kilowatthour of electricity generated from photovoltaics

*One Quad equals one quadrillion (10^{15}) Btu might cost $0,50, compared to $0.05 from conventional sources. Several studies, including OTA's solar assessment, make a plausible case that photovoltaics will be competitive. If cost reductions fall short, however, subsidies of $1 bill ion per year for every cent per kilowatthour differential will be required to reach the 1-Quad goal. Thus, if society has a choice between photovoltaic electricity delivered at $0.15/kWh and electricity from other sources delivered at $0.10/kWh, choosing the Quad of photovoltaics will cost an extra $5 billion per year. Program evaluation is a critical element in keeping programs on track and in determining when goals should be revised.

Other problems that concerned the panels were the long delays in DOE processing of C&SE requests for hiring new staff and letting contracts. Reports of procurements that took up to 18 months are common. This is a nearly impossible situation. Not only are important projects delayed, but high-quality people and companies may not be willing to wait so long. **There is a pervasive belief within and outside of DOE that senior DOE management does not really care about the C&SE programs, and that the quality of management has been inadequate, as well as transient.** The present staff in some programs is clearly overburdened. There is a tendency to rely on existing contractors to do work for which they may be unprepared. These delays are evidently so crippling for C&SE that upper levels of DOE management should be quite concerned if they take solar and conservation seriously.

The panels also noted that **C&SE could improve its coordination with other Federal agencies, such as the Department of Housing and Urban Development, and other governmental levels** (State, local, and foreign). Such cooperation could greatly facilitate the implementation of solar and conservation technologies. By the same token, cooperation with private industry (both suppliers/installers and utilities) is vita l for C&SE's planning. All of these institutions are involved in C&SE's implementation and R&D programs, but not to the degree that appears desirable.

A final general suggestion is **for C&SE to develop its own perspective in keeping with long-range planning.** C&SE is the focus of a great many expectations, but as mentioned above, **C&SE** cannot simply react to pressure. Some technologies may be worth developing in the national interest but may presently lack a large, well-organized constituency; for example, decentralized applications of solar energy. **It** is easier to find parties with an interest in centralized applications, but **C&SE** must find an appropriate balance between the two even while cooperating with the unequal constituencies.

The panels also identified a series of issues related to specific programs:

- Wind.– Wind is a nearer term technology than DOE appears to believe. Rapid commercialization could have a high payback, but commercialization programs must be designed appropriately for the different machines and applications.
- **Photovoltaics.—** This program may not meet its goal unless its budget is enlarged. DOE has been slow in meeting congressional requirements for detailed plans and an advisory panel. An emerging shortage of refined silicon may also interfere with growth.
- **Solar thermal.– The wide range of technologies and applications** require intensive evaluation and planning to achieve the fastest possible implementation into the energy system.
- **Ocean systems. –** Ocean thermal energy conversion may be very expensive to develop and demonstrate, but a full plan for Federal involvement has not been prepared to estimate the total costs. Rapid development could entail large economic risks,
- **Biomass.—** Management of the biomass programs should be tightened and the staff augmented. Several potentially attractive systems are neglected, particularly small and multipurpose facilities. Large increases in the use of alcohol fuels must be carefully planned.
- **Transportation conservation. –** The advanced-engine program has made progress, but it is

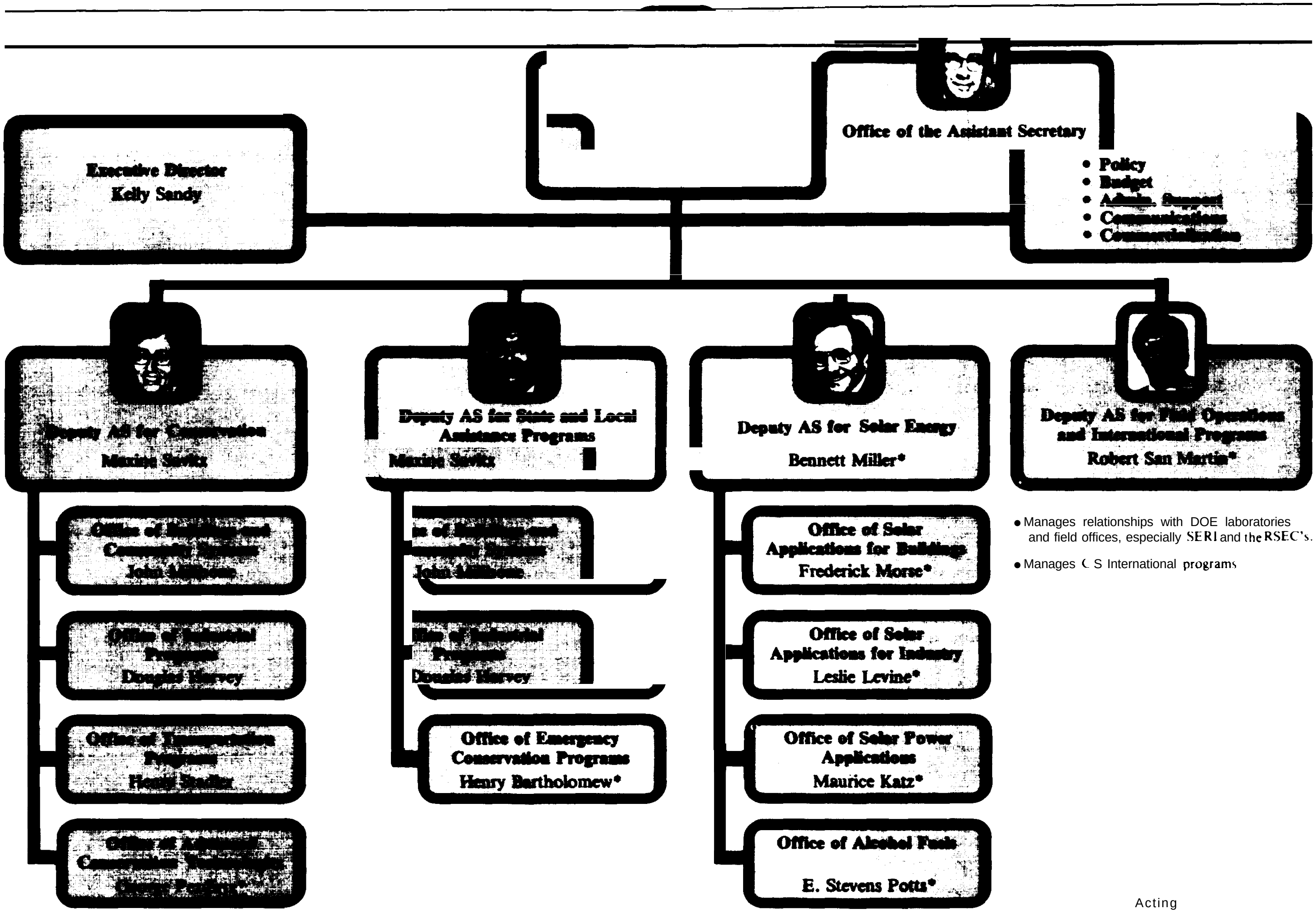
not clear that even successful developments will be the preferred choice for many applications. Electric vehicles (EV) have a more readily identifiable market, but extensive commercialization will depend on the availability of improved batteries. At present, battery development takes only 20 percent of the **EV** budget, which seems remarkably low in light of its importance.

- **Solar active and passive. —** Closer cooperation with conservation programs is needed to formulate a least cost buildings strategy for combining passive features, active systems, and conservation measures in the most economical way for different types of buildings and climates. Several important areas are underemphasized, especially building retrofits, solar district heating, solar ponds, passive product development for commercial buildings, passive cooling, and demand analysis for solar industrial process heat.

Buildings and community systems. — The enormous potential for saving energy and protecting people against rapidly increasing costs means that improving the energy efficiency of buildings should be a high priority. Research on products to improve the energy efficiency of existing buildings should be increased, as well as research on neighborhood-scale technologies and the energy uses of commercial structures. Non hardware research on institutional questions and on the attitudes and behavior of consumers is also necessary. This type of research, combined with an increased attempt to commercialize products, can help to move products into the marketplace. The buildings program must improve its interaction with the Office of Solar Applications for Buildings.

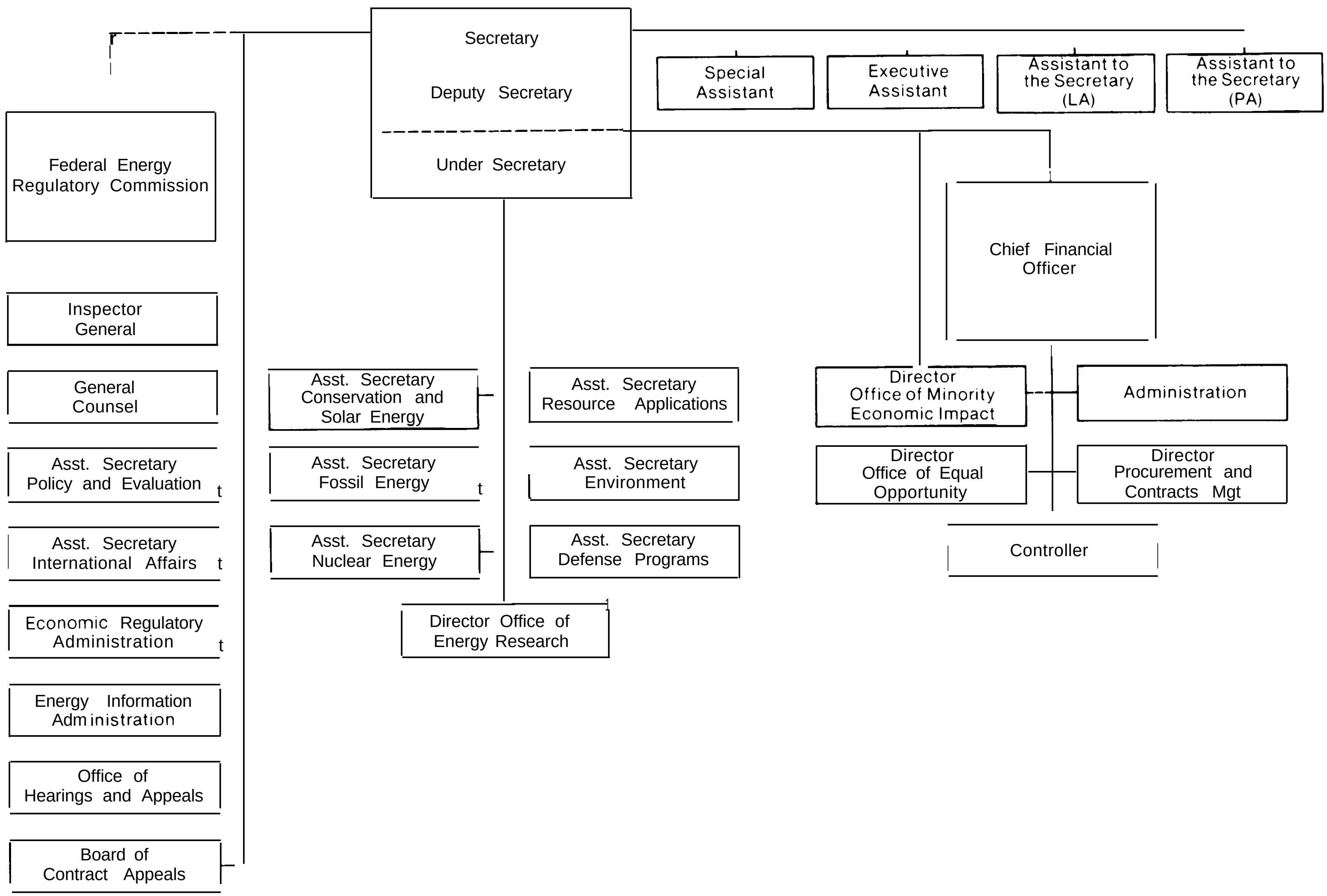
- Office of State **and Local Programs. –** Existing State programs should be consolidated, and DOE must find ways to provide more technical assistance to States.
- Office **of Industrial Programs (OIP).–** In view of the urgency of the energy situation, OIP should continue its emphasis on funding near-term technologies, and should emphasize those that can save the most energy quickly. This would select against those projects that save little or no energy but allow fuel-switching or assist ailing industries. Questions remain as to whether the existing priority selection criteria best serve national needs. Long-term, basic research relating to process and thermodynamic principles is urgently needed.

Figure 1.—Organization of Conservation and Solar Energy Programs at the Department of Energy



SOURCE Department of Energy

Figure 2.—Organization of the **Department** of **Energy**



SOURCE Department of Energy

Chapter II

DEPARTMENTAL GOALS AND PRIORITIES

Chapter II
DEPARTMENTAL GOALS AND PRIORITIES

Some of the most basic questions and issues raised by this critique can only be answered at the highest levels of the Department of Energy (DOE). During the course of the review, it became clear that the elements of meaningful goals and priorities, and strategies to meet those goals, were lacking. These elements are crucial to the success of any effort, either in Government or in the private sector, and they are particularly important in clarifying the value of an effort undertaken to deal with a problem of enormous national and international importance, such as the present energy situation Goals, priorities, and plans must be set not only for programs within Conservation and Solar Energy (C&SE) areas, but these goals must complement or match similar goals, priorities, and plans for conventional fuels and other new supply opt ions. Senior DOE management is responsible for this effort, the sum of which represents our national energy policy.

Issue 1

Goals and Plans

The ambitious goals set by the President for solar and conservation must be kept current and translated into specific interim objectives for the various programs.

Summary

Goals are used in planning programs to meet national object Ives To be relevant, solar and conservation goals must be derived from the best estimates of what is desirable and achievable This analysis requires the consideration of factors such as the expected cost and availability of other sources, economic growth, technologicla development (and failure), and new concepts for achieving the same end. The Program Summary Documents (PSDs or goldbooks) present energy production goals for solar energy based on the Domestic Policy Review (DPR), and energy-saved goals for conservation based on the the Committee on Nuclear and Alternative Energy Systems (CONAES) scenarios. Refinements of these goals should be expected in future versions of the gold books. In particular, the conservation goals must be much more more rigorously defined, perhaps by a DPR for conservation.

Simple Quad goals for 1990 or 2000, however, are not adequate for planning programs It is necessary to define what actually has to happen for the Nation to meet the goals and what DOE role must be to ensure success. Explicit, year-by-year milestones should be provided so that Congress can determine it these goals should be accepted as national policy, appropriate the resources necessary for meeting them, and hold the programs accountable for progress made. Congress ion a l pressure may be required to ensure that DOE augments its analytic capability to produce i m proved goals and plans.

Quest ions

1. **Has** DOE accepted the DPR scenarios as the guides for the solar programs?
2. When will comprehensive conservation goals (that will be useful for program planning) be developed?
3. When will DOE prepare detailed plans for the Nat ion to reach the stated goals?
4. How will DOE keep the goals current and how often should they be revised?
5. Can the Assistant Secretary for Policy and Evaluation work with the Oft ice of Planning and Analysis in C&SE to produce such a plan w ıt h their present resources and mandate?

Background

Table 1 contains DOE's solar goals, as announced by the President on June 23, 1979, which were derived from the Maximum Practical Scenario of the DPR on solar energy.

The conservation goals (table 2), which have not been endorsed directly by the President, are stated to be at least adequate to meet the savings suggested by the recent report of CONAES, evidently for scenario A of that report,

As pointed out in the CONAES study, achieving these goals will require great and sustained efforts by both the private and public sectors, This effort can be estimated only if detailed breakdowns by specific program objectives are available. For instance, the wind-power goal is 1.7 Quads in 2000. An adequately detailed plan would specify how many machines of varying sizes would be required to produce 1.7 Quads, the industrial capacity over time to produce and deploy them, material and capital requirements, the schedule for technological improvements and resource mapping, and estimates of when and how non-hardware-related market barriers can be evaluated and addressed. Such a plan would delineate a clear path to the desired goals including what must be done this year as part of the overall effort Not only would such a plan provide clear direction to the programs, but it would also provide a means for Congress to evaluate programs' progress and need for funding relative to other programs and national objectives. The wind energy program was chosen here as an example because it is

Table 1.—Solar Goals[a]

Solar technology	1977	2000 Base case at $32/bbl	2000 Maximum practical	2000 Technical limit
Active heating and cooling	Small	1.3	2.0	3.8
Passive heating and cooling	Small	0.3	1.0	1,7
Industrial and agricultural	—	1.4	2.6	3.5
Biomass	1.8	4.4	5.4	7.0
Photovoltaic systems	—	0.2	1.0	2.5
Wind systems	—	0.9	1.7	3.0
Solar thermal power	—	0.2	0.4	1.5
Ocean thermal	—	—	0.1	1.0
Hydro		4.0	4.3	4.5
High head	(2.4)	(3.5)	(3.5)	(3.5)
Low head	(Small)	(0.5)	(0.8)	(1.0)
Total (Quads)	4.2	12.7	18.5	28.5

[a]The estimates in this table represent the amount of conventional energy than can be displaced by solar systems, rather than the amount of energy actually delivered by solar systems

[b]Includes process heat, onsite electricity, and heating and hot water

SOURCE "Solar Energy Domestic Policy Review, Response Memorandum, February 1979, as printed in the *Solar Energy Program Document*, January 1980

Table 2.—Conservation Goals

	U.S. energy consumption (Quads) Residential/ commercial	Industrial	Transportation	Total
1975 consumption	16.8	36.7	17,3	70.8
1990 no change path (scenario C).	23.6	69.5	26.9	120
1990 possible (scenario B).	18.4	58.6	23.0	100
Percent savings	220/0	15.7%	14.5%	16.70/0
1990 possible (scenario A).	14.1	43.6	16.5	74.2
Percent savings	40.3%	37.30/0	38.6%	38.1%
Scenario A Quad savings.	9.5	25.9	10.4	45.8%

SOURCE Committee on Nuclear and Alternative Energy Systems, December 1979, as printed in the *Energy Conservation Program Summary Document* February 1980 corrected by OTA one of the best defined, but it still does not present a long-term plan of what must happen by when and what DOE's role must be to make sure it happens.

The goldbooks describe a range of energy measures, and provide suggested budgets and timetables Unfortunately, however, the programs are not clearly l inked to the goals. On **page I I-7 of** the conservation PSD it is stated that the "overall objective of the Federal Government's Conservation Program is to encourage the adoption by the economy of **cost-effective** conservation measures as rapidly as possible." Yet nowhere in the document can one find a ranking of the proposals in terms of cost effectiveness Many interesting programs are presented, but without clear represent ation of anticipated costs, benefits, or probabi1ities of success. There is a substantial range of investment between what is cost effective for an individual and what is cost effective for the Nation; this range holds many opportunities for policymaking, Nor are overall quantitative goals of energy conservation presented; one would be interested, for example, in the total energy to be saved in the United States as a result of the completion of the proposed programs The contribution of each solar project is a l so presented without ranking, The costs and benefits of each program are essential elements in deciding how the whole system fits together

Goals and plans are critical elements to the success of C&SE, but they must be used with caution. Goals must be kept up to date with other energy, environmental, and societal objectives. They can be invalidated by changes in energy demand, or the price and availability of other fuels (either shortfalls or unexpected surpluses such as conceivably might develop with natural gas as the price rises). National security considerations may make solar and conservation implementation even more imperative than it appeared at the time the goals were set Progress in technological development is always uncertain, especially in the early stages, and future costs are unpredictable These factors cannot simply be cranked into an equation that could be solved. There is no one best goa1, on l y estimates of what is desirable and achievable. Thus, goals, and the plans for meeting them, m ust explicitly incorporate these uncertainties and contingencies for dealing with setbacks.

Finally, it also follows that plans and goals should not be changed **continually in** response to possibly short-term trends or premises. Program implementation can become hopelessly unstable if objectives shift frequent l y. Measurable targets, and criteria for revising the targets, should be set for each technology and conservation strategy, in accordance with explicitly stated assumptions.

Issue 2

Setting Priorities

DOE does not appear to have set priorities among the various programs in C&SE to ensure that the total resources are being apportioned to achieve the maximum benefit.

Summary

The impending budget constraints, as well as normal fiscal prudence, suggest that C&SE favor those programs most likely to produce energy benefits. The gold books do not indicate that priorities are being set by rigorous, comparative analysis. An analytical basis for comparing technologies and emphasizing the most successful ones must be employed, or programs that eventually prove to have only minor benefits may receive a disproportionate share of the budget. This analysis should include (in addition to Quad goals) the ultimate energy contribution of the technology, economic factors, environmental impacts, effect on employment, stage of development, and other factors. Such a listing of priorities would be an integral part of the overall plan to reach the goals, as discussed in Issue 1. Congressional insistence on both the analysis and the analytical capability to produce it would probably be required to ensure that a process is created to lead to this type of effort.

Questions

1. What priorities does DOE now accord the various C&SE programs?
2. What are the criteria DOE uses to set these priorities?
3. What are the procedures by which DOE will be evaluating the programs in light of these criteria to revise the priorities?
4. How will DOE use these priority rankings, and how will they be integrated with DOE priorities for other efforts?

Background

Setting relative priorities is a way of determining which programs are most likely to contribute substantially to national objectives, and which therefore should be expedited. DOE should be able to demonstrate that it is distributing its funds in such a way as to have maximum impact both in the near and long term. Ideally, DOE would have a clear concept of how each technology would be implemented, and the costs and impacts of doing so. Then a cost/benefit analysis of DOE funding could be confidently performed for each program, and the appropriate funding levels determined. It is clearly premature to expect such a convincing analysis, but some sort of cross-technology comparison is sorely needed to maximize the overall effectiveness of C&SE. Assigning rationally determined priorities to each technology is a way of doing this.

The goldbooks present neither a cross-technology analysis nor sufficient data to perform one. Even comparing the Quad goals for 2000 and the program costs is impossible because meaningful cost data (for the full periods of the programs) are not known. Table 3 compares the DOE fiscal year 1981 budget request with the DPR solar energy goals for 2000 or the conservation savings expected in 1990 (see issue 1). This table is much too simplistic to use for planning purposes. For instance, the low ratio for industrial conservation indicates that DOE expects private industry to do most of its own R&D. Nevertheless, some sort of program comparison must be done to know if DOE is getting the maximum value for its funding in the context of meeting overall goals. Table 3 also presents qualitative estimates of the importance of several other factors.

If the budget were closely related to the goals, a low ratio would indicate a high national energy return on DOE money. As stated above, this table must be used with extreme caution. Expensive long-term R&D programs, such as photovoltaics, cannot be expected to compare with near-term applications such as solar heating, but their eventual contribution could be much greater. Furthermore, the estimates for 2000 could shift, changing the ratio considerably. However, the table does suggest which programs might be scrutinized for either augmenting (low ratios] or cutting back (high ratios).

The qualitative rankings are relative indicators of promise or problems. These preliminary rankings are illustrative only, and different orderings could be justified, Ultimate potential refers to the maximum Quad production (or conservation) that might eventually be expected. The indirect solar applications rank highest because they have the most general use. Conservation technologies are the lowest because the potential shrinks as implementation progresses. **However, it is noteworthy that the potential for conservation before the end of the century dwarfs that of solar.** Conservation technologies have very attractive economics at this time; economics for the solar R&D programs are largely speculative. The stage of development refers to technological readiness and the risk in depending on that readiness. Institutional and market barriers are the nontechnical problems that may beset new technologies, particularly if they call for radically new producer or consumer patterns, or different ways of managing the energy flow. Both these columns are subjective.

Table 3.—Comparison of the DOE Fiscal Year 1981 Budget Request With DPR Solar Energy Goals for 2000 or Conservation Savings Expected in 1990

	Fiscal year 1981 budget request	Quad goal (2000)	Ratio	Ultimate potential (Quads)	Economics	Stage of develop-ment	Institutional and market barriers
Solar							
Active heating and cooling	$57.7	2	$ 30	B	B	A	c
Passive heating and cooling	33.9	1	30	B	B	A	c
Industrial and agricultural	49.0	2.6	20	B	B	B	A
Biomass	**66.7**	3 6 a	20	A	B	A	A
Photovoltaics	175.6	1.0	180	A	?	c	B
Wind	80.0	1.7	50	A	A	B	c
Solar thermal (electricity)	117.5	0.4	290	A	?	c	c
Ocean	39.2	0.1	390	A	?	c	c
Conservation		(1990)					
Residential/commercial	97.6[b]	9.5	10	c	A	A	c
Industrial	58.9	25.9	2	c	A	B	A
Transportation	113.0	10.4	11	c	A	A	B

A = favorable outlook B = intermediate C = limited potential or difficult problems
[a]Excludes the 18 Quads already being used
[b]Does not include $202.5 million for th, Schools and Hospitals Grant program or $19895 for the Weatherization Ass[stance Program The *energy* contribution Of these programs presumably is Included in the 95 Quads but the high budget levels result from the actual implementation being done by DOE. unlike the other programs which are limited to R&D or demonstration projects

SOURCE Office of Technology Assessment

Issue 3

Planning Programs to Meet Goals

DOE Solar and Conservation Programs do not appear adequate to meet the suggested goals.

Summary

It is difficult to discern the impact of the President's goals on the DOE programs since neither the PSDs nor the fiscal year 1981 budget submission relate the programs and the goals in any detail. The solar R&D components are generally described adequately, but there is little evaluative perspective to indicate whether the programs are actually on track. Commercialization plans are described more vaguely, evidently reflecting DOE uncertaint y about how to address this phase. Meeting the goals will require that considerably more effort be given to implementation relative to R&D than is now the case. In the absence of a detailed technology implementation plan coupled with rigorous evaluation to ensure appropriate progress, there will be a natural tendency to continue perfecting technology that may never be introduced to the marketplace.

Present solar programs appear inadequate for reaching the President's 20-percent solar goal. In real dollar terms, the fiscal year 1981 budget request for DOE solar programs is slightly lower now than before the President's goal was announced. While solar funding probably must be increased to meet the goal, increases should be justified and determined by an improved analytical rationale to ensure that a coherent, least cost solar strategy is developed.

Quest ions

1. Was the fiscal year **1981** budget request prepared under a plan to meet the President's goals? If not, should such a plan be developed ?

2. What procedures is DOE using to determine if its programs are operating at the appropriate level and efficiency?
3. What mechanisms does DOE have for accelerating programs shown most promising by the research, development, and demonstration and commercialization programs and curtailing those considered less promising? For abandoning failed initiatives? How are these evaluations to be made?

Background

At a minimum, the development of a program strategy requires an initial assessment of:

- potential contribution to goals assuming technological and commercial success;
- alternate program approaches and identification of resources required for achieving levels of contribution for each technology path and confidence levels of attaining these contributions;
- potential infrastructure or societal barriers to commercial application, and plans for overcoming such barriers;
- the optimum timing and degree of private sector involvement in program development;
- potential environmental and socioeconomic impacts; and
- methods for determining when the level of effort should be reduced or eliminated, either because commercialization has been achieved or the strategy has failed,

The strategic plan should clearly identify specific subprogram goals, the program approaches to meet them, methods of implementation, the required funding levels, contingency plans, schedules, and decision-point milestones,

Coherent, long-range solar and conservation plans of this kind have not yet been developed by DOE. At present, different documents produced by DOE do not even contain agreed-upon estimates of the most basic parameters, such as the number of solar systems that must be deployed to meet the DPR goals. For example, the fiscal year 1981 budget request estimates that 14 billion ft^2 of collectors must be installed to reach the DPR goal of 2.6 Quads of agricultural and industrial process heat, while the 1980 PSD estimates that only 5.9 billion ft^2 will be required. There is little evidence of in-place mechanisms for objective evaluation of relative progress, changing assessment of ultimate potential, timing, and resource requirements.

In addition, there appear to be no centingen-(-y plans to effect required changes in emphasis, should the need be identified, Some technological approaches almost certainly will fail to meet short- or long-term goals If the over-all goals are to be reached, other technologies will have to be developed or deployed more rapidly than expected.

A major deficiency of the gold books is the lack of evaluation of existing programs. Historical achievements and results to date are not described. Each program is presented as virgin, without review of previous failures and successes. Most ongoing programs should involve adjustment and correction as they proceed, as well as evaluation to ensure that they are still relevant to achieving the overall goals. This topic is discussed in Issue 5.

Chapter III

MANAGEMENT AND INSTITUTIONAL ISSUES

Chapter III
MANAGEMENT AND INSTITUTIONAL ISSUES

This chapter discusses issues that are important for the successful operation of all programs within the Office of the Assistant Secretary for Conservation and Solar Energy (C&SE). They overlap in some cases with problems in other portions of the Department of Energy (DOE).

These issues are not specific to certain programs or technical areas, as are the issues discussed in chapter IV. Rather, they examine questions of program administration (such as evaluation, procurement, and staffing) and institutional questions, such as whether or not an appropriate role has been defined for utilities, for States, and for other parts of the Federal Government regarding energy problems. By and large, these issues must be dealt with by the Assistant Secretary and the Deputy Assistant Secretaries, with the involvement of program managers. A number of the points discussed in this chapter have been chronic problems within DOE, and attention to these questions may a prerequisite to moving the entire C&SE effort forward more vigorously and with greater long-term impact.

Issue 4

Program Staffing and Management

Development of conservation and solar energy research, development, and demonstration (RD&D) and commercialization programs has been hampered by imbalance between staff and a rapidly expanding program level, lack of organizational stability, and management turnover.

Summary

The C&SE programs show a significant growth in budget authority during a period when organizational structure and management have changed several times. Congressional initiatives, often requiring rapid development of plans and regulations, have grown much faster than C&SE staff. Delay in appointing an Assistant Secretary and repeated internal reorganizations have added to the strain on the staff. As a consequence, the ability of DOE to provide guidance for the development of solar and conservation programs has not seemed to equal the capability or interest of industry and citizens to move the technologies forward. This lack of management guidance and adequate staff has caused a lack of momentum, and has contributed to the difficulty of developing coherent long-term goals and strategies.

Questions

1. Are the job levels and pay classifications for C&SE managers equal to that of their peers in DOE?
2. Are the authorized positions within C&SE adequate to handle the workload? How many authorized positions are filled at this time?
3. Why have so many authorized positions within C&SE not been filled?
4. What techniques are used to evaluate staff performance?
5. Why have more personnel not been assigned to high payoff new initiatives such as the Building Energy Performance Standards (BEPS), which require entirely new analytical tools and management strategies?
6. How many personnel positions designated for program management have been con-

verted to staff positions to support supervisory work?
7. Have the conflict-of-interest regulations inhibited recruiting and retention of quality personnel ?
8. How does the ratio of personnel to number of contracts in C&SE programs compare with other technology programs?
9. Does the intrinsic diversity of conservation and solar technologies require more staff and management resources per dollar of hardware procurement or submarket analyses than other technologies (i. e., fossil and nuclear)?

Background

During the 30 months since DOE was established in **1977,** C&SE was without an Assistant Secretary for about half that time, and without an approved organizational structure for 26 months. This resulted in an inability to fully staff the office, which continued to have a high proportion of vacancies. At the same time, pressures associated with quickly implementing major legislation, — Energy Policy and Conservation Act (EPCA), Energy Conservation and Production Act, and National Energy Conservation Policy Act (NECPA)— combined with the need to brief a new and changing management structure, contributed to a deterioration of morale and made it difficult to attract talented people to work in such an environment.

Under these circumstances it has been virtually impossible to develop an integrated conservation and solar strategy, with measurable goals and evaluation programs, above the subprogram level. Without such a strategy, and a management structure that alines program responsibility with planning and implementation authority, conservation and solar technologies cannot be effectively developed and commercialized.

Continuity in management could provide an opportunity to develop both strategies and needed program integration approaches (see Issue 12). With a full complement of Deputy Assistant Secretaries, program managers can give full-time attention to program direction. Congress can rightfully expect that the Assistant Secretary and his Deputies establish program milestones and be held accountable for meeting them. The Assistant Secretary must be responsible for program integration and direction, for improving the balance of staff (technical and nontechnical) in each division, and for removing the remaining vestiges of the old "Federal Energy Administration/Energy Research and Development Administration" split. Each Deputy Assistant Secretary must be responsible for actually managing their program areas as well as helping to set goals.

Staffing levels have clearly been inadequate. Congress must keep in mind that authorizing new programs while staffing levels remain constant will mean delays, inadequate analysis and regulation development, increased use of contractors for policy development, and inability to fully respond to the needs of States, localities, and industry. The apparent absence of a formal evaluation **personnel process** for DOE staff means that normal procedures for reviewing staff performance are not part of the standard management responsibility, thus eliminating an obvious opportunity for feedback and direction.

Issue 5

Program Evaluation

DOE has no consistent method for evaluating program performance. Such evaluation is needed to allow adequate congressional oversight, to measure meaningful progress toward goals and milestones, and to assist DOE in determining levels of effort for new initiatives or reduction in program support.

Summary

Despite large expenditures, many diverse projects, and continuing requests for information on program effectiveness and impact, DOE has not mandated or strongly encouraged careful evaluation efforts, Lack of such efforts adds to the impression that little is being accomplished, particularly in areas such as conservation where measurement is inherently difficult, (Taking credit for energy NOT used is a complex business.) In the absence of careful evaluation, program managers must rely on instinct in selecting new initiatives. Although evaluation is difficult and time consuming, it is worth both the money and the time.

Questions

1. How many efforts within C&SE have been formally evaluated? How many by trained evaluators? How many by DOE staff?
2. To what extent has program experience been specifically analyzed and applied to succeeding or related programs?
3. How can DOE personnel obtain thoughtful and objective insights into the actual impact of the programs they administer?
4. What methods of evaluation are most applicable to conservation programs? Are new methods of evaluation needed to measure "energy saved?"
5. How does the DOE Office of Policy and Evaluation assist the program offices in project evaluation and review?

Background

Evaluation is the tool needed to answer the variety of questions raised about programs, The questions can be grouped into two major categories:

- **process (formative) evaluation** seeks to provide prompt feedback to program managers and staff to help them modify the program to improve performance, For example, formative evaluation of the schools and hospitals program might lead to a reduction in the number of forms that each institution must complete
- **Outcomes (summative) evaluation** seeks to quantify the effects of the program on client groups. These responses are of interest both to program personnel and to policymakers. For example, a summative evaluation of the Residential Conservation Service (RCS) Program would show the effects of the RCS Program on annual energy consumption for program participants in comparison with changes in annual energy consumption for nonparticipants.

Both types of evaluation are important, although for somewhat different reasons.

Unfortunately, DOE is unable to answer such questions concerning most conservation and solar programs. To make matters worse, very little work is now underway to provide such information in the future.

Although evaluation is a time-consuming, uncertain, and expensive task, it is much too important to ignore. A reasonable budget for data collection and program evaluation activities is probably about 5 to 10 percent of total program funds.

Why has so little attention been devoted to evaluation? Failure of the Department and of Congress to expect such evaluation and consequent lack of funds, changing organization, and program goals that make evaluation criteria uncertain, and intense day-to-day pressures on program staff all contribute.

Within the Office of Buildings and Community Systems, several behavioral research programs — Project Payback, Low Cost/No Cost Conservation Program in New England, use of energy feedback devices in homes — have included careful evaluation efforts. Some States—particularly Michigan, Minnesota, and Tennessee— have carefully evaluated some of their conservation programs. Thus, it can be done.

As an example of what a careful evaluation might include, consider RCS. The first step in any program evaluation is to define the goals of the program in a measurable fashion. The RCS goals might include provision of information to residential customers on the conduct of energy audits and other services, and ultimate reductions in household consumption for program participants. The second step is to design the evaluation to collect data that can be used to answer the evaluation questions of program staff and management. This might include telephone surveys with program participants and also with nonparticipants to collect demographic information, structural characteristics of their homes, their sources of energy conservation information, their reactions to RCS (if they participated), and their estimates of what conservation actions they recently took and why. An additional effort might include collection of fuel bills from utilities to measure changes in energy consumption before and after RCS for program participants and nonparticipants. A key issue here is the need to carefully separate the effects of RCS on energy savings from the effects of other determinants. Because any measurement technique is subject to errors, it is useful to measure program effectiveness in several ways; here telephone interviews are used with personnel involved in delivering RCS services to households (e.g., utility staff, State energy office, contractors, suppliers, banks),

The above example illustrates the difficulties and time required to do a careful evaluation. It is not enough to ask program participants what they did; this does not allow adjustment for what they might have done without the program. Collecting postprogram data from both participants and nonparticipants is also not enough; self-selection will surely influence the prior energy use behaviors of the two groups.

The difficulty of measuring the impact of conservation efforts suggests that a number of evaluation techniques be tested. Staff and contractor evaluations will both be important. New techniques may be needed to understand efforts to conserve energy.

Issue 6

Relationship of Regulatory, Incentive, and Budget Outlay Options

Without redefinition of conservation and solar program goals, regulatory and incentive programs will continue to be poorly integrated with RD&D and information programs into a coherent commercialization strategy throughout the Government.

Summary

In the past the Office of the Assistant Secretary for C&SE has had insufficient leverage in either planning or implementing "off-budget" Federal policies such as gas guzzler taxes, tax credits, auto fuel economy standards, and utility rate regulation. As a result, program progress tends to be measured by budget levels, and off-budget policies are not fully understood as critical tools for achieving a more broadly defined objective. Defining **total** program goals, and expanding the scope of program planning to include off-budget policies and programs, may correct the current imbalance. Program plans would then be explicitly based on comparisons of the full range of policy instruments and their relative effectiveness in meeting program goals. Developing off-budget mechanisms requires a serious commitment of resources. This type of planning may also assist DOE in urging other agencies (such as the Treasury Department) to move more vigorously in implementing "off-budget" policies.

Questions

1. Which solar or conservation technologies could be developed and implemented by private industry with no Government role other than incentives or regulations? What fraction of the R&D budget supports these technologies?
2 What amount of budget outlays could be avoided by policies such as guzzler taxes, technology-forcing standards, and financial incentives that would create a market for products? Would such policies obviate the need for DOE to finance demonstration projects by making it worthwhile for competing vendors to underwrite such projects? Are such policy alternatives compared with budget outlay options on any systematic basis? Can the cost of incentives be compared with the cost of outlay programs?

Background

The effectiveness of off-budget conservation and solar policies, such as tax incentives and regulations, has been frequently underestimated by DOE and its predecessor agencies, Energy performance standards for new autos and buildings resulted from congressional initiatives. Legislation establishing these programs, and for appliance efficiency standards, typically calls for the most stringent standards that are technically feasible and economically practical. This places an extraordinary burden on the Government to build and maintain — in the public domain — a body of expertise nearly as sophisticated as that developed by the industry. In the areas of building performance and appliance efficiency combined, however, DOE has less than 20 full-time professionals charged with regulating tens of thousands of producers and dealing with conservation technologies for which little information exists (e. g., passive solar) or is proprietary (e.g., appliance efficiency). Moreover the nature of the regulations required by statute (minimum standards instead of "fleet average") requires that they be set at a "least common denominator" level to avoid anticompetitive impacts in industries characterized by many small producers. For them to be technology-forcing would require introduction of a "fleet average" feature or a complementary program of subsidies for exceeding the minimum standards by a significant amount.

Inadequate staffing of and attention to regulatory programs leads to delays (statutory deadlines missed for BEPS, appliance labeling, appliance standards) and to poor regulatory analysis. Without extremely sophisticated and credible regulatory analyses, DOE will either be afraid to propose stringent standards, or will be vulnerable in the face of industry pressure, Regulatory analysis and enforcement are not inexpensive, Their full costs, however, should be weighed against alternate approaches.

In cases where regulations must be implemented by States (e. g., RCS, BEPS) DOE technical assistance has been inadequate to ensure program effectiveness.

With more imaginative and aggressive use of taxes, incentives, and regulations, many of the functions now performed by DOE budget outlay programs could be performed by manufacturers of energy-efficient equipment. Accompanying an aggressive off-budget conservation strategy would be a complementary set of RD&D and information programs. In cases where the industrial RD&D capacity does not exist, direct Federal involvement is needed. Work that produces information whose benefits may not be fully captured by patents, or programs that are too risky or long term for the private sector perspective may also require Federal outlays.

The problem is complicated by the fact that DOE does not have authority over such options as tax incentive implementation. The Department has supported tax credits for solar and conservation systems that would go well beyond those released by the Treasury.

In short, DOE and Congress must give more emphasis to changing the institutional environment to give private enterprise more incentives to increase RD&D and commercialization efforts. A restructured DOE program would complement such efforts, and be focused on developing new technologies that are appropriate to the changed institutional environment.

Issue 7

Procurement and Contracting

The substantial delays and bureaucratic complications that characterize the current DOE procurement process threaten the viability of even the best conceived and most competently planned initiatives.

Summary

Successful programs depend as much on timely and efficient procurement as on technical competence. DOE should emphasize speed and responsiveness to program objectives as well as fiscal soundness. Accountability is not merely an auditing function. Lengthy and difficult procurements result in a variety of uniformly unfortunate impacts on conservation and solar activities.

Questions

1. How long does a "normal" DOE procurement take?
2. Are contracts for C&SE processed as quickly as contracts for other offices?
3. How are priorities for processing determined within the procurement off ice?
4. Does the procurement process damage either small or large firms in particular?
5. Do DOE procurement processes more properly apply to the weapons and defense activities of the Department than to other areas?
6. Is an entirely new or separate procurement system needed?

Background

In an organization such as DOE, technical excellence and careful planning of the scientific, engineering, and commercialization activities depend on procurement actions that bring the best available talent to bear on the problem at hand. Delays in executing procurement actions seriously hamper program progress. Delays running into years, with an average procurement cycle of 14 months, destroy the best-laid technical plans and convert potentially successful ventures into failures.

One effect of very long procurement is that the system sometimes favors large firms with established operations, high overhead rates, and the ability to sustain themselves against major delays. Many smaller firms cannot retain high-quality personnel while waiting and may be forced to release employees or shift to other work. This is unfortunate because many innovative ideas originate with small firms and individuals outside the mainstream of private sector funding, and because the diverse nature of both conservation and solar opportunities — there are literally dozens of solutions for many problems— means that a wide diversity of responses is important in exploring options. (The delay in processing actual payments, even when a contract is in place, also weighs heavily on small firms and individual s.)

On the other hand, large firms that offer major opportunities for cost reduction and market penetration are sometimes excluded or restricted in contract bidding because of small business setaside policies. Such setaside policies (throughout the Government) must consider the return on Federal investment, product performance, and innovation.

The present lengthy process encourages program managers to establish large, open-ended management contracts with firms that can then be called on for quick-response work, including program planning support. Many of these firms become alter-egos of the program offices, and people not directly employed by the Federal Government actually shape policy. (Individual employees often go from firm to firm in order to perpetuate their relationship with program off ices.)

A simple but critical effect of delay is that opportunities are simply missed. By the time the money comes, the window is closed.

It is possible that an essential element of the problem is that DOE procurement procedures were designed to fit the needs of the weapons components of the Department. Thus, DOE offices whose purpose is to catalyze private and public sector activity and generate unusual types of research may be unduly burdened. A similar concern is that procedures needed for very large contracts are imposed on small contracts. (Methods developed at the direction of Congress for the Small Grants Program have shown that change is possible.) Care is needed to ensure that procurement procedures are adequately flexible and carefully applied.

The protective nature of the procurement regulations and related bureaucratic layers has resulted in a long list of required signoffs and clearances, almost certainly more than should be necessary for some types of purchases.

There is a role for sole-source procurement by DOE, because of the many firms and individuals with unique expertise and information, and the number of unsolicited proposals. Speeding up procurement would remove the present incentive for program managers to request sole-source approval for the sake of speed alone.

One result of the clifficulties of procurement has been the use of field offices and national laboratories to manage procurement. This may expedite the process (or not), but it results in a real transfer of responsibility. The extent of such delegation and its effects should be reviewed as part of an effort to improve the procurement process.

It is unclear whether existing problems can be resolved through review and clarification, or whether an entirely new approach, preceded by congressional debate, is necessary. Perhaps each major division within DOE should have a separate procurement staff, implementing procedures appropriate to the needs of the programs. Absent such an overall revision, the DOE leadership could perhaps most effectively prove its commitment to conservation and solar by resolving the delays in the procurement process.

Issue 8

Data Collection and Analysis

DOE data acquisition, analysis, and information dissemination are inadequate to understand current energy problems, take advantage of what can be learned from current programs, and analyze future responses to policy options.

Summary

There is a serious absence of usable data regarding energy use in all sectors of the economy. This situation is even more severe regarding distributional data such as disaggregations of national statistics by income groups, regions, etc. Although data is now being generated through a number of federally funded programs, much of the data appears destined to collect dust rather than contribute to understanding energy needs and uses.

Questions

1. What systematic plan have the Energy *In*formation Administration (E IA) and C&SE prepared to meet the numerous gaps in the information on current and future energy use and the buildings, vehicles, and equipment that use it?
2. What arrangements exist between the Department and States or other institutions to improve the data base on regional and local energy use? For sharing E 1A data?
3. What plans are there for ensuring that data generated under current programs funded by the Federal Government are validated, documented, and made available within the Department and elsewhere?
4. In planning data collection, how are the preferences of the policy office, the program managers, and E 1A balanced? Must the program office be tied to use of E 1A data?

Background

Energy data acquisition and forecasting are central to the evaluation of energy development and commercialization programs, and to the development of policy. DOE's existing data gathering, forecasting, and analysis efforts are virtually unusable for determining the impact of its programs or of the programs of States and local governments. One reason for this is the extraordinarily high level of aggregation used in national energy planning, wherein it is simply not possible to determine what the impact is (on coal, oil, gas, nuclear use, or consumer prices) of insulating the uninsulated homes in, for example, the State of California. (One year ago, DOE's model showed energy use in California 20 percent higher than the intensely detailed "end-use" models developed by the State.)

EIA has recently begun to collect detailed primary data from energy users in the residential and commercial sectors. The attempt to improve knowledge of the housing stock is thorough, careful, and well-balanced between survey work and validation. If E 1A continues these efforts into the future, information will then be available concerning changes over time. At the present time, there is little understanding of the determinants of energy use, in particular how Government conservation programs interact with market forces to improve efficiency of energy use.

As improved data collection increases, end-use modeling of energy use (present and future) will improve policy makers' ability to rate the effectiveness of particular energy programs, to target important R&D areas for oil savings (choose one option), and even to rate the agency's ability to deploy its own programs. DOE must work closely and cooperatively with each State to collect, analyze, and model end uses of energy if priorities are to be correctly set, programs are to be evaluated, the cost effectiveness of incentives, regulations, and other policies are to be judged, and States are to be effectively integrated in energy planning.

For example, the Schools and Hospitals Grant Program has funded audits generating professional engineering analyses of proposed capital modifications for hundreds of buildings. A careful synthesis of this raw data could produce information vital to determining the targets for future loan and grant programs, estimating the impact of legislative proposals on energy consumption, and identifying research needs. At present, there are no plans to perform such a synthesis.

DOE should provide technical assistance to State energy offices on the best methods of collection of energy use data. Existing and planned Federal conservation programs require States to collect large amounts of data related to energy use and program effectiveness. However, the data are likely to be varied in quality and organized differently in each State. This will make it difficult to develop national data bases and to use these data to help understand patterns of energy use and their determinants.

Improved data collection and analysis will require more funding. Such an increase is necessary to underpin program efforts.

Issue 9

Basic Research

DOE has paid insufficient attention to basic research directed at energy conservation and solar energy.

Summary

One of the principal weaknesses of the DOE conservation program has been the lack of basic and applied research designed to broaden the conservation technology base. A strong effort in the physics and chemistry of industrial processes is needed to assist the transition away from fossil fuels to solar energy and electricity. Similarly, research on materials and heat transfer needs more attention if advances in insulation, heat recovery, and energy storage are to continue. Building energy conservation could benefit by work on airflow and the physical conditions affecting comfort. An effort to begin a basic research program is now being made with the establishment of an Office of Conservation Research within C&SE. This Office should not only fund critical research efforts but bring together relevant research results from programs funded by other Federal agencies and encourage the development of university graduate research programs in process chemistry and physics.

Questions

1. What are DOE's long-term goals for basic research in energy conservation?
2. How will the Office of Conservation Research interact with the other conservation off ices charged with near- and mid-term responsibilities? Will there be some systematic way of trading information and ideas?
3. Does the Office of Conservation Research plan to catalog other federally funded research that may be relevant to basic research in energy conservation?

[1]John H. Gibbons, "Long-Term Research Opportunities," *Energy Conservation and Public Policy* (Englewood Cliffs, N.J.: Prentice Hall, Inc., 1979), p. 210.

Background

The basic research activities of DOE have focused primarily on supply questions such as combustion research, fusion, and fission. Little work has been undertaken concerning the use of energy, particularly in industrial processes. The Nation is facing a transition in the coming decades away from direct fossil fuels combustion as the primary energy source for industry to direct solar and electricity. As these shifts are made it will be very important that new ways to use these sources are developed to maximize economic efficiency; the direct substitution of solar and electricity as heat sources into current thermal chemical processes may be very wasteful and costly. Therefore, increased attention should be given to electrochemical and photochemical processes. Examples include using electromagnetic radiation through lasers and microwaves or photochemistry with appropriate catalysts to drive chemical reactions, These processes could be useful for chemical processes, heat treating of metals, and transformation of raw ore to finished metals, al l of which are now predominately driven by heat from direct combustion of fossil fuels, Similarly, electricity may be more efficiently used as a heat source by using induction heating or isolating particular portions of the spectrum (infrared or ultraviolet).

More work could be done to understand the basic properties of materials for their use as insulation, heat transfer equipment, and energy storage devices, While programs are underway to develop and demonstrate technologies in most of these areas, they are principally oriented to applying existing technologies to the problem, and devote only a small effort to basic research. Examples are the ceramics program in advanced engine research and the battery program, both of which are attempting to develop finished products. They do not have the resources or the charter to explore more fundamental materials' properties questions related to their mission.

Other basic research opportunities in conservation include exam i nation of building airflows with the goal of al lowing smaller operating temperature ranges for heat pumps and air-conditioners (and therefore higher efficiencies), examination of the effect of temperature, humidity, and air velocity on comfort, and lighting levels and techniques, particularly those using solar.

Many of the items mentioned above are receiving some attention in the research community. The efforts are not coordinated toward energy use goals, however, and it is possible that valuable results will be lost or not attained unless a directed conservation basic research program exists. The new Office of Conservation Research within C&SE may be able to provide this coordination and leadership in addition to funding new work. Efforts should be made by the Office to make use of relevant work sponsored by other Federal agencies and perhaps to expand those projects where possible. The Office should also look into ways to encourage the reestablishment of university graduate programs in process chemistry and physics. This could be of great assistance in supporting industry research on more efficient and productive industrial processes.

Issue 10
Commercialization

Confusion exists regarding appropriate and effective methods to commercialize conservation and solar technologies, both within the Department and Congress. More careful analysis of commercialization techniques and better delineation of authority within DOE are needed.

Summary

Legislative guidance to DOE includes the responsibility for research, development, and commercialization of solar energy and conservation devices. The OTA *Analysis of the ERDA Plan and Program,* completed in 1975, states the issue, "The development of effective commercialization policies and procedures is not adequately addressed in the ERDA plan, " The

new administration goals for the use of renewable energy by 2000 add to the urgency of this problem. Commercialization connotes many methods and approaches to both Congress and DOE management, thus adding to the confusion. A recently established Office of Commercialization within C&SE has been charged with the responsibility of better defining the effort. Experience from early demonstration programs can be applied to commercialization.

Questions

1. Who is responsible for determining commercialization strategies for C&SE? For selecting products or technologies to commercialize? What does commercialization mean within C&SE?
2. How does DOE decide on the relative merit of channeling commercialization subsidies directly to industry (via budget outlay programs) v. indirectly through tax credits, utility rates, or regulatory programs?
3. Has DOE carefully studied the successes and failures of other Federal agencies in commercialization (e. g., the U.S. Department of Agriculture)?
4. Are DOE commercialization efforts consistent with general principles that emerged in the administration's Domestic Policy Review?

Background

The R&D process leading to a commercial product is seldom a staged, linear process. In fact, the stages in the process are separated by formidable gaps, often difficult to bridge even in a monolithic organization, and not always easy to describe as a set of sequential events. Engineering development, for example, often depends on many lines of research carried out earlier which are recombined into new patterns to develop a useful device or product. Similarly, successful commercialization depends on economic and marketing factors, and perhaps regulatory considerations, that go far beyond the bare existence of a useful, reliable product. For these reasons, one should not expect Government-sponsored R&D to lead directly to successful commercialization. Those instances where Government R&D has led to a successful outcome have almost always been with large systems for the military or space where cost considerations have not been paramount or with nuclear energy for an already organized market. The success of these systems cannot be translated easily into commercializing the diverse and numerous products and design approaches required for the penetration of solar and conservation technologies.

This lack of applicable experience combined with a belief that the Government does have the resources to achieve market impact (based on successful defense and space work) causes confusion. On the one hand, Congress has sometimes simply expected that DOE could somehow force new technologies to be used. On the other hand, attempts by DOE to deal directly with the market through supporting particular products, to support one technology at the expense of the other, or to undertake private sector type traditional market research and advertising, have been met with strong resistance by both private industry and some members of Congress. For example, one resource important to private sector commercialization is the availability of money to use flexibly, so that unexpected market opportunities can be seized. Is existing DOE reprograming authority sufficient to meet this need? Would Congress allow greater flexibility?

Similarly, there is no concensus as to how far along toward commercialization Government efforts should continue. It is clearly inappropriate and inefficient for a unit of the U.S. Government to assume the role of entrepreneur. Even before this point, Government involvement can be counterproductive, since Government-sponsored developments are generally made equally available to all industrial comers. If Government activity prevents any one company from acquiring a sufficient market share, successful commercialization may be impossible. Government-sponsored R&D in fields such as conservation, where the associated industry is too fragmented to carry out these tasks for itself, may be productive. Government demonstration of technical viability, particularly for technologies to be used by utilities and industry, is clearly justified. A concurrent responsibility is to make the results of such activity available to industry.

The principal questions regarding commercialization then revolve around the degree of DOE involvement in accelerating industry activity when national goals require it. This is the situation in the energy arena today. Steps available beyond information dissemination include technical and financial assistance and market guarantees as well as a host of less direct measures, such as removal of institutional barriers.

Effective strategies must be based on an accurate understanding of current market conditions. For example, the nature and extent of capital investment in solar heating systems would be a useful piece of information to people responsible for accelerating the use of solar systems. Such research is not being done within the Department at this time.

There is no one answer as to what approach would be most effective or appropriate. Each technology and each industry has its own characteristics and may play a different role in the national energy system. Hence the commercialization efforts must be designed for the particular situations.

An Office of Commercialization has **recently** been created within C&SE, with responsibility to try and identify the best commercialization strategies and methods for various technologies, for both short- and long-term needs. It is too early to assess the effectiveness of the Office, but its existence may indicate a stronger commitment by C&SE to come to grips with the commercialization issue and try to develop coherent approaches.

Experience gained through the Federal solar heating and cooling system demonstration program and other demonstration efforts suggest some lessons that the Department can apply in trying to bring technologies into the market successfully. Federal demonstration programs have had very mixed results in demonstrating the practicality of solar heating and cooling systems. The programs have resulted in technical innovations, increased public awareness of solar technology, and important information on system performance. However, the programs have been criticized on many grounds, including unreliable operation of solar systems due to poor installation and the use of unproven technologies, and unacceptable economic performance due to the use of costly systems. Many critics believe the demonstration programs, which were mandated by Congress, have been so problem-plagued that they have been of questionable or negative value in demonstrating the attractiveness of solar energy to the general public.

Much of this confusion can be clarified by making a clear distinction between engineering field tests and public market demonstrations. Engineering field tests involve constructing systems that are considered well along in the technical development process, allowing them to operate with minimum interference and adjustment in a field environment, and monitoring their performance over time. Industry never treats engineering field tests as a public demonstration. Rather, such tests are done carefully, and when the technology is judged ready, it is given a "public demonstration" in the marketplace. The same principle should apply in Government programs.

Public exhibitions should feature only proven, reliable, cost-effective technologies. They should assure that equipment is certified and installation is done correctly. Strict selection criteria should be established to assure that a large number of builders can participate, that locations are chosen for high public exposure, and that a few large projects do not dominate the budget.

Demonstration programs should only be undertaken after a careful evaluation of alternative approaches. For example, information, education, and advertising programs, the development of codes and standards to assure consumer satisfaction, cooperative Federal-State programs to identify and publicize private sector "model projects, " and other approaches may be more cost-effective than public demonstration programs for promoting consumer awareness and acceptance of solar technologies. Historically, funding for construction programs has been easiest to obtain from both the Office of Management and Budget (OMB) and Congress, while funding for information, education, and related programs has been a prime target for budget cutting. The questionable results of past Federal solar demonstration programs suggest that historical patterns need to be reassessed.

Issue 11

Non hardware Research

DOE has given social science research an insignificant level of funding despite important and relevant discoveries in this field, and opportunities to enhance public acceptance of conservation and solar energy investment.

Summary

The success of many conservation and solar programs depends on hundreds of millions of decisions made by millions of individuals. However, DOE has shown little interest in examining the consumer's "energy environmerit, " or in learning how attitudes and motivations affect the level of energy use, and how to best encourage people to take energy-saving actions. Yet this research field is well-defined and can be targeted at finding crucial aspects of attitudes and action that most affect energy use. DOE should expand this research to reflect its potential contribution to changing energy use.

Questions

1. Why has the applied social science R&D budget remained at the same level for the past **3** years?
2. Why is DOE putting more effort into public information than into determining what information is most effective in altering energy use patterns?
3. What plans does DOE have to coordinate its social science research with conservation and solar "hardware" research?

Background

The amount of control that individuals exercise over their own energy use has gone largely unrecognized by DOE, despite the significant contributions that an energy-conscious society of consumers could make toward reducing energy consumption. The bulk of research conducted on energy conservation has been within the sphere of physical sciences. The conservation social science budget has remained constant for the past **3** years, failing to keep pace with the rapid expansion of the overall conservation budget and gal loping inflation.

There is ample evidence that social science research can produce meaningful and effective results, not simply in understanding people's actions, but also in helping them make more informed decisions. For example, in DOE's "No-Cost, Low-Cost" experiment carried out in New England last fall, over a million residents took actions in their homes to cut down on their energy bills. Basing the program on prior marketing and behavioral research, DOE prepared a brief guide outlining **12** simple steps which if adopted could cut the resident's energy bill by 25 percent for an investment of less than $100. About 30 percent of the residents receiving the packet (which was a brochure and a waterflow controller) took actions because of the information. DOE estimates that for every $1 it spent on the program, New England residents will save about $26 in energy costs, making this an unusually cost-effective program. Knowledge gained in previous DOE marketing experiments and advertising efforts was used to determine the preparation of all materials and promotion for "Low-Cost, No-Cost, "

In research at Twin Rivers, in Princeton, N. J., researchers found that some families use twice as much energy in their homes as others, even though they live in identical homes, with many similar traits such as family size, education level, and income. I n another project, DOE discovered that if people realize at what rate they use energy, they will cut down on its use. Appropriate feedback to motivated people has cut home electrical energy use by 10 percent.

Research has also shown that many attitudes that might be thought to affect home energy use (such as belief in the reality of the energy crisis or optimism about a technical solution) are not related. Information of this kind is valuable because it provides the basis **for** design of effective conservation campaigns.

Another valuable finding involves utility companies' equal monthly payment plans. Since these plans soften the impact of large bills, there was concern that people selecting this form of payment might increase energy use; a concern that was heightened because of rapid growth of participation in equal-monthly payment plans. Subsequent research indicated that this type of payment plan did not foster excessive consumption.

Well-defined and carefully conducted social science research plays an important role in selecting strategies for changing energy use. More attention to this work, and use of the results by program offices, could substantially improve DOE effectiveness

Issue 12

Conservation and Solar Integration

The division of authority into "conservation" and "solar energy" causes competition where cooperation should exist, and may reduce the effectiveness of both programs. *

Summary

It is essential that conservation and **renewable energy be understood as a unified approach, consisting of demand reduction** plus a shift to sustainable energy. **The DOE organizational structure accentuates the differences between conservation and solar, rather than finding opportunities for cooperation.** This can result in **pitting conservation against** solar in the competition for limited resources, and can generate solutions that are not optimal. A particularly clear example of the need to begin to integrate these approaches lies in the buildings area, although the need for a more integrated approach is also evident in the areas of industrial and transportation programs.

Questions

1. **Is new** legislation necessary to directly integrate the programs now separately defined as conservation and solar?
2. What is the rationale for conducting two separate programs, both designed at reducing fossil-fuel use in buildings, without a unified approach to solving the problem?
3. To what extent are buildings likely to change in response to conservation measures? Will the more efficient buildings "fit" the types of solar systems now under consideration by the Department?
4. How frequently and in what ways, formal and infer-mal, do the staffs of both offices assigned to buildings compare research and applications experience?

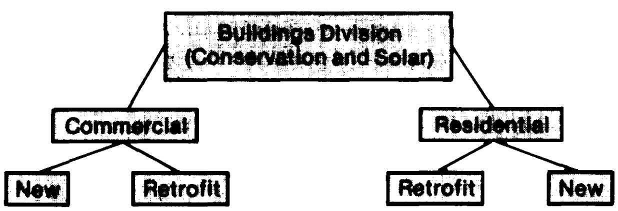
Background

The Buildings Program, within the Office of the Deputy Assistant Secretary for Conservation, is now organized into three areas: Architectural and Engineering Systems, Regulatory Programs, and Applications and Incentives. Within the Office of the Deputy Assistant Secretary for Solar Energy, the areas of Solar Active, Solar Passive, and Photovoltaic all fund work relating to building energy use. Because of these organizational distinctions, there is little integration of conservation techniques that can radically alter the configuration of a structure, and thus alter the type and cost of a solar system. While some research will be necessary for various technologies and should be conducted separately, application of research can best be done by end-use category.

An approach is needed which seeks to provide the most efficient solution to the problem, instead of focusing on conservation and solar as mutually exclusive technologies. Integration of conservation and solar would help

*This issue does not recommend an immediate reorganization of all programs. The issue points out one way in which a desired redefinition could eventually be reached architects, engineers, designers, and builders to produce the most energy-efficient solutions by providing them with integrated energy-conscious designs. An integrated approach to building design would focus attention on critical and relatively neglected questions like the following: To what extent can conservation measures improve the economics of solar systems by reducing the collector area needed for meeting building heating requirements? What combinations of solar systems and conservation measures are more cost effective than the conservation measures alone? What changes in solar design philosophy should occur as buildings are made tighter? How does greater thermal integrity affect the comparative costs of backup systems and thermal storage systems? Could "superinsulation" techniques virtually eliminate the need for conventional heating sytems in new buildings? What passive additions are economically justified in building retrofits? Should existing homes with fireplaces generally convert to wood burning "fireplace furnaces" in areas where wood is readily available? Is solar heating preferable to oil and gas for minimizing air quality problems in heavily insulated buildings? In what circumstances will solar district heating systems be superior to solar retrofits on individual buildings?

The existing division of responsibility tends to produce "separate but equal" solutions, discouraging designs that combine both approaches. An organization that would emphasize the most efficient problem solving could replace the existing organization with divisions by building type (see below). Within each program, staff would seek the most effective combination of conservation and solar techniques.



The different stages of work within each of the four programs above could be:

1. collection of baseline data and goal setting;
2. R&D in the thermodynamics by building type;
3. collection of climate data on a region-by-region basis;
4. R&D in energy-efficient systems, materials, and components that integrate solar with conservation;
5. analysis and load quantification;
6. R&D in institutional barriers;
7. evaluation of the results of the preceding programs; and
8. information and education to the public on techniques and products.

A full reorganization of the solar and conservation buildings programs along the lines suggested here may not be desirable in the immediate future. (In fact, the OTA panels were unanimous in the view that a respite from major reorganizations is needed.) Nevertheless, it is desirable that DOE move over time toward an integrated "buildings program, " and many cooperative steps toward that goal are feasible in the near future. For example, solar and conservation programs could cooperate closely to define and promote a "least cost retrofit strategy" (see Issue 31), and the passive program could emphasize the development of designs and prototype buildings that integrate passive features with conservation measures and active solar systems (see Issues 32 and 33).

Issue 13

Federal Energy Coordination

There is no indication that Federal agencies are coordinating their energy activities in accordance with the President's Executive order and the June 1979 solar message to Congress.

Summary

Many Federal agencies, quasi-public corporations, and departments within agencies can be employed in the implementation of energy policy. Effective coordination and use of these resources is essential in obtaining the desired solar goals. The Energy Coordinating Committee (ECC) was formed for this purpose, but has yet to show visible progress.

Questions

1. How will the effectiveness of ECC and the Solar Subcommittee be assured?
2. Why has the Energy Productivity Subcommittee apparently been abandoned?
3. Will ECC provide Congress with a first-year progress report detailing each agency's actions in accordance with the President's June 1979 directives reported in the Message to Congress?
4. How can coordination be promoted without adding red tape and reducing DOE's managerial effectiveness?

Background

In his June 1979 message on solar energy, the President announced the formation of a Standing Subcommittee on Solar Energy within ECC, which had been established by Executive order the previous year. The subcommittee was created to coordinate the solar-related activities of over a dozen Federal agencies. The subcommittee has no authority but reports to ECC which in turn reports to the President. As a cabinet-level committee, ECC has authority to resolve problems. It is not clear that ECC is fulfilling its mandate (or even meeting), Since ECC can play a vital role in efficiently implementing national policy, Congress might request progress reports and encourage ECC to aggressively pursue its mission.

Issue 14

Assistance to States

The Office of State and Local Programs (S&LP) needs increased technical capability and discretionary monies to properly assist the States and encourage flexible and responsive efforts meeting both State and National needs.

Summary

States are expected to be the prime movers in implementing many national programs mandated by Congress. The wide variation in the level of funding, staffing, and resources of State Energy Off ices, combined with the diversity of energy use patterns, fuel sources, living patterns, and climate of the States, suggests that effective implementation by States of national goals must be based on a flexible approach. Congress and DOE should understand this need for flexibility and for support to the States. S&LP needs additional capability to provide technical assistance to States.

Background

Many of the programs that the States are called on to implement are technical in nature. A comparison of resources between the C&SE offices shows that S&LP has a much smaller staff than the research offices; and that the S&LP staff has fewer employees with training in technical fields such as engineering and economics. In the absence of technical guidance provided directly by the central office, or regional offices, assistance could be given to the States by contractors. However, the very large C&SE budget is dedicated almost entirely to the State grants themselves, with very little discretionary money for contractor support and technical assistance. R&D offices, on the other hand, have great discretion in how their funds are allocated.

State programs are largely composed of common elements, most required by Congress. These elements include energy conservation telephone hotlines, home energy audit programs, audit training, energy management seminars, energy use data collection and management systems, consumer publications, and so on.

DOE does not generally provide "models" for these programs, which the States could adopt, modify, or reject. This leads to great duplication of effort. While there is an understandable and legitimate desire on the part of the States to have materials that are uniquely theirs, basic guidance, particularly in highly technical areas, would be helpful. An example is the Schools and Hospitals Program, which contained Federal requirements concerning training and certification of audits. A Federal guidebook to this process would have been helpful. Contractors must be well-chosen, and have experience with field operations or State and local environments. Assistance provided by the evaluation of the Energy Extension Service in the 10 pilot States was apparently helpful to those States. The Office of Buildings and Community Systems preparation for implementing RCS includes development of a model audit and model audit training program. If this effort is delivered soon and of good quality, it will help the States and improve the effectiveness of the RCS program.

In providing technical assistance to States, close cooperation is required. State energy offices are best able to say what type of technical assistance they require, and to help design the projects. Good ideas are often too late in arriving (see Issue 7).

It might be helpful in general if DOE Washington personnel responsible for working with States could actually spend more time in State energy offices, to learn first-hand the day to day reality of a State energy office, and their real capabilities and needs,

Issue 15

Consolidation of State Programs

SL&P now manages three separate but similar programs that impose too much paperwork on State energy offices, and unnecessarily duplicate services. The programs should be consolidated and streamlined, as both DOE and Congress have proposed.

Summary

The State Energy Conservation Program, the Supplemental State Energy Conservation Program, and the Energy Extension Service should be combined into a single program to facilitate their management by the State energy offices as well as by DOE. Goals need redefining so that States have a single set of objectives that elements of all programs combine to achieve. The most effective methods of providing technical assistance to States should be identified by the States and retained, with less appropriate approaches dropped. Precautions are needed to ensure that consolidation does not burden States under the guise of helping them.

Questions

1. Has DOE carried out an evaluation of its existing State and local programs to provide guidance for their consolidation?
2. What plans does DOE have to eliminate the duplication that now exists among these three programs?
3. What steps is DOE planning to ensure that consolidation will make it easier, not more difficult, for States to achieve energy conservation goals?
4. Has DOE considered conducting a pilot project to test the proposed consolidation in several States before expanding it nationwide?

Background

DOE now manages three State energy conservation programs, the State Energy Conservation Program, the Supplemental State Energy Conservation Program, and the Energy Extension Service. To be eligible for grants under the State Energy Conservation Program and the Supplemental State Energy Conservation Program, a State must develop plans to promote energy efficiency in buildings (both structure and components), and transportation, with techniques to be used including coordination among Government bodies, reform of procurement regulations to promote energy efficiency, and public education. Under the Energy Extension Service, States are to develop energy-saving programs such as self-help workshops for the public, energy audits for homeowners and small businesses, and energy management services for local governments.

Because many of the services provided are similar (e.g., technical assistance, information dissemination, building audits), there is considerable overlap. The programs are managed by different staff at DOE, and operate on different budget cycles and different grant application deadlines. Consolidation would eliminate much duplication and inefficiency.

Also, the grant application process needs to be simplified. The experience of some State and local agencies with these programs suggests that getting hold of Federal funds is a discouraging, laborious process. This can impede creative development and efficient pursuit of programs on the State and local levels. For example, if reporting forms are too time consuming or redundant, groups may be sloppy in submitting them. In one case under the Schools and Hospitals Program, for example, an institution applying for a $300 grant must fill out separate forms for DOE, EIA, and OMB. These grants, for walk-through energy audits, may well not be worth the cost of preparing and processing them.

To the extent that State and local groups get bogged down in applications for and administration of Federal monies and in coping with Federal requirements, their ability to tackle their own programs is eroded.

As DOE consolidates these State programs, precautions are needed to avoid encumbering the States with still more regulations and requirements, without providing them with more resources. The Energy Management Partnership Act (EM PA) proposal could result in adding more requirements for States without providing additional funds to help the States meet those requirements. This would make EMPA counterproductive rather than increasing flexibility in State programing.

Testing of EMPA through a pilot program in a few States would provide an opportunity for Congress to evaluate and modify EMPA before expanding it nationally. Such a test could be similar to the pilot testing of the Energy Extension Service.

Issue 16

Role of Utilities

Private and public utilities can play a major role in promoting the use of conservation and solar energy but are inhibited by Federal disincentives.

Summary

Although utilities are potentially effective promoters of conservation and solar energy, they are currently prevented from undertaking this role by Federal law. NE CPA prohibits utilities from supplying, financing, and installing conservation and solar energy services because of concerns over anticompetitive effects. If the restriction is removed by Congress, DOE can encourage utility experimentation with various approaches, and can provide technical and economic information to assist utilities.

Questions

1. Should the Federal Government allow utilities to directly assist customer-owned conservation and solar investments by removing current financing and supply restrictions?

2. What information is DOE providing to utilities regarding the experience of those companies now actively involved with conservation and renewable?
3. What steps is DOE taking to coordinate the numerous departmental activities affecting utilities?
4. What types of demonstrations in conservation and renewable might DOE fund through utilities?

Background

Utilities are expected to deliver energy efficiently, reliably, and at the lowest possible cost. Their promotion of conservation measures and renewable energy sources is consistent with these goals. Utilities offer a unique delivery system that reaches nearly every commercial, residential, and industrial building in the country; technical capabilities, consumer services, and consumer contact; and service area familiarity and access to money markets that can positively affect the penetration of solar technologies and conservation measures.

NE CPA requires utilities to offer energy audits, to disseminate information, and to arrange for the installation and financing for various conservation and solar energy measures, through RCS. But NE CPA also prohibits new programs to supply, install, or finance conservation and solar energy technologies in residences. Only under certain conditions may DOE, in consultation with the Federal Trade Commission, issue a waiver of this prohibition.

The major concern leading to this prohibition was over the fear of allowing a monopoly power to influence a competitive marketplace. Methods are needed to ensure that utility energy marketing programs do not lead to anticompetitive effects. To the extent that these new technologies can be developed by many openly competitive firms, utilities should not be allowed to act in a manner that would unreasonably favor one or a few firms over others, or limit consumer choice in any manner. The potential for competitive prices and varied technical design must be maintained. However, a blanket prohibition on utility activities in this area obstructs the stated national goal of the accelerated use of conservation and renewable energy sources in cost-effective applications and limits innovation. DOE could sponsor and evaluate a variety of utility programs designed to promoted conservation and solar energy development in a competitive environment, while avoiding the concerns that led to these restrictive regulations/prohibitions.

In many cases, the requisite program analysis can be accomplished at the State level. All State regulatory commissions are required by law to consider the potential anticompetitive impacts of utility programs. Some States have supplemented this requirement with additional regulatory restrictions (see, for instance, California Public Utilities Code). States are in a better position to tailor utility initiatives to their own circumstances than DOE because they have more authority and clearly have responsibility for decisions with ratepayer impacts. DOE should further scrutinize utility programs only where the States have failed to fulfill this responsibility.

A few utilities that had active or planned programs to promote the use of conservation and renewable resources by customers have recorded striking success. The Tennessee Valley Authority (TVA) has launched an aggressive program to place wood stoves and solar water heaters in its service region. The TVA program of home energy audits and interest-free financing on loans for insulation has generated a strong consumer response. Both of these programs, and other TVA efforts, save money for all customers through lowering demand for electrical generation and delaying or eliminating the need for new thermal generating plants. Pacific Power and Light, in Portland, Oreg., has saved both capital and operating costs through an active program of home energy audits and utility-financed retrofits.

The existence of these programs indicates two things. First of all, it will be very much in the economic interest of many utilities and their customers to encourage and finance conservation and renewable energy devices. Secondly, many utilities have not acted to establish such programs, and may not do so even if current legal restrictions are removed. Thus, the Department can play an important role in helping utilities understand the potential of these technologies.

Another major incentive provided by utilities for deployment of solar energy and cogeneration is the potential for utility purchase of excess power. A key to such buyback is the development of technologies that can be successfully connected to the existing utility grid. Technical compatibility issues can best be addressed by direct contact between utility engineers and local entrepreneurs.

Price issues are partially resolved by the recently issued regulations implementing the Public Utilities Regulatory Policy Act. These regulations establish mechanisms to guide States in determining the rates at which utilities will purchase power from local generators and the rates at which the utility will sell standby power. States have 1 year to implement their own methods. Continuing Federal oversight in this process, along with information sharing, can help launch this new effort constructively.

Issue 17

International Markets

The requested level of funding for the solar international program is inconsistent with the potential importance of the international solar market and the needs of developing countries for solar and conservation options.

Summary

Solar exports, especially of relatively high-technology products such as solar cells, wind generators, electrical controls, and heat engines, could greatly benefit both U.S. industry and developing countries where conventional energy costs are high. Commercialization in the United States for some products such as photovoltaics, which evidently are susceptible to large cost reductions with mass production, could be accelerated by this expanded market.

A large international market also exists for relatively low-technology products such as low-temperature collectors for water heating and agricultural applications. Stimulating indigenous production capacity may be more beneficial for developing countries and could reduce pressure on the world oil and financial markets. DOE activity in the international solar area appears to be increasing, as there is now an Office of International Programs reporting directly to the Assistant Secretary for C&SE as well as a specific line item budget. However, the projects being managed by this new Office do not result from a coherent U.S. export policy and are not responsive to the urgent needs of developing countries.

Questions

1. Is an international plan being developed? What should be the objectives of such a plan? What balance is appropriate between an emphasis on maximizing opportunities for U.S. exports and providing technical assistance for the creation of an indigenous solar industry in developing countries with a limited capacity to finance imports?
2. To what extent should simpler, low-temperature technologies be targeted for export along with more high-technology options?
3. Should conservation technologies be integrated into the solar international program?
4. To what extent should the solar international program be restructured on the basis of foreign policy considerations such as the balance of payments and the economic stability of poor countries? To what extent are such factors being considered in planning the DOE program?
5. Did DOE take the DPR on **innovation into account** in developing its international program?

Background

No systematic surveys have been undertaken to estimate the total size of the solar export market, but many observers are convinced that a potential market of many hundreds of millions of dollars in annual sales could be developed in the 1980's. Developing these markets would be highly beneficial to the domestic solar equipment market, **since the additional overseas demand would result in larger production runs and accelerated research.** This would reduce domestic prices and accelerate improvements made **in devices** sold in the domestic market, yielding the United States a long-term advantage, even if many developing countries began to manufacture their own systems with U.S. technical assistance.

Developing nations may have both the greatest need and the best conditions for many solar technologies. As OTA's study of the *Application of Solar Technology to Today's Energy Needs* emphasizes, poor nations are likely to be most vulnerable to energy shortages and steep increases in energy prices. They typically have not yet invested in an extensive network of transmission and distribution facilities, so that onsite solar technologies could provide power to dispersed sites without the expense and delay associated with building such facilities. Onsite solar equipment can be installed in small increments, as needed, reducing the lengthy periods of construction required for conventional energy facilities.

Some applications of solar energy may well become economically attractive in developing nations before they do so in the United States. The cost of competing energy–when it is available at al 1— is often high. Labor costs — which represent a substantial fraction of the total costs of some solar installations — are usually quite low. And most developing countries are located in areas where sunlight is more plentiful than in North America.

Solar energy may also prove especially attractive to many developing countries on broader grounds of social utility. The relatively high labor intensity of some solar technologies can help alleviate the endemic high unemployment and underemployment that plague most developing countries. Solar facilities can often be constructed using materials that are locally available. And using solar energy does not commit developing countries to forms of energy production that they may not be able to sustain because of fuel shortages or the lack of secure funds for fuel costs and other operating expenses.

The attractiveness of solar technologies for many developing countries, the expense of transporting bulky solar equipment, and the limited capacity of many poor countries to finance extensive imports suggest that many developing countries will find solar energy an ideal import substitution industry. The U.S. international program should find an appropriate balance between maximizing opportunities for exports and providing technical assistance for the creation of an indigenous solar industry in developing countries. Since conservation measures can often be combined effectively with solar technologies (see Issues 12 and 33), it may be cost effective to integrate conservation technologies into the international solar program.

A new Office of International Programs is described in the solar energy goldbook, though it has not yet been officially organized. The initial projects for the Office, apparently inherited from other programs, are not large enough to have significant impact either abroad or on the domestic solar industry. The total budget request is only $15 million ($11 million in solar technology, $4 million in solar applications). Of the $11 million, $9.2 million is allocated to projects in Saudi Arabia and Italy. The largest is a 350-kW (peak) photovoltaic system in Saudi Arabia, to begin operation in **1981.**

These projects represent neither a coherent U.S. export policy nor a coherent policy for providing technical assistance to developing countries. It might be hoped that future agreements will involve some of the more constrained developing countries; that a more appropriate balance be found between export-oriented programs and technical assistance programs; and that conservation technologies be integrated into solar- technical assistance programs.

Fruitful relations with other countries will depend on careful planning and implementation of agreements, and coordination with other Government agencies. An overall plan for what the Office is trying to accomplish and how it will go about it would be extremely useful, both in directing activities and avoiding the many pitfalls that exist in dealing with other countries.

Issue 18

Energy Use in Federal Buildings

DOE should consolidate existing programs to equip Federal buildings with energy conservation and solar energy systems, and move more aggressively to implement these programs.

Summary

Federal buildings offer an important opportunity to test integrated conservation and solar technologies, reduce fossil energy use, assist market penetration and cost-reduction of products through large-scale procurement, and prove the commitment of the Federal Government to reducing fossil energy use. Currently there are three separate congressionally authorized programs in this area. DOE should couple the consolidation of these programs with aggressive implementation, and solicit more active interagency participation to meet the legislative goals for Federal buildings.

Questions

1. How much did the Federal Government spend on building energy use last year?
2. What progress has been made toward reducing the total energy use in Federal buildings?
3. What methods have been established to ensure uniform building audits? How much is known regarding energy use by various building type and climate zones?
4. Why has the Department failed to move vigorously to cut fossil energy use? What are the staffing plans to coordinate this effort this year?
5. How will the Department ensure that solutions are optimized for each building, that the results are shared within the Government, and explained to the public?
6. How does the Federal Government ensure that components and appliances purchased for buildings are energy efficient?
7. How will the present "solar" and "conservation" Federal Buildings Program be coordinated? Why are they not directed by the same off ice?

Background

The Federal Government has an obvious opportunity to display publicly its commitment to renewable technologies, conservation, and more efficient fossil fuel use through energy-conscious management of its own buildings. In addition to demonstrating its credibility, Federal properties serve as a useful instrument for testing some new technologies and demonstrating new but proven technologies (see Issue 10). The large, coordinated procurements represented by the Federal market offer the prospect for creating a market-induced, cost-lowering mechanism for such devices as solar collectors and high-efficiency furnaces.

The Federal Government accounts for about 2.6 percent of total U.S. direct energy use, through its 490,000 buildings and related operations. While promises about reducing this consumption are strong, there is little evidence that change is occurring. Congress has given DOE goals for the conservation-based efforts that include reducing energy in existing Federal buildings by 20 percent in **1985,** and by **45** percent in new buildings (below the **1975-76** levels). These goals are easily achievable technically and would clearly be cost effective, yet little progress has been made toward achieving them. Congress has also asked DOE to submit a 1 O-year plan for energy conservation in al l Federal buildings.

Separately, the Solar Federal Buildings Program is aimed at demonstrating Federal leadership through the use of solar heating and cooling in new buildings. With limited resources, centralized program integration is essential. In addition, one of the principal lessons of research and experience with building energy use over the past few years is that solutions must be carefully tailored to each building, with consideration given to existing energy use and cost, building function, site orientation, and so on. The arbitrary determination that "solar" or "conservation" is the choice for a building retrofit reinforces the undesirable distinction that already exists between these two complementary options. The Assistant Secretary should act to develop methods to integrate these programs, including consultation with appropriate congressional staff.

At present no coherent data base exists regarding energy use in Federal buildings. No program effort can be carefully crafted until such a base is created. Many buildings will immediately emerge as candidates for simple retrofits which will quickly lower energy use. Information gained from examining the patterns of energy use will indicate what types of effort should go to training building managers, to major retrofits, and to minor retrofits.

Strategies developed for an integrated Federal buildings approach might include widespread demonstration of low-cost, no-cost techniques that could also be used in homes, including explanations of the devices; testing of advanced energy systems in a few carefully selected sites; timely implementation of strong energy standards for Federal structures; and Government-wide monitoring of energy use by building type. Discount rates used in determining investment for Federal buildings should be scrutinized to determine if they correctly assess market impacts and marginal costs.

While DOE must be the catalyst for Federal action, all agencies must be held responsible for their own properties, and a supportive position by OMB is critical to the success of a Government-wide effort.

DOE has not acted aggressively in the past in implementing the Federal Energy Management Program, in spite of clear instruction from Congress. [1] Vigorous leadership by DOE, as coordinator of Federal energy conservation and solar energy programs for all Federal agencies and facilities, is necessary to demonstrate to the public that integration of solar and conservation techniques produces the most energy-efficient results.

[1] See House Government Operations Committee report, *Energy Conservation Within the Federal Government,* The Department of Energy's *Role,* November 1979.

Issue 19

Organizational Conflicts— SERI, RSECs, ROs

Confusion and competition between the several "arms" of C&SE add to the difficulty of meeting goals.

Summary

There is considerable uncertainty and conflict regarding the appropriate roles to be played, in both research and commercialization, by the non-Washington components of C&SE –the Solar Energy Research Institute (SERI), the DOE Regional Offices (ROs), the Regional Solar Energy Centers (RSECs), and the national laboratories. Lack of clearly defined roles for these units, and lack of a clear understanding of their relationship to each other and to DOE headquarters, add a needless obstacle to effective program operation and constrain limited resources.

Questions

1. What is the exact responsibility of each of the agencies identified above regarding research and commercialization of solar technologies and energy conservation? What is their relationship to each other?
2. **Is** the organizational decision that places a separate administrator (Deputy Assistant Secretary for Field Operations and International Programs) over these agencies likely to improve coordination and reduce competition?
3. **Is** the organizational decision to place a separate Deputy Assistant Secretary over these agencies likely to further separate these agencies from headquarters program direction?

4. Is there a long-term strategy to combine these agencies?
5. How do these agencies ensure that they assist the State energy offices rather than complicate their work?

Background

Solar and conservation activities require much more local outreach, education, and grassroots activity than most Federal programs. It is also clear that solar and conservation choices must be responsive to local climate and other variable characteristics, and that many types of research and many avenues to implementation will be needed. In response to this conclusion and in response to the seemingly universal desire of States and localities to locate Federal facilities in their areas, specialized agencies have come into being.

Since the agencies have often been limited (or understand themselves to be limited) to either "conservation" or "solar," their existence has contributed to the competition between these two divisions (see Issue 12). Since the agencies wish to conduct their own projects, repetition of effort could occur, Perhaps most critically, opportunities for cooperation and complementarily are lost.

The 10 DOE ROs seem to operate primarily as administrative vehicles for transmitting various forms and applications from States to headquarters. Consequently, most staff effort goes into such activity. The staffs typically are not well informed on the programs run from Washington, thus making it difficult for them to deal effectively with States and citizen groups, No meaningful technical expertise has been made available through the ROs. Those headquarters programs that have attempted to decentralize management, such as the Small Grants Program, have found that staff assigned to their program in the RO report to the RO Director, and their time can be redirected to whatever tasks or programs are highest current priority for the Regional Director. This further reduces the incentive for programs to be decentralized, as Washington management cannot ensure the availability of staff assigned to their program. If there is no demonstrated need for the ROs, perhaps they should be eliminated or replaced by an office that only dispenses information produced by DOE.

SERI and RSECs reflect a strong response to the Department's solar constituency, as well as an attempt to distribute Federal funding for solar across the country. While SE R I is beginning to consider its mandate to include the promotion of solar and related conservation technologies, RSECs have tended to concentrate entirely on solar. RSECs have difficulty providing comparable levels of service to all States, due to their geographic location, and the role of SERI has clearly changed from the initial concept of the principal solar research arm of the Department to a much broader entity, with an expenditure level expected to reach $122 million in fiscal year 1980 and over 700 employees. The level of funding for the four RSECs was $13.5 million in fiscal year 1979, and should be about $21.7 million in fiscal year 1980. Authorized personnel level for RSECs is 235.

The Energy Extension Service, now underway in al I States following a pilot program in 10 States, is primarily concerned with conservation techniques, although the legislative mandate specifies both conservation and renewables. The Energy Extension Service programs can be expected to vary widely and be responsive to specific State needs.

As program budgets grow and strategies become more clearly defined toward the goals of the DPR, it will be increasingly important to find complementary roles for these groups. A thorough review and analysis of the actual activities conducted by each at this time, including staffing patterns and the outreach activities, plus a rigorous evaluation of effectiveness, would be helpful as a first step.

Chapter IV

PROGRAM REVIEW

Chapter IV
PROGRAM REVIEW

The program efforts of the Department of Energy (DOE) are the vehicles for translating legislation and administration goals into real world actions. This chapter contains issues, comments, and questions pertaining specifically to program operation and decisionmaking. It is not an exhaustive list, but includes areas of immediate importance and areas that should be considered for continuing review. The issues are grouped by technologies (solar electric, biomass) and by end-use function (transportation, buildings, and industrial conservation).

Solar Electric Applications

The major solar technologies being developed specifically to produce electricity are wind, photovoltaics, solar thermal power, and ocean thermal energy conversion (OTEC). Some hybrid systems also produce mechanical or thermal energy or both. The contribution to the maximum practical scenario for the year **2000** of the Domestic Policy Review (DPR) from these technologies is 3.2 Quads.

Both wind and photovoltaics systems are currently being sold for commercial applications on a limited basis. These two technologies account for **2.7** of the 3.2-Quad contribution for **2000.** The other two solar electric technologies, solar thermal and ocean, account for the remaining 0.5 Quad.

Direct funding for the solar electric applications program has increased from **$189.7** million in fiscal year 1978 to **$371.7** million in fiscal year 1980 (table 4). The DOE estimate of $376.5 million for fiscal year **1981** indicates decreasing support for the solar electric technologies in real dollars.

Photovoltaics and solar thermal have received the majority of the funding for fiscal years 1978-80, totaling $315.9 million and $283.9 million respectively. For the same time period, wind has received $158.4 million and ocean systems $110.4 million.

Table 4.—Budget of the Solar Electric Applications Program, Fiscal Years 1979-81 (in millions of dollars)

	FY 1979	**FY** 1980	**FY** 1981 **estimate**
Photovoltaics	**$103.8**	**$147.3**	$140.0
Wind	59.6	63.4	80.0
Solar thermal.	98.3	121,0	117.5
Oceans systems . . .	41.1	40.0	39.0
Total	$302.8	$371.7	$376.5

SOURCE *Program Summary Document,* Solar Energy, FY 1981, Department of Energy, January 1980, p 1-4

A major portion of the above funding is for large projects. The most expensive project is the 10-MW solar thermal powerplant at Barstow, Cal if., whose total estimated cost (as of July **1979)** was **$108** million ($10,800/kW). The next two most expensive projects were the OTEC-1 test facility at a cost of $33 million and the MOD-2 wind turbine project at a cost of $27.3 million.

To date, the only program-specific legislation Congress has passed concerns photovoltaic energy systems. First, the Federal Photovoltaics Utilization Program (F PUP), contained in Title V of the National Energy Conservation Policy Act (NE CPA – Public Law 95-619), established a 3-year $98 million authorization for the purchase of photovoltaics at Federal facilities.

Second, Congress passed the Solar Photovoltaics Energy Research, Development, and Demonstration Act of 1978 (SPERDD– Public Law 95-590) which had among its goals the total cumulative production of approximately 4 million peak kW of photovoltaics and the reduction of the average cost of installed solar photovoltaic energy systems to $1,000 per peak kW by 1988. The Act required DOE to form an outside advisory panel to advise the Secretary of DOE and to formulate a plan for demonstrating applications and facilitating the use of photovoltaics in other nations.

Issue 20

Wind Energy Strategy

Wind technology appears close to commercial readiness but the DOE programs don't reflect this near-term payoff.

Summary

The DOE Wind Program documents indicate that: 1) wind energy is currently competitive in specialized markets, and 2) wind energy systems currently being developed for use in 1983 should be cost competitive for wide-scale use. Increased production will probably foster more cost reductions than will improved designs, particularly for small wind machines. However, operational plans to achieve the 1985 (and later) commercialization goals are currently lacking.

Questions

1. How will DOE implement the commercialization plans?
2. Would DOE geographically distributed cooperative funding (or other cost-sharing type approaches) speed deployment on a large scale, after the current design development programs are completed? If so, is such funding contemplated?
3. What steps are being taken to ensure the deployment of wind energy conversion systems by those Federal agencies that could successfully deploy them?
4. Why has funding for implementation and market development been zeroed out for 1981 ?

Background

DOE has estimated that if wind energy conversion systems reach a cost range of 4.6 to 5.7 cents/kWh (in 1980 dollars), markets adequate to justify mass production will emerge. Moreover, an energy cost goal of 2.3 to 3.4 cents/kWh (in 1980 dollars) has been established for both small (up to 100 kW) and large (1 to 3 MW) machines. Wide-scale deployment of wind energy conversion systems will be possible if these goals are met.

DOE expects the development of both small- and large-scale wind energy conversion systems by 1983 will meet these latter goals. Further, DOE estimates that wind energy conversion systems costs are already sufficiently low to support early production quantities. The DOE estimates can be justified by recent utility interest in two high-wind areas. In California, U.S. Wind Power is negotiating the sale of twenty 50-kW machines; in Hawaii, Windfarms Ltd. has contracted to supply 80 MW of wind energy to Hawaiian Electric.

On the basis of the DOE research developments, DOE estimates that wind energy has a potential market penetration of **0.17** Quad (fossil-fuel equivalents) in **1985 (0.51** Quad in 1990, 3.04 Quads in 2000). Approximately 600 large machines and .50,000 small machines would be required to meet the 1985 goal.

Achievement of the cost goals does not ensure the attainment of the energy goals. There are barriers between the development of wind turbine designs and their acceptance for widespread application. Demonstration of machine reliability and at least several years of field experience in power production and operation and maintenance will be required to instill customer confidence. Additional uncertainties include the availability of information on wind data, systems, economics, and market identification. Operating experience will be necessary to resolve these questions.

Insufficient funding may result in these areas being inadequately addressed. DOE must determine as soon as possible, the Federal responsibility for overcoming these barriers.

Issue 21

Large v. Small Wind Systems

The steps required to achieve commercialization of large and small wind machines are different and DOE programs must recognize and accommodate these differences.

Summary

Both large and small wind machines are expected to make a substantial contribution to the Nation's energy supply in 2000. DOE has formulated commercialization plans for both small and large wind energy conversion systems. These plans indicate that the commercialization requirements and the timing may be substantially different for small and large machines. However, the organization and funding of the Wind Energy Program do not indicate that the requirements of both small and large wind machines will be adequately addressed.

Questions

1. Has DOE adequately addressed the needs of both large and small wind machines?
2. Is the large-scale wind program structured to ensure the development of a competitive industry?
3. Is C&SE involved in the development of simple guidelines and methods for State Public Utility Commissions to use in developing fair and reasonable buy back/backup rates pursuant to the Public Utilities Regulatory Policies Act (PURPA)?
4. Should DOE fund additional utility interface experiments with large numbers of small-scale machines on a single grid?

Background

Both large- and small-scale wind machines must contribute to meeting the Quad goals for wind suggested by the DPR (1.7 Quads of fossil-fuel equivalent in 2000) and of higher goals suggested in various DOE commercialization plans (3.04 Quads in **2000).** While large machines are likely to contribute the major share in **2000, small machines are estimated to have** the **larger impact** in the midterm **(1990).**

DOE funding for wind energy machines has concentrated on product development. This emphasis was necessary for large machines and has resulted in the development of the MOD-1 and a substantial improvement, the MOD-2. However, for small machines, nonhardware problems currently are more important and failure to adequately consider these problems may result in failing to meet the midterm goals.

PURPA required the Federal Energy Regulatory Commission (FERC) to establish guidelines for backup/buyback rates for small power producers. FERC has established guidelines which indicate that backup rates charged small power producers must be nondiscriminatory and that buyback rates must be essentially margin priced. Within a year State Public Utility Commissions must issue rates structures for buyback and backup rates. The outcome from these commission hearings could have a significant, favorable effect on the economics of wind energy. DOE has the authority to intervene in State Public Utility Commission hearings and can use this authority to ensure that the electrical output from wind machines (and other decentralized solar technologies) is sold at the true marginal cost and that wind machines owners are provided nondiscriminatory rates for electricity backup.

Other nonhardware areas that need more attention for small-scale machines are utility interface problems, user awareness and acceptance, market analysis, and the development of a competitive industrial wind systems manufacturing capability and supporting infrastructure. DOE should determine its role in these issues and the extent to which lack of available funding has hampered the ability of DOE to deal with them.

Issue 22

Photovoltaic Program Strategy

The DOE photovoltaic program may not be adequate to meet the administration goal of 1 Quad in 2000.

Summary

The administration has announced its intention of achieving the potential for solar indicated in the DPR. This intention implies the achievement of the maximum practical estimate of 1 Quad listed in the DPR. Congress has expressed its support for photovoltaics through SPERDD, FPUP, and other legislation. In SPERDD Congress required DOE to **formulate a goal-oriented plan, to establish an out**side advisory panel, and to formulate an international photovoltaics plan. None of these were completed within 1 year after the passage of the Act. Moreover, Congress authorized $98 million for Federal purchases of photovoltaics in fiscal years 1979-81 through FPUP. DOE has been reluctant to request funding for this program and less than two-thirds of the monies authorized for the years 1979-81 may be spent.

Questions

1. Why has DOE been so slow in complying with its responsibilities as required by SPERDD? Will the recently formed advisory panel play an important role in setting photovoltaic priorities?
2. Why has DOE been reluctant to request authorization under FPUP? What can be done to ensure that the Federal agencies to which DOE has transferred FPUP dollars obligate those dollars in a timely and judicious manner?
3. DOE is currently sponsoring research into at least four materials (polycrystalline silicon, cadmium sulfide, gallium arsenide, amorphous silicon) for advanced photovoltaic cells. How does DOE decide the level of funding for each of these materials?
4. How will other Federal agencies (e.g., the Federal Buildings Program, the Department of Defense construction budget, the Agricultural Extension Service) be encouraged to utilize photovoltaic technologies where appropriate?
5. Congress set a goal of photovoltaics energy systems costing $1 per peak watt (in 1978 dollars) in SPERDD. The solar array is anticipated to account for half of the cost while the balance of system components is anticipated to account for the other half. While DOE has a detailed plan to attempt to reduce the cost of the solar array, a comprehensive development plan to reduce the cost of the balance of system components is currently lacking. Why has DOE been slow in formulating a plan to reduce the balance of system costs for photovoltaic energy systems?

Background

Congressional support for photovoltaics has been strong, yet DOE programs have not carried out this congressional interest. In 1978 Congress passed SPERDD to establish an aggressive research, development, and demonstration (RD&D) program for photovoltaics. Research on solar cells had progressed significantly since their early use in space missions. It was thought that an aggressive program could speed the commercialization process from the normal 30 or so years to perhaps only a decade. Congress set as the goals of the Act:

1. to double the production of solar photovoltaic energy systems each year during the decade starting with fiscal year 1979, measured by the peak generating capacity of the systems produced, so as to reach a total annual U.S. production of solar photovoltaic energy systems of approximately 2 million peak kW, and a total cumulative production of such systems of approximately 4 million peak kW by fiscal year 1988;
2. to reduce the average cost of installed solar photovoltaic energy systems to $1 per peak watt by fiscal year 1988; and

3. to stimulate the purchase by private buyers of at least 90 percent of all solar photovoltaic energy systems produced in the United States during fiscal year 1988.

In section 4 of this Act, the DOE Secretary was given the authority to achieve these goals. Section 9 required DOE to form an outside advisory panel to advise the Secretary of DOE regarding RD&D, and utilization of photovoltaics, Moreover, Congress recognized the importance of the international market in establishing a competitive photovoltaics industry. (In many overseas areas photovoltaics may be cost competitive even though they are not competitive domestically.) I n section 11, of the Act, DOE was required to consult with other Government agencies and to formulate a plan for demonstrating applications and facilitating the use of photovoltaics in other nations. None of these were completed within 1 year after the passage of the Act.

Congress has also attempted to support the development of the photovoltaics industry through Federal purchases. NE CPA (part of the National Energy Act) contains FPUP, which authorized $98 million for Federal purchases during fiscal years 1979-81. DOE has been reluctant to request money for this program. In **1980,** DOE **initially requested no funds, Congress eventually appropriated $10 million. Less than two-thirds of the amount authorized may be spent under this program.**

Issue 23

Polysilicon Shortage

A shortage of polysilicon material may develop unless DOE supports new production facilities that would use either unproven or outmoded technologies.

Summary

SPERDD suggested as a goal the cumulative production of approximately 4 million peak kW of photovoltaics by fiscal year 1988. Studies (for example, DOE/JPL-1012-33) have indicated that these goals may be unobtainable due to a shortage of polysilicon material manufacturing capacity using current production processes. DOE-sponsored research promises to develop significantly less expensive production processes in the next few years, thus inhibiting investments i n new facilities using current technology. According to the present DOE schedule, which may be somewhat optimistic, commercial quantities from the new processes are not expected before 1986.

Questions

1. Should the Government take action to stimulate production with present processes? If so, what type of action should be considered ?
2. Is there any reasonable way to speed implementation of the new lower cost process u rider development?
3. Has DOE estimated the long-term (year 2000) effects of the impending shortfall ?

Background

One of the photovoltaic program's objectives is the development of a national capability to manufacture photovoltaic arrays by 1986 at a price of less than $0.70 per peak watt in 1980 dollars. Since the price of silicon material is a large proportion of the cost of s i l icon arrays, DOE has been sponsoring considerable research into processes that would lower the cost of silicon material. DOE has as its cost objective the development of processes for producing silicon for applications at a market price of less than $14/kg in 1986 (in 1980 dollars). Several processes have been suggested that may lead to the achievement of approximately these cost goals The achievement would be a substantial reduction in the price of obtaining silicon from today's conventional process (Siemens process), which is approximately $87/kg

This anticipated abrupt price decline has deterred manufacturers from expanding capacity using the existing expensive process that may be outmoded in the next few years. Consequently, expansion of polysilicon manufacturing capacity may be limited in the next few years until these new **processes are justified. This failure to expand manufacturing capacity may make the goals implied by SPERDD and the DPR unobtainable.**

Issue 24

Solar Thermal Power Strategy

The solar thermal demonstration strategy must be carefully planned and justified.

Summary

The technologies and applications of solar thermal systems are unusually diverse. DOE has evidently shifted from an emphasis on large-scale, central receiver power systems to a broader approach including smaller scale and distributed receiver systems. it is not yet clear which technology or scale will be most advantageous. Detailed evaluation of the initial markets and planning of the most efficient demonstration programs to prove the feasibility of these applications will be required to avoid unnecessarily large expenditures. Some elements of this planning are evident in the DOE documents, but alternative strategies should be considered. For instance, unexpectedly high costs for components of the 10-MWe Barstow central receiver demonstration plant have evidently forced a reduction in the performance of the plant. If analysis shows that central receivers can still be viable competitors, DOE should investigate the possibility of moving immediately to assisting utility repowering demonstrations.

Questions

1. When will cost comparisons of central and distributed receiver systems be available? Which is likely to have a larger near-term market ?
2. Has DOE adequately analyzed the market for small- and large-scale solar thermal systems? If small central receiver systems prove successful, will private industry invest in large ones without further demonstrations by DOE?
3. How much has the expected performance of Barstow been reduced from a year ago? How will this affect its value as a demonstration? How will this experience affect ultimate cost projections?

Background

Solar thermal power technology concentrates the Sun's heat to heat water or some other fluid to produce electricity or provide steam for industrial and agricultural processes. These systems can be utilized in either centralized or dispersed applications and can be sized to suit specific needs.

Central receiver solar thermal powerplants have been a major focus of the solar thermal program. Although the plants can be as small as 1 MWe, DOE has estimated the optimal size for certain bulk electrical production application in the 100- to 300-MWe range. DOE has initiated the construction of a 10-MWe demonstration plant at Barstow, Cal if., to demonstrate the feasibility of central receiver solar thermal plants. Barstow is the largest and most expensive solar thermal project, so it has been subjected to many audits and assessments, which have caused delays and cost increases. Nevertheless, costs for construction and operation of the plant still need careful monitoring, particularly in the present phase of construction.

Larger pilot plants will cost considerably more, These demonstrations are particularly vulnerable to cost overruns because of the limited size of the manufacturing runs and conservatism on the part of the designers, who may have inadequate data to assure optimal performance (part of the reason for the demonstrations). if such overruns do develop, DOE can:

- seek additional funds to build the plant as designed;

- eliminate the demonstration and concentrate on distributed systems that may not require large-scale demonstrations, delaying the implementation of centralized systems;
- delay other projects and transfer their funds to the centralized demonstration plant; or
- reduce the size or performance of the demonstration, thus reducing its value to the program leading to large centralized facilities.

DOE-sponsored studies indicate that there is a near-term market to repower (convert) existing gas- and oil-fired utility plants in the Southwest. Repowering is the addition of solar power collectors to an existing powerplant, not to increase total power but to decrease the *use* of fossil fuels. DOE should consider the feasibility of reducing or eliminating funding of demonstration plants if major cost overruns occur and substituting them with a larger amount of repowering projects. In these projects, cost sharing with utilities is available, and utilities will have strong incentives to help control costs.

Distributed receivers collect the Sun's energy at each concentrator rather than at a central power tower. Since each unit (parabolic troughs, bowls, and dishes) is virtually identical to the others, scaleup is simple and large demonstrations might be unnecessary. Direct cost comparisons are not yet conclusive. However, a specific experiment to compare directly the costs and advantages of central v. distributed receiver systems is under construction by the International Energy Agency at Almeria, Spain (U.S. support comprises approximately 20 percent of the project). Both a central and a distributed receiver system are being built at the same site. Results from this facility should be used to test the validity of the DOE emphasis on central receiver systems.

An important and potentially large application for solar thermal power will be cogeneration applications (using steam for both electrical generation and heat generation) and applications in industrial processes heat markets. Detailed analysis by DOE of the amount of each type of solar thermal power (distributed or central) that may best suit these markets is currently lacking. Distributed systems may be best for many industrial process heat and cogeneration applications and may offer more near-term applications. DOE should also accelerate the removal of barriers that tend to discourage cogeneration (see Issue 37).

Issue 25

OTEC Strategy

A comprehensive plan for the development and implementation of OTEC has not been prepared. Without such a plan, the total program cost–which will be high–cannot be accurately estimated.

Summary

The DOE program documents indicate that a crucial point in the OTEC Program occurs in fiscal year 1982 with the decision to proceed on the construction of the first 10- to 40-MW pilot plant. Congress is considering legislation to expedite this schedule. An affirmative decision will necessitate a substantial increase in the level of OTEC funding. The Congressional Budget Office (CBO) estimates that a single plant of this size will cost $300 million. The full development program may require several such plants and several larger demonstration plants. If this decision does not consider the total costs and technological uncertainties based on a comprehensive development plan, then DOE will risk entering an undefined program where potential costs may be far above those now envisioned. Further, criteria measuring interim success or failure must be established so that the program can be revised up or down in accordance with explicitly determined estimates of the risks and benefits of proceeding at any given pace, The Federal involvement and investment must be balanced against the potential benefits to ensure that

Federal funds are effectively spent. DOE has evidently not performed such a detailed analysis.

Questions

1. Why has DOE failed to estimate the total cost and involvement required to bring OTEC to commercialization? What legal, environmental, insurability, and other noncost questions must be resolved?
2. What is the DOE pilot-plant strategy? How many pilot plants and their sizes will be required in the DOE commercialization plan? What is the purpose of each plant? What goals will be accomplished by the first OTEC pilot plant and what goals will remain?
3. When will DOE complete a detailed resource assessment of the potential for OTEC?
4. Has DOE analyzed the potential for other forms of solar energy (wind, photovoltaics, solar thermal, biomass, and geothermal) in the potential markets for OTEC?

Background

OTEC is a concept for using the temperature difference that exists between warm water at the surface of oceans and cold waters in the deep oceans to release stored energy to power a turbine. This concept could provide an important source of energy for the generation of electricity or power for manufacturing energy-intensive products such as ammonia and aluminum. The main Federal research goal in OTEC is the construction of a new type of baseload powerplant. Thus, unlike the other solar technologies of solar thermal, wind, and photovoltaics, OTEC could continuously produce electric power without the necessity of storage.

No scientific breakthroughs are needed to build an OTEC plant but the technology is not in routine use. The technical problems are by no means minor, and the satisfactory solutions to the critical engineering problems will require long-term laboratory and at-sea testing, (OTA completed an assessment of these technical problems in May 1978, and updated that review in April 1980).

The DOE program documents, including the Multiyear Plan, are incomplete as to the total Federal cost and involvement that will be required to bring OTEC to commercialization. CBO estimated that a commercialization plan suggested by congressional legislation **(S-1830** and HR-5796) would cost $1 billion by 1986 alone. DOE program documents indicate that a 1-MW test facility (OTEC-1) will be deployed in 1980, and that a crucial decision to begin construction of a 10- to 40-MW pilot plant will be made in fiscal year **1982.** However, the program documents do not indicate the number of additional pilot or demonstration plants (and their sizes) that will be needed before Federal involvement is ended.

A comprehensive development plan for OTEC is necessary in order to estimate the total Federal cost and involvement. This development plan should have a well-defined pilot-plant strategy delineating the goals that will be accomplished for each pilot plant. Criteria to determine the interim success or failure of the program must also be established.

The Federal investment in OTEC must be balanced against its relative value. Currently, even under its present level of funding of $40 mill ion per year, OTEC has the lowest ratio of energy payoff compared to the present budget level as shown in Issue 2. An accelerated program could, if successful, produce much more than 0.1 Quad in 2000, but a commitment to such a program now would entail much higher (but as yet undetermined) expenditures with uncertain prospects for producing a viable economic power source.

The worldwide potential for OTEC is clearly very great if the technology proves economic, Application to the U.S. market is not so clear since most of the U.S. coast has only moderate temperature differentials. DOE has identified islands (especially Hawaii and Puerto Rico) as being the initial candidates since their present energy costs are high and they are near attractive OTEC sites. This is a reasonable first approximation, but by the time OTEC is commercially available, other options may be more attractive. For instance, Hawaii has large geothermal and wind resources. Even coal will be a competitor for several decades since ocean shipment is quite inexpensive. The United States already ships large quantities of coal to Japan and South America. OTEC may in fact prove to be the least costly of these options, but DOE has not completed either an adequate resource assessment or a detailed market survey to determine where OTEC is likely to be the preferred alternative, and any cost projections are highly speculative until larger plants are actually built and tested.

Alternative strategies to building subsequent pilot plants should be considered, Proposed OTEC designs use standard heat-engine cycles which are typical of those used in all powerplants when the heat from burning fuel is converted into electrical power. OTEC is designed to create useful power from the temperature difference between the surface and depths of the ocean; this difference is not much greater than that discarded as unusable in some conventional power plants. Heat exchangers, which are designed for that purpose, could be tested in a less expensive manner in the bottoming cycle at nuclear powerplants.

Other countries have expressed interest in OTEC and in cooperative agreements (among these countries is Japan). There is a uniquely attractive site at Abidjan, in the Ivory Coast, in which the French are already actively interested. Exploitation of this opportunity could provide invaluable construction and operating experience at minimal risk. These cooperative agreements should be explored to lower the Federal costs of RD&D for OTEC systems. The possible delay in implementing cooperative agreements should be balanced against the reduction in Federal investment.

Biomass

Biomass currently provides approximately 1 **5 Quads (2** percent) of U.S. energy requirements each year. The goal of the DOE Biomass Energy Systems (13 ES) Program is to provide an additional 0.5 to 1.5 Quads/yr before 1985, through the direct combustion and conversion of biomass to gaseous and alcohol fuels; an additional 6 Quads/yr before 2000, through improved biochemical and thermochemical conversion technologies; and a total of 8 to 10 Quads/yr after 2000. The goals are more ambitious than those of the DPR discussed in Issue 1.

The BES Program s the largest and most visible biomass program **in the Federal Government, and has the responsibility for integrating and coordinating national efforts The major emphasis of the program has** been on the direct combustion and gasification of wood, and the production of ethanol from crops, crop residues, and wood, To a lesser extent, DOE efforts are directed toward onfarm anaerobic processes from a variety of feedstocks.

The program is structured according to the kinds of R&D activities needed at different stages of technology development. For near-term technologies (expected to enter the marketplace by 1985), activities focus *on* achieving process improvements and demonstrating commercial-scale applications. Mid-term technologies (1 985-2000) are supported by laboratory-scale investigations, studies of process economics, and development of engineering models. Longer term technologies are supported primarily by applied research. The actual elements of BES are: 1) technology support (commercialization expected before 1985); 2) production systems (after 1985); 3) conversion technology (after 1985); 4) research and exploratory development; 5) administrative support and other. Table 5 shows the BES Program budget for fiscal years **1979-81.** In fiscal year 1978, the total program budget (then called Fuels From Biomass) was $20.2 million.

The Solar Energy Research, Development, and Demonstration Act of 1974 (Public Law

Table 5.—Biomass Energy Systems Program Budget, Fiscal Years 1979-81
(in thousands of dollars)

Biomass energy systems	FY 1979 appropriation	FY 1980 appropriation	FY 1981 base	FY 1981 request
Technology support:				
Operating expenses.	$16,406	$16,000	$16,000	$19,500
Construction.	0	0	0	2,500
Subtotal.	16,406	16,000	16,000	22,000
Product ion systems:				
Operating expenses.	5,085	5,700	5,700	11,600
Conversion technology:				
Operating expenses.	14,695	22,500	22,500	9,500
Construction.	0	2,000	2,000	2,000
Subtotal.	14,695	24,500	24,500	11,500
Research and exploratory development:				
Operating expenses.	4,713	7,800	7,800	13,650
Capital equipment	500	500	500	750
Subtotal.	5,213	8,300	8,300	14,400
Support and other:				
Operating expenses.	1,001	1,500	1,500	3,500
Total:				
Operating expenses.	41,900	53,500	53,500	57,750
Capital equipment	500	500	500	750
Construction.	0	2,000	2,000	4,500
Total biomass.	$42,400	$56,000	$56,000	$63,000

SOURCE *Congressional Budget Request, FY 1981,* vol 2, Department of Energy, January 1980, p 48

93-473) is the principal law which authorized broad-based research programs for all solar energy, including "products of photosynthetic processes." The law also directed that RD&D be initiated on "the conversion of cellulose and other organic materials (including wastes) to useful energy or fuels. " Furthermore, this Act directed DOE to carry out research on incentives to commercialize these solar technologies.

The 96th Congress is considering several bills to accelerate biomass production through increased research and financial incentives for biomass energy facilities. In particular, S.932 contains several features aimed at fostering synthetic fuels production from wood and agriculture. The enactment of S.932 would likely affect subsequent DOE program development.

Issue 26

DOE Support for Biomass Energy Systems

Despite the recognized potential of biomass as an energy source, DOE support for biomass programs has lagged well behind that for other solar technologies.

Summary

Although the DPR recognized biomass as the single most important solar technology in terms of its potential future energy contribution, DOE funding and staffing levels are still well below those for solar thermal, wind, photovoltaics, and active heating and cooling programs. The biomass program's growth is due in large part to repeated congressional budget increases. Furthermore, DOE's biomass programs have consistently been understaffed. It appears that sufficient personnel slots have been budgeted and mandated by Congress, but some have yet to be filled. This has hampered the program's effectiveness. The lack of coordination between DOE and the U.S. Department of Agriculture (USDA) has also hindered bioenergy development although there is reason to believe this is improving. The passage of S.932 into law would require substantial reevaluation of the relative roles of the two agencies.

Questions

1. Has DOE analyzed funding and staffing levels needed for the various biomass projects in order to achieve its goals?
2. The DPR "maximum practical" estimate of about 5.4 Quads by 2000 is about the same as OTA's projected level assuming only a continuation of present subsidies and moderate energy price increases. Will DOE accept the more ambitious BES goals?
3. What have been the benefits of the transfer of funds to USDA for biomass R&D?

Background

DOE has been designated the lead agency in bioenergy development and has responsibility for integrating and coordinating national efforts. Until recently, DOE considered biomass a low-priority item. This was reversed in the latest DOE solar energy PSD, perhaps as a result of the DPR's recognition of biomass as the single most important solar technology. Even so, DOE funding is still below that for other solar technologies ($56 mill ion in fiscal year 1980), and most of the biomass funding increases were mandated by Congress.

BES has also experienced severe understaffing, which has affected the day-to-day operation of the program. Within the last year, two to three full-time professionals managed the $56 million budget at DOE headquarters. Program management also changed several times in the last few years. These shortcomings have contributed to program operating deficiencies such as the lack of an adequate program plan, lack of coordination with other Federal agencies, and the lack of commercialization activities. The absence of a clearly defined plan has resulted in numerous changes in priorities, often to the detriment of the program. Many biomass projects require long-term R&D commitments. The intervention or premature termination of a project or project element(s) will often void the entire effort.

Despite recent interagency agreements between USDA and DOE, very little has been done to coordinate and develop joint RD&D programs or parallel/complementary bioenergy commercialization plans. However, there are indications that DOE/USDA coordination may improve in the future. For example, recent interagency agreements define a more explicit role for both agencies, and USDA is expected to receive a significant portion of the DOE biomass budget via pass-through funding for the purpose-of administering some biomass development projects. Such cooperative efforts will probably require careful monitoring.

Within DOE, more than 10 distinct programs support bioconversion activities with apparently no significant coordination. For example, seven different offices in DOE have been involved in alcohol fuels development. Each office has in the past conducted its activities largely independent of the others, though the new Office of Alcohol Fuels has now been designated as the responsible agency.

Finally, little attention has been given to commercialization. No strategy has been developed to convert program R&D results to practice. This has resulted in neglect of near-term technologies, such as the use of wood. The forthcoming OTA report, *Energy* from Biological Processes, shows that wood in the single largest potential source of biomass and that production of methanol from wood is nearly commercial. However, the DOE program almost totally ignores methanol production,

Within the last year, the BES Program has undergone reorganization in order to rectify some of its management problems. DOE's fiscal year 1981 budget request stated that reorientation of the BES Program would be complete in fiscal year **1981.** Although some changes have been made in budget and staff allocation, the adequacy of these measures s still to be demonstrated.

Issue 27

Scale and Emphasis of Biomass Fuel Production Facilities

DOE has inadequately emphasized smaller scale biomass systems and approaches that integrate the energy and nonenergy parts of these systems.

Summary

In the past, DOE has emphasized large-scale, long-term biomass systems and approaches dedicated solely to the production of fuel. This approach is flawed because it: 1) reduces the quantity of bioenergy that could otherwise be obtained from smaller scale and/or multi product systems; 2) ignores the potential benefits of integrating energy with nonenergy objectives; and 3) ignores the fact that dedicating large areas of land suitable for food crops to biomass energy will compete with food production. The development of multi product/multipurpose biomass systems, generating high-value food/feed/fiber, in addition to fuels, is very likely a more rational approach. Recently, DOE has proposed smaller scale conversion processes for onfarm production of methane and alcohol. However, it is not clear whether these actions represent a change in DOE biomass policy. Also, DOE apparently still is not addressing the need to integrate energy with nonenergy objectives for biomass.

Questions

1. Most of the projects supported by the BES Program emphasize large-scale, long-term single-purpose fuel production systems. Has this emphasis been changed? I f so, how?
2. What steps does DOE intend to take to integrate energy objectives with nonenergy objectives (e. g., increased forest management) i n the development of bioenergy systems?
3. What fraction of the budget will be allocated to onfarm and other small-scale applicat ions?
4. Will the long-term research and exploratory development component of the BES Program remain essentially focused on the ocean farm project? What are the alternatives?

Background

Biomass-derived fuels are, at present, mostly byproducts or waste products of agricultural, forestry, and related activities, Lumber and paper mill residues make up the largest fraction of currently used biomass fuels. Municipal solid wastes, animal residues, food-processing wastes, and spoiled or excess crops can and, in some cases, are beginning to be used as feedstocks for alcohol or methane production and steam generation. Fuelwood is also used extensively.

Over the past 5 years, DOE has almost exclusively supported the development of large-scale systems whose sole product is a fuel. Specific examples of this policy include: greater emphasis on large systems for algae biomass production rather than integrated algae biomass/waste treatment processes, emphasis on large-scale biomass energy farming, and neglect of onfarrn systems for animal waste conversion to methane or production of alcohol. The reasons for this policy can be attributed to DOE's view that: 1) it should not be involved in agricultural or forestry systems (traditionally a USDA area); 2) small-scale systems would result in severe diseconomies of scale in fuel conversion processes due to small feedstock flows; 3) large-scale systems would tie in with established energy distribution systems (e. g., pipelines); and 4) the problems of providing a reliable supply of biomass can best be solved with dedicated energy plantations. This policy is too narrow and neglects a major potential of bioenergy.

The OTA assessment of bioenergy, currently being completed, indicates that the largest potential source of bioenergy in the near to mid-term is residues from increased forest management. Because of the importance of the Nation's forests in providing nonenergy products and the potential for severe environmental damage to the forests if logging increases, it is important that the objective of wood energy be integrated with and complement the objectives of environmental protection of the forests and increased production of nonenergy forest products.

Similarly, most other major near- to mid-term sources of bioenergy cannot be isolated from other sectors of the economy. (Even large energy farms would require land that could probably be used for food production.) Consequently, it is important to integrate the energy and nonenergy objectives for each source of bioenergy in order to avoid inflationary competition for feedstocks and to exploit any nonenergy benefits that bioenergy production end use can provide.

Because the major near- to mid-term sources of biomass are dispersed, OTA's analysis indicates that a significant potential exists to utilize the biomass in smaller scale dispersed systems, such as small industrial applications. The high transportation costs for biomass means that economies of scale cannot be exploited to the same extent as with coal conversion facilities. Thus, maximum exploitation will require an emphasis on small- to medium-sized conversion facilities.

Issue 28

Biomass Liquid Fuels

DOE must carefully plan a strategy for integrating alcohol fuels into the petroleum system to optimize the use of the resources.

Summary

Because of its limited production potential and its physical and chemical properties, ethanol's best use may be as an octane-boosting additive to gasoline. Such use would also maximize its petroleum displacement potential. However, while gasoline/alcohol blending can contribute to reducing petroleum needs, it may also aggravate the shifting of gasoline supplies from urban to rural areas during al location periods.

Blending methanol with gasoline may cause more problems with the existing automobile fleet than would ethanol, Although new cars can be designed to accept methanol blends, problems such as evaporative emissions and acceptable effluent water disposal in the distribution systems and refinery are less easily resolved. Consequently, various end uses of methanol (such as blends with gasoline, a standalone fuel, or an intermediate in liquid hydrocarbon production) should be examined for potential refinery and distribution problems to ascertain the most effective and economical strategies for introducing methanol as a liquid fuel.

Questions

1. What are the best strategies for methanol refining, distribution, and end use?
2. Will DOE continue to neglect methanol production? Has DOE carried out any analysis of small-scale methanol plants (1 50 ton/d or less)?

3. Are potential environmental concerns with alcohol-gasoline blends (i. e., evaporative emissions and effluent water disposal) being adequately addressed?
4. Is C&SE cooperating with the Economic Regulatory Administration to prevent a distortion of supplies from urban to rural areas caused by unleaded gasoline assignments for gasohol blending?

Background

When the alcohol is manufactured using nonpetroleum process energy and used as an octane-boosting additive, ethanol use can make a contribution to reducing crude oil needs. Experience to date has shown that gasohol (lo-percent anhydrous ethanol in gasoline blends) can best be handled logistically by blending the gasohol at terminals and exercising care to keep service station tankage dry. With an expanded program, however, additional concerns may develop. These concerns, recently expressed by the Environmental Protection Agency (EPA), are: 1) the use of ethanol would Slightly increase vapor pressures and require exclusion of about 2 percent of the butanes in the gasoline to avoid increased evaporative emissions; and 2) phase separation is more likely, presenting a problem of acceptable disposal of the effluent water containing alcohol.

Some experts have expressed concern that gasohol blending may shift gasoline supplies away from urban toward rural areas during allocation periods, The currently proposed DOE assignment of unleaded gasoline by refiners to blenders/resellers and alcohol manufacturers could result in gasoline being diverted from historic base period customers, largely those in urban markets.

Methanol from biomass or coal can be produced in significantly larger quantities and at lower costs than ethanol. Although methanol's octane-boosting properties provide a potential energy savings at refineries if it is used in gasoline blends, methanol's physical and chemical properties pose problems not present, at least to the same degree, with ethanol. First, blending 10 percent methanol with gasoline would require removal of about 8 percent of the butanes and other light gasoline components to avoid excessive evaporative emissions. The removal of these components from the gasoline pool would largely negate the contribution of methanol to expanding gasoline supply, unless automobiles using the blends are engineered to accept a more volatile fuel without vapor lock or excessive evaporative emission. Second, methanol also is more susceptible to separation from gasoline in the presence of very small amounts of water; disposal of large quantities of a separated fuel would be a related problem. Cosolvents or drying of the gasoline before blending could conceivably reduce these problems. A blend containing 2.5 percent methanol and 2.5 percent t-butanol (another alcohol) is being test marketed by Sun Oil Co., and may answer some of the questions. Third, service station underground tanks may also be damaged by methanol blends and require replacement.

Although all of the problems with methanol blends are technically solvable in several different ways, it is unclear whether the use of methanol blends would be the most economical strategy for consumers or the optimal way to introduce methanol as a liquid fuel. Other possible high-value uses for methanol include: 1) as a fuel by itself in captive fleet automobiles (12 percent of the U.S. automobiles are in captive fleets, such as taxis, corporate fleets, etc.); 2) in gas turbines for peakload electric generation; 3) in diesel engines with a dual-fuel capability with later expansion to methanol-fueled vehicles that are not part of a captive fleet; and 4) further conversion of methanol to gasoline.

To provide early guidance for methanol policy decisions, an accelerated analysis should be undertaken to examine the relative attractiveness of alternative methanol strategies. This should include an examination of the entire liquid fuels systems from refineries through distribution to the various potential end uses; it should also quantify the costs and delineate and analyze the constraints associated with the various options for using methanol.

Transportation Programs

The Office of Transportation Programs (OTP) is an end-use division in the Office of the Assistant Secretary for C&SE, and has four major program areas: Vehicle Propulsion RD&D, Electric and Hybrid Vehicles RD&D, Transportation Systems Utilization, and Alternative Fuels. The goals of OTP are to reduce the transportation sector's energy consumption and its nearly complete dependence on petroleum by developing and commercializing alternative transportation and fuel technologies, as well as disseminating information and conducting educational programs to encourage energy efficiency. The programs within OTP are based on legislative mandates, budgetary considerations, industry estimates, technology expectations, and market assessments. Table 6 gives the OTP budget for fiscal years 1979-81.

The principal laws mandating R&D activities on electric vehicles (EVs) and automotive propulsion systems are the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1975 (Public Law **94-413)** and the Automotive Propulsion Research and Development Act of 1978 (Public Law 95-238). Public Law 94-413 authorized $60 million for programs which would evaluate and demonstrate some 7,500 EVs. I n addition, the law authorized a $60 million program for loan guarantees to aid small manufacturers, and directed DOE to contract for the production of a number of urban passenger and commercial EVs. Public Law 95-238 also provided for ongoing R&D on EVs and established an Electric and Hybrid Vehicle Development Fund for the purpose of carrying out loan guarantees and assistance programs. The Automotive Propulsion R&D Act of 1978 established within DOE an R&D program to ensure the development of advanced automobile propulsion systems. The law directs DOE to: 1) establish and conduct new projects and accelerate existing ones; 2) give proper attention to the development of advanced propulsion systems; and 3) ensure that the program supplements and does not duplicate or supplant industry programs.

Table 6.–Office of Transportation Programs Budget, Fiscal Years 1979.81
(in thousands of dollars)

Transportation	FY 1979 appropriation	FY 1980 appropriation	FY 1981 base	FY 1981 request
Vehicle propulsion RD&D:				
Operating expenses.	$46,300	$ 59,500	$ 59,500	$ 55,400
Capital equipment	1,500	1,000	1,000	500
Subtotal.	47,800	60,500	60,500	5,900
Electric and hybrid vehicle RD&D:				
Operating expenses.	37,500	41,000	41,000	42,100
Transportation systems utilization:				
Operating expenses.	6,100	6,700	6,700	6,700
Alternative fuels utilization:				
Operating expenses.	5,800	5,200	5,200	4,300
Capital equipment	0	100	100	1,000
Subtotal.	5,800	5,300	5,300	5,300
Total:				
Operating expenses.	95,700	112,400	112,400	108,500
Capital equipment	1,500	1,100	1,100	1,500
Program direction	1,949	2,923	3,000	3,000
Total transportation.	$99,149	$116,423	$116,500	$113,000

SOURCE *Congressional Budget Request FY 1981* vol 2 Department of Energy, January 1980, p 48

Issue 29

Advanced-Engines RD&D

Government support for advanced engines RD&D should be evaluated in light of the engines' potential contribution to energy conservation.

Summary

A major part of DOE's transportation energy conservation program is the development of advanced engines, specifically the gas turbine and Stirling engines. The advanced-engines RD&D project accounts for about half of the fiscal year 1981 budget request ($11 3 million). While it is possible that advanced engines could meet future exhaust emissions standards and achieve multifuel capability, there are serious technical obstacles to meeting fuel economy goals. DOE is making progress, but it is not certain that advanced engines will be able to attain fuel efficiencies sufficiently beyond those expected for internal combustion and diesel engines to justify a major shift by the automobile industry to turbines or Stirling engines. In view of the time and effort already given to these programs and the lack of major breakthroughs, Congress should perhaps direct DOE to reassess these programs and their prospects for meeting fuel economy and emissions goals within the established time and budget. Otherwise, the programs may continue on their own momentum without assurance that the goals are still attainable and relevant to national needs. Other approaches or other forms of technology may offer greater promise of attaining the same goals.

Questions

1. Could the automobile industry meet fuel economy and emissions goals without Government R&D assistance?
2. Will these engines, if perfected, offer significant advantages over stratified-charge or diesel engines? If not, would it be less costly for DOE to develop improved spark-ignition and diesel engines instead?
3. Will these engines have a role if the expected improvements in fuel consumption are not realized ?

Background

The Advanced Heat Engine Development Program was first established in EPA in **1971 and** its primary goal was the reduction of exhaust emissions. Later, a second goal of fuel economy was added and responsibility for the program was given to the Energy Research and Development Administration/DOE. The Automotive Propulsion R D&D Act of 1978 further emphasized the need for developing advanced automotive systems, to improve fuel economy and lower exhaust emissions, and directed DOE to support private industry efforts. However, DOE was not limited to support activities and was authorized to initiate projects not undertaken by industry. The Government undertook the alternative engines program in the belief that the automotive industry was unwilling to make a major commitment to developing. new engines and vehicle propulsion systems.

While much of the R&D in the automobile industry has concentrated on short-term improvements to spark-ignition and diesel engines, there has been some rather limited work on the gas turbine (Brayton cycle) engine. In the 1950's and 1960's – as an outgrowth of development of the gas turbine for aircraft — experimentation was conducted on the use of gas turbine engines for trucks and stationary applications. Several years ago, both General Motors and Ford were close to offering large turbines in trucks and buses, but the engine was not marketed. The present GM gas turbine development program is quite active. Within the last 6 months, DOE has signed two cost-sharing contracts with industry to develop and demonstrate a gas turbine engine. A $56.6 million contract was signed with A i Research Manufacturing Co. and Ford Motor Co,; the Federal share was $53 mill ion. A second contract was signed with Detroit Diesel Allison, a division of General Motors, for $65 million, with the Federal share amounting to $59.8 mill ion, Until recently, most experience with the Stirling engine has been in the research laboratory The only commercial application of the Stirling cycle has been in a cryogenic machine for producing liquid air, Some development was done for the potential application of the Stirling in heavy-duty trucks and some minor production for military hardware.

The major thrust of DOE's program is to develop gas turbine and Stirling engines because they offer the potential for meeting fuel economy and low exhaust emissions goals and have multifuel capability. The programs' objectives include increasing fuel economy 30 percent over the best 1984 gasoline internal combustion engine (ICE) vehicle of equal performance, meeting exhaust emissions, and producing engines with multifuel capability. No major propulsion system development is planned specifically for trucks and buses because many of the automotive technological advances achieved can be applied to trucks and buses.

Both engines have a high probability of meeting future emissions standards and achieving multifuel capability. However, it appears doubtful that fuel economy goals can be met within established time frames. The gas turbine's poor part-load efficiency is the major obstacle to achieving fuel economy, Greater fuel efficiency depends on reaching higher operating temperatures, which will require the use of special materials — ceramics. The substitution of ceramic materials for the expensive, high-alloyed metals presently used will also reduce costs. DOE has emphasized the testing and development of ceramic materials for critical components (turbines and nozzles). However, DOE considers the development of these materials to be technically risky, requiring long-term testing and evaluation. Without the development of these materials, the use of gas turbines would be improbable.

The Stirling engine has received considerable attention in Europe (Phillips in Holland and United Stirling in Sweden) since the 1800's. Only within the last few years have Stirling engines been demonstrated in passenger cars. The inherent advantages of the Stirling, which make it attractive as an alternative engine, are its high theoretical efficiency, low level of noise, low carbon monoxide and hydrocarbon emissions, and fuel versatility The major disadvantages of the engine include its high initial cost and high specific weight. In order to penetrate the automotive market, experts have concluded that engine cost and weight must be reduced and efficiency improved. Therefore, DOE R&D efforts have focused on improving fuel economy through the development of a higher temperature engine and reducing size and weight through lightweight con struction and system matching (engine/vehicle). According to DOE, reducing the weight of the Stirling so that it can be used in automobiles (4 lb/hp) will be difficult but improving fuel economy will be less of a problem.

Even if both engines meet their fuel efficiency goals, a question still remains concerning the extent of their commercial application, The automobile industry is continuing research on improving the fuel efficiency of spark-ignition and diesel engines, It is noteworthy that the DOE work on gas turbine and Stirling engines very likely plays an important role in motivating the industry research, In any event, it is not clear **that the difference in efficiency between gas turbine and Stirling engines and spark-ignition and diesel engines, assuming their respective R&D goals are met, will be sufficient to justify substantial industry conversion. The capital costs needed** to tool up for completely new engines will be very large, and the gas turbine and Stirling engines will have to be significantly superior to current engines for industry to make this investment. It the DOE program is to be justified because it motivates industrial research, analysis should be done to see how this compares to regulation in achieving the same end.

Issue 30

Electric Vehicles

Extensive commercialization of EVs is improbable unless improved batteries are made available.

Summary

The goal of the EV program is to promote and accelerate the commercialization of personal and commercial use of EVs. The major obstacle to extensive commercialization is the limited storage capacity of present-day batteries. Currently operating EVs use lead-acid batteries which are expensive and provide **very** limited performance. Improved lead-acid batteries may be forthcoming, but are still unlikely to be adequate to lead to a significant reduction in gasoline consumption. Most experts agree that EV commercialization would be greatly accelerated if batteries with improved service life and performance were developed. However, the current battery R&D budget amounts to less than 20 percent of the total EV budget of $42 million (fiscal year 1981 request).

Quest ions

1. Is the present demonstration program justifiable given the current state of battery development?
2. **Is** DOE's EV program duplicating the efforts private industry could be expected to make if adequate batteries were available to power a mass-marketable vehicle?
3. What energy/petroleum savings can be expected as a result of this program over the next several decades? At what cost?
4. What other benefits (and negative impacts) might be expected to accrue as a result of widespread EV use?
5. How much new utility capacity might be necessary to handle charging during peak-load hours, such as late afternoons when commuters arrive home and expect to plug in?

Background

The EV program budget accounts for a large percentage (37 percent) of the fiscal year 1981 transportation energy conservation budget request of $113 million. The program was enhanced by the passage of the Electric and Hybrid Vehicle RD&D Act of 1976 (Public Law 94-413) as amended by Public Law 95-238. These laws established requirements for EV demonstrations, provided financial incentives to industry, and emphasized the commercialization process. The goal of the EV program is to promote and accelerate the introduction of EVs into the national transportation fleet. The DOE program consists of four main elements: demonstration, incentives, product engineering, and R&D. The Product Engineering Branch and the National Battery Testing Lab are responsible for work in near-term battery development. DOE has concentrated on three battery types: lead-acid, nickel/iron, and nickel/zinc. In addition, research has recently been started on the zinc/chloride battery which, according to DOE, shows great promise.

A major obstacle to extensive commercialization of EVs is the high cost, weight, and relatively short service life of present batteries. The present range of EV's is approximately 50 miles between recharges, and battery life expectancy is 18 months to 3 years, depending on maintenance procedures. In addition, replacement costs for battery packs now range from $800 to $1,600. Nevertheless, improvements have been made in lead-acid batteries. Before the program started, lead-acid batteries typically stored 30 watthours per kilogram (Wh/kg). Recent tests show that improved lead-acid batteries will store more than 40 Wh/kg. Nickel/zinc batteries show a storage capacity of 60 Wh/kg. The near-term battery project's goal is to achieve 20- to 30-percent improvements in performance and life. The most promising batteries will then be used in vehicle testing. Federal support for battery R&D appears to be necessary and should be given proper emphasis.

Some experts feel that major automakers could readily build EVs if improved batteries were available, and that commercialization would not be a serious problem. Several companies in the private sector are currently designing and building EVs and industrial markets for specialized EVs already exist, such as industrial fork trucks, However, DOE has concluded that the demonstration of a small number of vehicles operated in "sheltered" environments would be a positive force toward commercialization and that optimization of non battery equipment is still necessary. DOE's demonstration project is oriented towards identifying, testing, and proving market sectors where EVs can be used. The demonstration project also provides necessary market support infrastructure.

EVs have the potential to become a preferred mode of transportation in urban areas for commuting and for small commercial and industrial shipments and limited personal transportation. EVs are less polluting and quieter than conventional vehicles in congested areas, and reduce the need for liquid petroleum. However, the EV's potential for petroleum savings will not be realized unless used in large numbers.

Buildings

Both the Office of Solar Applications for Buildings and the Office of Buildings and Community Systems have programs dealing with energy use in buildings. Solar Applications is responsible for active, passive, and hybrid solar systems for building heating and cooling as well as photovoltaics, which are discussed in Issues 22 and 23, Buildings and Community Systems is responsible for programs to improve the efficiency of energy use in buildings, building components, appliances, and community designs. These two offices are treated together here as a single DOE "buildings program" to highlight their complementary character and the need for a unified approach to innovation in the building sector.

The programs in Solar Applications include both system development and market development activities. Systems development focuses on the engineering phases of product development, while market development includes market testing and product support along with programs in information dissemination, training, education, building codes, standards, testing, and certification. Buildings and Community Systems contains major programs in community systems, consumer products, appliance efficiency standards, and building energy performance standards (BEPS). It is also responsible for the Residential Conservation Service (RCS) and the Federal Energy Management Program. The budgets for these programs from fiscal years 1979-81 are shown in table 7.

The solar energy DPR estimated that active heating and cooling systems could provide 2 Quads of energy while passive heating and cooling could provide 1 Quad by 2000. DOE has subsequently discussed short-term goals for 1985 of 0.2 Quad for active systems and 0.1 Quad for passive systems. Goals for energy conservation in buildings are less explicit. The DPR on solar energy contained an implied conservation goal of limiting demand to 95 Quads in 2000. What that level of demand might mean for the building sector is suggested by the report of the demand/conservation panel of the recently published Committee on Nuclear and Alternative Energy Systems (CONAES) energy study. In the panel's scenario involving 94 Quads of primary energy consumption in 2010, the building sector used 13 Quads — a reduction of 6 Quads from the 19 Quads used in buildings in 1978. The OTA report Residential/ Energy Conservation also supports the conclusion that dramatic reductions in building energy use are achievable.

Authorization for solar energy programs is scattered through legislation enacted from the 93d Congress (1973-74) to the present. The Solar Energy RD&D Act of 1974 established an Office of Solar Energy Research within the

Table 7.—Buildings and Community Systems and Solar Applications Program Budget Requests, Fiscal Years 1979-81 (in thousands of dollars)

	FY 1979 appropriation	FY 1980 appropriation	FY 1981 base	FY 1981 request
Buildings and community systems (CS):				
Building systems:				
Operating expenses	$17,600	$ 17,350	$ 17,350	$19,565
Capital equipment	900	750	750	500
Subtotal	18,500	18,100	18,100	20,065”
Appliance standards—operating expenses	*4,950*	*6,000*	*6,000*	*7,925*
Community systems:				
Operating expenses	*19,400*	*16,550*	*16,550*	*15,550*
Capital equipment	*300*	*250*	*250*	*250*
Subtotal	*19,700*	*16,800*	*16,800*	*15,800*
Urban waste:				
Operating expenses	*8,500*	*13,000*	*13,000*	*10,100*
Capital equipment	*0*	*0*	*0*	*800*
Subtotal	*8,500*	*13,000*	*13,000*	*10,900*
Technology and consumer products:				
Operating expenses	*20,350*	*29,600*[a]	*29,600*[a]	*22,040*
Capital equipment	*0*	*0*	*0*	*200*
Subtotal	*20,350*	*29,600*[a]	*29,600*[a]	*22,240*
Analysis and technology transfer—operating expenses	2,800	5,400	5,400	5,900
Residential conservation service:				
Operating expenses	0	4,600	4,600	5,000
Capital equipment	0	0	0	200
Subtotal	0	4,600	4,600	5,200
Federal energy management program—operating expenses	500	700	400[b]	2,700
Small business—operating expenses	*500*		700	750
Emergency building temperature restrictions program—operating expenses		3,675	3,675	
Program direction—operating expenses	3,533	5,137	5,284	6,120
Total				
Operating expenses	78,133	102,412	102,559	95,650
Capital equipment	1,200	1,000	1,000	1,950
Total buildings and community systems	$79,333	$103,412	$103,559	$97,600
Solar applications:				
Systems development(CS):				
Operating expenses	$ 40,000	$ 52,000	$ 52,000	$ 54,500
Capital equipment	1,000	1.000	1,000	1.500
Subtotal	41,000	53,000	53,000	56,000
Market test and commercial applications				
Buildings:				
Operating expenses	(55,00)	(35,750)	(35,750)	(17,000)
Capital equipment		(1,000)	(1,000)	(1,000)
Subtotal	(55,000)	(367%0)	(36,750)	(18,000)
Agricultural and industrial process heat—operating expenses	(11,000)	(14,000	(14,000)	(20,800)
Photovoltaic—operating expenses	(15,000)	(10,000)	(10,000)	(35,200)
Total market test and commercial applications				
Operating expenses	81,000	59,750	59,750	73,000
Capital equipment	0	1,000	1,000	1,000
Subtotal	81,000	60,750	60,750	74,000
Market development and training (CS)—operating expenses	2,800	20,500	20,500	39,500
Solar international applications (CS)—operating expenses				4,000
Program direction (CS)—operating expenses	2,230	2,341	2,664	2,786
Total				
Operating expenses	126,030	134,591	134,914	173,786
Capital equipment	1,000	2,000	2,000	2,500
Total solar applications	$127,030	$136,591[c]	$136914	$176,286

NOTE Programs printed in italics are not specifically discussed in this document
[a] Includes $9 million for 40 kW fuel cell demonstration
[b] A supplemental request for $2.3 million has been approved by OMB and will be forthcoming
[c] Funding does not include $156.000 for cost of increased personnel contained in FY 1980 Supplemental Request

SOURCE *Congressional Budget Request FY 1981* VOI 2 Department of Energy January 1980 pp 24and27

Federal Government, and the Solar Heating and Cooling Demonstration Act of 1974 provided for commercial demonstrations of heating and cooling systems. The National Energy Act of 1978 contained an Energy Tax Act which provided purchaser tax credits for home installation of solar devices and an investment tax credit for businesses that install solar systems. The National Energy Act also contained NECPA, which authorized a program to install solar heating and cooling equipment on Federal buildings and a program of loans for solar devices operated through the Federal National Mortgage Association. The Energy Supply Act would create a Solar Bank to provide low-interest loans to purchasers of solar systems and also to provide for coordination of solar information dissemination programs. Other laws provide incentives to small businesses and farmers, encourage international programs, and mandate the use of solar equipment in military construction.

In the area of building conservation, the Non-Nuclear Research and Development Act of 1974 mandated RD&D to promote efficient energy use in residential and commercial buildings. The Energy Policy and Conservation Act of 1975 (EPCA) established programs in appliance efficiency standards and BEPS. NECPA created RCS and the Federal Energy Management Program.

Not all activities within the Office of Buildings and Community Systems are specifically examined in this analysis.

Issue 31

Retrofitting Buildings

DOE's conservation and solar buildings programs should cooperate closely to define and promote a strategy for retrofitting existing buildings with the most cost-effective combinations of conservation measures and solar energy systems.

Summary

DOE conservation and solar research programs focused on new buildings are important, but they have greatly overshadowed retrofit opportunities that could have an even larger impact on near-term energy availability. The oil and gas that could be saved by an aggressive retrofit program during the next 10 years is equivalent to discovering two Alaskan oilfields. The prospect of low economic growth and a tight capital market makes it essential to determine how conservation measures, passive additions, active solar systems, storage, and backup systems can be combined most economically for different kinds of buildings and climates, Developing a "least cost retrofit strategy" can be an opportunity for achieving a better integration of DOE's conservation and solar buildings programs.

Questions

1. Does DOE have a long-term strategy for retrofitting existing buildings? I f not, why not?
2. What is the balance of funding in the buildings research program between new buildings and retrofits? Between single-family and multifamily residences? Between residential and commercial buildings?
3. Have retrofit programs adopted a strategy for combining conservation measures and solar energy systems? Is consideration being given to the development of standards for existing buildings?
4. How much effort does the passive program allot to retrofit technologies and retrofit commercialization ?
5 What institutional and behavioral barriers are the major roadblocks to an aggressive retrofit program, and what Federal policies have been developed to remove these barriers? Is sufficient attention being given to behavioral research related to retrofit barriers?
6 How will the Department integrate what it learns in the weatherization and RCS programs, the active and passive solar buildings programs, and other related programs, to meet President Carter's goal of retrofitting 90 percent of the Nation's housing stock by 1 995?

Background

Over the decade of the 1980's, improving the energy efficiency of buildings can reduce U.S. dependence on depletable fuels more rapidly and at less cost than virtually any other energy policy action. OTA analyses indicate that cost-effective investments in conservation technologies could actually **decrease residen**tial energy use in 2000 (compared to 1977) with no loss of comfort and despite a substantial amount of new construction. Saving energy in buildings is a rare situation where the fastest and least expensive investments are also preferable because of the opportunities they present for individuals to protect themselves against rising fuel prices and for the Nation as a whole to improve environmental quality and generate new employment.

The current DOE buildings programs in both conservation and solar energy emphasize R&D related to new buildings. This reflects the large proportion of resources allocated to implementing BEPS, developing and testing new passive designs, and lowering costs on promising new conservation and solar technologies. While programs focused on new buildings are important and should be maintained, OTA research indicates that even more oil and gas can be saved over the decade ahead by programs to retrofit existing buildings. It will take over 50 years to replace most of the existing building stock, and most of these buildings are very inefficient because they were built during a period of cheap energy when there was little incentive for conservation (1 940-73). Substantial funding is earmarked for the schools and hospitals and weatherization programs, which directly affect existing buildings.

Table 8 indicates the potential impact of implementing an aggressive program for retrofitting U.S. residences and setting strict standards for new construction. It demonstrates that approximately two-thirds of the potential savings result from retrofits, with the remaining third resulting from improvements in new construction practices.

[1] *Residential Energy Conservation* (Washington, D.C.: Office of Technology Assessment, July 1979), OTA-E-92.

Table 8.— Potential Energy Savings by 1990 From Housing Retrofits and Strict Building Standards (millions of bbl/d oil equivalent)

	Oil and gas	Other	Total
Retrofit savings	1.9	0.4	2.3
Strict building standards. . .	0.7	0.9	1.6
Total savings	2.6	1.3	3.9

Assumptions
— Baseline case continues present construction practices to 1990 and includes no further retrofits
—Retrofit savings are based on 50°. heating savings and 20°. hot water savings in all existing housing still used in 1990
—Strict building standards Incorporate BEPS and 35% hot water savings in new buildings

SOURCE Testimony of Dr Henry C Kelly, OTA, before the Subcommittee on Energy Conservation and Supply of the Senate Committee on Energy and Natural Resources, July 31 1979

The potential retrofit savings of oil and gas by **1990** is equivalent to 1.9 million bbl/d of oil. That is over three times as much energy as the U.S. imported from Iran before their revolution and approximately half the total amount of recent imports from the Middle East. Moreover, the estimates in the table reflect only the potential savings available in residential buildings. Since commercial buildings use approximately 60 percent as much energy as is consumed in the residential sector, and since these buildings are often even less efficient than residential buildings, equally dramatic savings are possible through retrofitting buildings used for commercial and public services.

Still more oil and gas can be saved by incorporating solar **energy** systems in retrofit programs. To do this in the most cost-effective way will require research to determine the performance and economics of various combinations of conservation measures, solar energy systems, storage, and backup technologies for different types of buildings and climates. Information is needed on how much of a role passive solar additions can play in building retrofits, and how passive and active systems can best be combined. Above all, better information is needed to clarify what combinations of conservation measures and solar energy systems can be more cost effective than the conservation measures alone. Preliminary evidence indicates that "tight" conservation retrofits can reduce the collector area needed to meet building heating loads enough to improve the economics of solar heating. In addition, neighborhood-scale district heating systems using coal or solar energy may prove economically attractive as part of retrofit programs in dense urban and suburban areas.

The fact that many cost-effective retrofit products are not being used at present suggests that a successful retrofit strategy must address institutional and behavioral issues as well as technical issues. For example, financing is usually a more difficult problem for retrofits than for new construction. Some situations, such as retrofitting inner city multifamily rental dwellings, will require new Federal policies to remove barriers and provide incentives. Aggressive information and outreach programs are needed to influence the investment decisions of homeowners, landlords, commercial building operators, bankers, installers, and other groups.

Developing a least cost retrofit strategy addressing both technical and institutional issues will require closer cooperation between the buildings programs in conservation and solar. These programs already cooperate both formally and informally in several areas. The effort to define and promote the most cost-effective combinations of conservation measures and solar systems can provide an opportunity for these programs to reduce institutional divisions still further and to move toward an integrated DOE "buildings program. "

Issue 32

Residential Conservation Service

DOE should conduct marketing research to identify the barriers to widespread public acceptance of energy audits and home weatherization measures as part of the planning for RCS. Its program design should take into account regional conditions such as local energy resources, previous consumer education, and local utility practices.

Summary

The RCS Program of DOE is based on the assumption that providing people with information about the cost effectiveness of weatherizing their homes will cause them to make such investments. Conflicting evidence exists about the validity of this assumption, and suggests that consumer response will vary in different areas according to regional energy conditions, utility programs, or prior State efforts to encourage energy conservation.

Quest ions

1. On what basis has DOE determined that the 35-percent response rate to the RCS Program is likely?
2. What research has DOE conducted to identify the barriers preventing people from investing in home energy efficiency?
3. Does DOE have plans to stimulate home weatherization should consumer response to RCS fall below expected levels?
4. Is a 5-year period long enough to allow residents to take maximum advantage of the program? To allow utilities to maximize return?

Background

The goal of the RCS Program is to offer energy audits to 95 percent of U.S. households by 1985, and to bring about a reduction in energy use in at least 35 percent of those homes through voluntary actions by homeowners. The program is based on the assumption that lack of information has prevented people from making energy-efficient improvements in their homes.

Despite the clear grounds for concern, no funds have been budgeted to identify **empirically** the barriers that may exist to the widespread enthusiastic public acceptance of this expensive, large-scale, high visibility, voluntary program. The $5,2 million currently budgeted for fiscal year 1981 is specifically meant for the operation of the program, e.g., review of State plans, development of model audit procedures, liaison and assistance to States, qualification of additional conservation measures, etc.

Lack of information may not be the only (or even a major) barrier to conservation. Evidence suggests that response to the RCS Program will vary in different regions, and will reflect energy costs, audit costs, public information campaigns, community action efforts, and the methods used by the utility to encourage participation. An analysis of consumer actions and attitudes, conducted in various regions and localities, would identify the real barriers facing RCS, For example, while ignorance about energy conservation might be the barrier in some areas, other considerations such as regional climate, availability of equipment, community concern, or previous utility experience with audits might prove to be more important than information in motivating people. In the State of California, utilities have already received a large volume of requests for audits, yet in other States, demand for audits has been small. Modification of the State programs to reflect these variations would contribute to the success of RCS.

In addition to conducting market research as part of its program design activities, DOE could build in an ongoing evaluation of RCS to assure that the solutions it offers continue to be appropriate, As energy costs continue to rise, RCS may well require modification to reflect changing economic conditions.

Issue 33

Passive Heating and Cooling

The passive heating and cooling program should emphasize designs and products that integrate passive, active, and conservation concepts. Greater efforts are needed on design tools, performance analysis, product development and testing, and basic R&D.

Summary

The passive program should cooperate closely with the active solar program and building conservation programs to identify and promote least cost solar building designs. **In general, the most cost-effective designs appear to be substantially "tighter" than typical construction practices today, leading to changes** in solar design philosophy. An expanded passive program will require increased staff and funding.

While the amount of R&D needed for a technology as "simple" as passive heating and cooling may seem surprising, optimizing the performance of passive systems actually requires a far more scientific approach to building design than has yet been attempted. Better data is needed on passive system performance, especially in multizone applications. Product development and test activities need to be expanded to include components for commercial as well as residential buildings. Basic R&D is needed on energy utilization in buildings, climate characteristics, and other environmental and physical phenomena that influence the performance of passive systems. Additional R&D is needed on passive cooling to determine its potential, which is not well understood.

Questions

1. Has the passive cooling program adopted a least cost strategy for combining passive solar features with conservation measures and active solar systems in new building designs?
2. Are detailed performance data being gathered from passive solar buildings of widely varied design, including designs with extensive conservation measures?
3. How much funding for product development and testing is being devoted to products for commercial buildings?
4. IS sufficient effort being devoted to basic R&D on energy utilization in buildings, climate characteristics, and environmental and physical phenomena affecting passive system performance?
5. How adequate are existing passive solar design tools?

6. To **what extent can passive cooling combined with dehumidification substitute for more expensive cooling** systems in residential applications?

Background

Passive systems represent a promising method for dramatically lowering energy demand. In the design of new buildings, as **in retrofits (see Issue 31), the passive heating and cooling program** should cooperate closely with the active solar program and building conservation programs to develop a more coherent "whole systems" approach. The goal should be to identify and promote designs that contain the most cost-effective combinations of passive solar features, conservation measures, and active solar systems for different types of buildings and climates

Table 9 shows the annual heating requirements of several types of recently built houses. The Balcomb house has a heating load of one-twenty-fourth the size of the typical U.S. house built in 1978 (some part of this difference can be accounted for by differences in climate and building size). Its heating load is so small that it can be met entirely by passive heating with a backup system The "tightest" house in the table, the well-known "Conservation House" in the cold climate of Regina, Saskatchewan, has such a low heating load that it can be met with modest passive features (mainly south-facing windows), a little more collector area than would otherwise be needed for solar water heating alone (9..5 percent of the floor area), and reasonably sized water storage (2.8 percent of house volume). The increased cost of its extensive conservation measures is largely offset by the reduction in required collector area and the elimination of a conventional furnace and heat distribution system.

Table 9.—Annual Heating Requirements of Selected Existing Houses (oil heat at $0.80/gal)

Typical U S. construction practice in 1978 scaled to correspond to a 1,400-ft² house in a 4,762 degree-day climate	$360
Bowman house near Gaithersburg, Md., 2,050-ft² house retrofitted by the National Bureau of Standards for $2,650	$200
Hart houses, Alexandria, Va., average for five speculative homes built in 1978 for an Incremental cost of $1,000 to **$2,000**	**$120**
Robinson house, Minneapolis, Minn., well-insulated house Incorporating passive solar heating .	$ **90**
Saskatchewan (Canada) Conservation House—super-Insulated house with modest passive solar system and small active system.	$ 20
Balcomb house, Santa Fe. N. Mex., heavily Insulated house with extensive passive solar features	$ 15

SOURCE Of fice of Technology Assessment

These particular buildings may prove to be extreme examples, but they illustrate the major changes in solar design philosophy that can occur as the Nation moves toward buildings with higher thermal integrity. Evaluating new designs like these, and many other possible combinations of conservation measures and solar systems, would almost surely lead to major changes in the DOE buildings programs as the most economical approaches are identified and refined.

The amount of scientific knowledge needed to optimize "simple" passive and hybrid designs is quite extensive. The effort is justified because the knowledge gained is likely to lead in time to a "scientific revolution" in the building industry. Moreover, design mistakes on passive buildings are big mistakes, difficult and expensive to correct. Research is needed to prevent such mistakes that could make builders and the public skeptical of the feasibility of passive solar design.

Better data on passive system performance are needed to guide further R&D efforts. Test cell and field-measured performance data are needed on a wide variety of systems, including clusters of relatively similar designs, because little is known about the sensitivity of performance to minor design changes and variations in environmental conditions Special attention should be given to identifying integrated passive heating and cooling designs that appear more effective for multizone commercial applications. Better quantification of passive system performance would also be valuable for the BEPS Program.

Product development and testing efforts are inadequate relative to the variety of geographical areas and building types for which new materials and components are needed. Glazings, absorber surfaces, storage systems, movable insulation, reflectors, shading devices, heat exchangers, sensors, actuators and controls, and other components all require further development and testing. Little product development has been done for commercial buildings, yet this area presents greater challenges than the residential area.

Passive designers need better data on climate characteristics, including information on local microclimates, day lighting, and cloud cover. More extensive basic physical studies are needed in solar insolation, landscaping, ground properties, atmospheric effects, night sky radiation properties, and heat exchange mechanisms. Data collected in these basic physical studies need to be integrated with system performance data to create better passive and hybrid solar design tools such as guidelines, handbooks, computer programs, and thermal models.

Additional R&D and information dissemination are needed on passive cooling. Some analysts believe passive cooling techniques, combined with dehumidification in humid climates, may eventually prove more cost-effective than active cooling or even conventional air-conditioning in many residential applications, but little is known about such systems today.

These areas of effort will require additional staff as well as a larger budget. The passive program has suffered substantially from the burdens of funding increases with no change in the size of the program staff.

Issue 34

Active Solar Hot Water and Space Heating

Nonhardware activities such as market development and the formulation of better "off-budget" policies should be emphasized in the active solar program, and R&D should be focused on long-term, high-risk, or generic problems.

Summary

The use of active hot water and space heating systems can now be accelerated more by market development activities, incentives, and other "off-budget" Federal policies than by Federal RD&D efforts. In recognition of this fact, the Off ice of Solar Applications for Buildings has been phasing out demonstrations and adopting a more comprehensive approach, supporting the development of the emerging solar industry in all phases of product development. This shift, which includes increased support for information and education programs, merits support. R&D funding should be maintained and focused on projects that are long-term, high-risk but high in potential rewards, or that involve generic problems and nonpatentable processes that industry is not likely to explore. Reducing the cost of active solar systems should be a prime goal in both systems development and market development activities.

Questions

1. How do the potential benefits of nonhardware actions for accelerating the use of active hot water and space heating systems compare with those of technology improvements?
2. Does DOE have the analytical capacity and level of staffing needed to design better "off-budget" policies to accelerate commercialization of solar systems?
3. Are programs for standards, testing, certification, professional and installer training, information dissemination, and education adequate to forestall constraints in the future?
4. Is Federal R&D on solar hot water and space heating systems duplicating efforts underway in the private sector or pushing into areas where the private sector would otherwise have a strong interest?
5. Is R&D being focused on long-term, high-risk, and generic problem areas such as materials research?

6. What cost reduction may occur from these R&D and market development activities?

Background

As a result of technical success over the past several years, the effort to accelerate the use of active solar hot water and space heating systems has shifted from R&D to field testing and market development activities, and is now supported by purchaser tax credits. This shift has been resisted to some extent, especially by the Office of Management and Budget, largely because present benefit/cost methods tend to discount benefits of nonhardware actions (e. g., solar information and education programs), which are difficult to quantify. This shift toward supporting all phases of product development appears fully appropriate, given the well-developed state of active hot water and space heating products. There is actually a risk that overemphasis on R&D directed at near-term results could tend to retard rather than accelerate investments in the private sector because of loss of market incentives such as proprietary know-how and patent protection.

A **great deal remains to be done to fully support the commercialization of these solar technologies beyond the** R&D stage. Many of the most effective measures involve "off-budget" Federal policies which have often been neglected in the past (see Issue 6). These include larger tax credits, loan programs, incentives, utility rate reform to prevent discrimination against solar homeowners, legislation and policy changes to equalize access to financing and equalize tax treatment, and initiatives to foster the development of institutional innovations like solar municipal utilities, solar co-operatives, or utility programs to finance and certify the installation of solar systems. An expanded capacity for economic and policy analysis is essential for developing better "off-budget" policies.

Many "on-budget" market development activities also merit increased support. For example, the lack of public confidence in solar systems is a major barrier. While too specific a set of performance standards could stifle cost-cutting innovations in the solar industry, it is important to increase support for the development of improved standards and testing and certification procedures. At present, the bewildering variety of State warranty and information laws makes it difficult for solar manufacturers to meet widely varying requirements.

Another major barrier is the widespread lack of adequate technical, economic, and market information. Few building professionals understand solar technology (active or passive) or appreciate its potential. Few heating, ventilating, and air-conditioning contractors or other potential installers are adequately trained. Expanded training programs could do a great deal to remove this barrier. Better information dissemination is also needed to consumers, industry, builders, bankers, State and local government officials, utilities, real estate appraisers, insurance agents, land use planners and other groups. Consideration should be given to expanded funding of the National Solar Heating and Cooling **Information** Service to allow it to market solar information more aggressively and to begin supplying conservation information. The demand for solar curriculum materials now greatly exceeds the supply at all levels of public education, and at the present level of funding only a small number of teachers and school administrators are able to participate in DOE-sponsored workshops and programs.

R&D on active hot water and space heating systems should be maintained and focused more specifically on areas that industry is not likely to explore. The understandable tendency to choose low-risk, high rate-of-return projects that can be preplanned for major milestones should be resisted; it tends to push R&D funding into areas where the private sector already has considerable self-interest, reduces market incentives for industry investment, and may lead to neglecting important new ideas and fundamental scientific advances. Thus it seems advisable to give priority to those R&D **areas in which risks are too great, the time** for commercialization too long, or the potential returns too low for private industry to countenance.

Key R&D **areas in** need of support include materials development, systems integration, selective surfaces, and thermal storage techniques. Materials R&D is especially critical because of the high and increasing cost of conventional materials, such as copper and glass, and the possibility of constraints on resource availability in the future. Research is needed on materials substitutes such as inexpensive plastics that can withstand high temperatures, ultraviolet light, inclement weather, and corrosive agents for periods of 25 years or longer.

Cost reduction should be a prime goal in R&D **as well as in market development activities.** As **recently** as 3 years ago, R&D on active solar heating did not treat the expense of proposed designs as a prime consideration. Perhaps the aerospace background of many researchers and policy makers entering the field of solar energy was a contributing factor to the emphasis on expensive, high-performance systems designed to maximize the energy extracted per square foot of collector surface. Now, however, there is a general understanding that a system must be cost effective to be good, no matter how excellent its technical performance. R&D should be directed at developing systems that are both technically efficient and cost effective, and at systems that are extremely low cost (even at some loss of efficiency). An immediate priority in this regard is the development of low-cost site-built systems applicable to new and existing homes of traditional design.

Issue 35

Solar District Heating

The potential importance of neighborhood-scale solar district heating systems in dense urban and suburban areas is not recognized in the C&SE budget.

Summary

DOE has done virtually no RD&D on neighborhood-scale solar district heating systems (10 to 1,000 dwelling units). Yet district systems may be the only feasible way to meet a large proportion of the heating load with solar energy in some high-density residential areas. These systems also appear likely to be economically attractive compared to individual building hot water and space heating systems in dense urban and suburban areas (more than eight people per acre) due to economies of scale in storage and collector operation. **In**creased RD&D funding also appears justified for the related, advanced concept of using solar ponds for community energy systems that provide both district heat and electricity.

Quest ions

1. Why has the Department done virtually no RD&D on solar district heating?
2. How much can the costs and land requirements of solar district heating be reduced by increasing the energy efficiency of the building stock?
3. Given a comparable degree of building tightness, how do the costs of solar district heating compare with the costs of solar units on individual buildings at different density levels?
4. What are the major technical problems involved in retrofitting neighborhoods with distribution mains under the streets and retrofitting houses with hot water pipes, heat exchangers, and ducts?
5. What institutional arrangements and financing mechanisms are necessary for building and operating district heating systems? Could local solar cooperatives play a major role?
6. Does DOE agree with SERI's finding that **solar** ponds are technically and economically feasible and capable of providing 1 Quad of energy annual l y by 2000?

Background

Solar district heating systems offer several potential advantages over individual building hot water and space heating systems in dense residential areas. Individual structures that are difficult to retrofit with solar systems can be served. The problem of "solar rights" can be minimized. Rather than having to create a solar "envelope" around each building– limiting the height of adjacent structures and trees to prevent the obstruction of sunlight—only the locations of clusters of collectors would need to be protected. In high-density neighborhoods where a large portion of the buildings lack the surface area to provide their own solar heating, district systems appear to be the only way to meet the heating load with solar energy,

The economics of solar district heating may be more favorable than is commonly realized, OTA's study of the *Application of Solar Technology to Today's Energy Needs* analyzed the cost of providing different forms of district heating and electricity to a new community of about 30,000 people living in an area a little more densely populated than the denser neighborhoods of Washington, D.C. (about 7,000 housing units per square mile). With fuel prices at historically low levels, district heating and cogeneration systems using conventional fuels cost less than any form of solar district heating **As** fuel prices rise, however, some of the less expensive solar district heating methods show a total monthly cost substantially less than the conventional district heating.

Solar heating with neighborhood-scale systems may prove cheaper than with individual building systems in many high-density residential areas because of significant economies in both storage and collector operation. The large shared-storage tanks now under consideration are cheaper and more efficient than the equivalent distributed-storage capacity. Large tanks can be better stratified than small tanks, or segregated into vertical cells They eliminate the need for storage in individual buildings and they can be backed up by a single cogenerator rather than individual furnaces in each dwelling unit. Because large-tank storage can operate on a true seasonal cycle, collectors can run at full capacity all year round. Collectors can be sited and oriented for optimal performance with less restriction, utilizlng areas like the space over parking lots and highways as well as building surfaces.

The major cost problem in district heating systems — the laying of distribution mains — may be reduced substantially if flexible plastic unrollable heat cables prove effective. Plastic heat cables are therefore an important area for R&D emphasis. In new developments, distribution mains could be laid along with other utilities. If natural gas pipelines were no longer installed, the overall cost of utility installation would not have to increase significantly because the amount of piping would remain constant. Some analysts (e. g., T. B. Taylor, A. B. Lovins, M. Ross, and R. Williams) believe properly designed neighborhood-scale solar systems could be less expensive than current individual building heating systems using electricity or oil.

Research is especially needed on the feasibility of retrofitting solar district heating systems into existing high-density areas. Some analysts believe it would be cost-effective to begin building small group and district heating systems in urban areas in the early 1980's, to be fueled by wastes or coal. They could be linked into larger, neighborhood-scale systems and converted to solar energy over time.

For existing urban areas, the most obvious technical difficulty with solar district heating is the land use requirement. The various ways of providing solar heating to the communities analyzed in the OTA study **all** require between one-quarter and one-half of the available land, which simply would not be feasible in many existing neighborhoods that are of high enough density to support district heating. This land use problem highlights the importance of increasing the energy efficiency of the housing stock to minimize the collective heating load and the collector area required to meet it. As a result, district heating retrofits may be most practical when combined with a more comprehensive building retrofit strategy.

The greatest barriers to solar district heating are probably institutional rather than technical. While municipal governments appear to have the jurisdiction to deal with the land use requirements of installing and operating district systems, new city and neighborhood-scale financing mechanisms and management arrangements are needed to allow communities to act in concert to realize the advantages of solar district heating. The lack of well-organized and well-financed neighborhood-scale constituencies is part of the reason why solar district heating has received so little attention.

A related, advanced concept, the use of solar ponds for integrated community energy systems, also merits increased RD&D funding. Ponds can provide district heating, low-temperature industrial process heat, seasonal heat storage, and electricity generated from heat engines that utilize the temperature variations that occur in salt-gradient ponds. A recent SERI study estimates that solar ponds could supply 1 Quad of energy annually by 2000, with an ultimate potential of up to 10 Quads. The low-level funding that solar ponds have received over the past few years is reduced in the fiscal year 1981 budget, despite the recommendation of the SERI study that ponds appear technically and economically feasible and should be vigorously pursued in the U.S. solar energy program.

Industrial Energy Conservation Programs

The potential for energy conservation in industry, which consumes **38 percent of the** U.S. energy budget, is very large. The sharp energy price rises of the 1970's left most industrial plants using energy at rates far above the economically optimum level. Most industry, in fact, was built when oil cost only $2/bbl.

The technical barriers to industrial energy conservation are not great, but institutional difficulties, especially in financing capital investments for energy conservation, can be se**vere.** DOE's Office of Industrial Programs (OIP), however, is alloted only 0.6 percent of the total DOE non-Defense budget to meet this considerable challenge.

OIP will spend most of its $59 million fiscal year **1981** budget on demonstration programs (table 10). These programs, the cost of which DOE shares with private industry, are geared to demonstrate the technical and economic feasibility of existing and new energy-conserving devices and processes. The basis of this

Table 10.—Industrial Energy Conservation Program Budget Requests, Fiscal Years 1979-81 (in thousands of dollars)

Industrial energy conservation (CS)	FY 1979 appropriation	FY 1980 appropriation	FY 1981 base	FY 1981 request
Waste energy reduction:				
Operating expenses.	$14,740	$16,450	$16,450	$19,800
Capital equipment	500	0	0	0
Subtotal.	15,240	16,450	16,450	19,800
Industrial process efficiency:				
Operating expenses.	14,400	20,675	20,675	19,000
Capital equipment	0	0	0	1,000
Subtotal.	14,400	20,675	20,675	20,000
Industrial cogeneration:				
Operating expenses.	5,000	10,750	10,750	12,000
Capital equipment	0	500	500	0
Subtotal.	5,000	11,250	11,250	12,000
Implementation and deployment:				
Operating expenses.	3,160	9,800	9,800	4,500
Program direction	2,193	2,067	2,131	2,600
Total:				
Operating expenses.	39,493	59,742	59,806	57,900
Capital equipment	500	500	500	1,000
Total industrial energy conservation .	$39,993	$60,242	$60,306	$58,900

SOURCE *Congressional Budget Request, FY 7987,* VOI *2,* Department of Energy, January 1980, p 48

approach lies in the belief that industries will not adopt unproven or unfamiliar technologies until it is demonstrated that the risk in their use is acceptably low relative to the potential for energy cost savings.

OIP selects, for the most part, unsolicited proposals which it finds consistent with its objectives and criteria. OIP's stated objectives are to:

- achieve maximum penetration of existing and new energy conservation technologies in as short a period as possible;
- substitute, where possible, abundant fuels for scarce fuels; and
- minimize the energy embodied in waste **streams of all types (discarded products, materials, and energies).**

Projects are selected to meet these objectives on the basis of high energy-saving potential, their effect on accelerating market penetration, nonredundancy with efforts of private industry, the degree to which benefits accrue to fragmented industries without research funds, and the degree and appropriateness of cost sharing. In addition to the foregoing, the following, more specific criteria must be met:

- return on investment for the investing industry must equal at least 15 **percent;**
- **the risk** to an industry of adopting the process or device involved is greater than industry is willing to accept;
- an industry is willing to share the cost of the demonstration project with OIP; and
- the value of energy saved by the project will be no less than 10 times as great as the Federal investment.

In addition to its RD&D efforts (authorized by the Federal Non-Nuclear R&D Act of **1974),** OIP conducts other programs in conservation. These include: setting and monitoring voluntary goals for energy and materials conservation [required by EPCA and NE CPA); funding of three pilot Energy Analysis and Diagnostic Centers (EADCs), which may be considered prototypes for an industrial energy extension service; and other programs for promoting the adoption of industrial energy conservation, including workshops, symposia, distribution of manuals, audiovisuals, and other materials. OIP must also evaluate the efficacy of mandatory efficiency standards for industrial equipment (pursuant to NE CPA), and works with the Internal Revenue Service (IRS) in drafting regulations for tax credits for investments in certain energy-conserving industrial equipment (in accordance with the Energy Tax Act of 1978).

Issue 36

Criteria for Selection

Improved criteria are needed for allocation of DOE funds to OIP, and for selection of projects within OIP.

Summary

Although OIP has established an analytical procedure for selecting industrial energy conservation R&D projects, there are indications that they may not be selecting the major conservation opportunities. First, the criteria used to select among industry groups for priority in funding projects do not seem to distinguish adequately among most of these groups. Second, budget constraints and OIP decisions have limited funding to relatively small demonstration projects. While this is not unproductive, it means that there is no opportunity to demonstrate new industrial processes or even large process steps that could result in major energy and cost savings. Third, fuel-switching projects, unless carefully structured to consider the unique properties of the target fuel, may not result in any increase in energy efficiency, It would be helpful in this connection for OIP to work in close cooperation with the program offices responsible for research on the fuels in question. Finally, it is possible that increased emphasis on an energy extension service, modeled after OIP's highly successful EADCs pilot programs, could be the best way to promote energy conservation in the next few years, Coupled with an effective OIP R&D program, this service could reach many indus-

trial operations currently lacking the resources to determine the best steps to take in reducing energy use.

Background

OIP has established a set of criteria for funding projects based on the amount of energy used by the industry, the fragmentation of the industry, the quality and type of fuel used, the difficulty of putting in a parallel process step, the private funds expended on RD&D, and the degree of secrecy connected with the process, **Using these criteria,** OIP has established a weighting system to judge the industry groups with the most potential for conservation through Federal R&D. The analytical methodology for selecting the best projects is commendable, but the process could be improved. The ratings for most of the industrial groups fall within **15 percent of each other which is probably too close to allow setting priorities among the various industries. This system provides no criteria for choosing among major energy-using equipment within one industry or across industries,** For example, examination of the OIP list of projects to be funded in fiscal year **1981** shows that industrial equipment that operates at high temperatures receives far more attention than devices that function at relatively low temperatures. Five types of equipment, ranging from furnaces with typical efficiencies of almost 50 percent (second-law efficiency), to ovens and heaters with efficiencies of an average of 23 percent, consume 30 percent of all industrial energy. Relatively low-temperature devices such as distillers, evaporators, dryers, washers, and sterilizers require 20 percent of U.S. industrial energy, but operate at efficiencies of only 0.3 to 6.0 percent (second law efficiency). Thus, the case could be made that devices with the greatest potential for improvement, that is, low-temperature equipment, are not receiving adequate attention.

The rating system does not truly clarify what OIP's priorities are, and it is difficult to evaluate its performance without better explanation of the selection process. It is clear, however, **that there are many** more opportunities to save energy that could benefit from DOE participation.

Another difficult in ensuring that the OIP projects accelerate industrial energy conservation is the limitation imposed by the budget and OIP decisions to fund small projects. **It** is not possible for **OIP** to demonstrate entire processes or even large process steps that could substantially reduce energy use and costs. In the past, industry could be counted on to introduce new processes because rapid economic growth allowed experimentation with new capacity production facilities,[2] Because growth may be slower in the near future, new energy-efficient processes will not be rapidly adopted except as replacements for old processes. Here the economic advantage of the new process will have to be great enough initially to offset the advantage the old plant has with its recovered capital investment (and its much lower initial price, because of subsequent rapid inflation). Without some way to demonstrate new processes that may be very energy efficient but are of high risk, their introduction will be greatly hindered.

Fuel switching can offer opportunities for more efficient processes, especially if account is taken of the unique properties of the new fuel. Most current fuel-switching projects in OIP, however, seem to be examining ways existing equipment can be altered to use different fuels. For example, most process furnaces are designed to burn oil or natural **gas. If they are modified to burn coal, they are likely to be less efficient even though a** more abundan fuel is burned. Designing a new process of process step around the fuel itself, however could result in a tar more energy-efficiency operation. The direct reduction of alum i nun project currently being undertaken by **OIP** is a good example; a fossil fuel process would be substituted for electricity with a significant in

[2] C A Berg, "Energy Conservation in Industry The Present Approach, the Future Opportunities," Council on Environmental Quality, Washington, D C, May 1979

crease in efficiency. Because of the necessity **for making the new fuel a major focus** in these cases, there should be a much greater role for the program off ice responsible **for that fuel,**

The complexity and diffuse nature of the Nation's industrial capacity may require that more than demonstration programs are needed to accelerate conservation. DOE should expand its excellent EADCs to a full nationwide industrial energy extension service to augment the demonstration program. Revision of the tax code to provide incentives for conservation investment, such as the 10-5-3 proposal for accelerated depreciation, could also bring Federal leverage worth billions of dollars per year to bear on the problem of industrial energy conservation.

Issue 37

Cogeneration

OIP should more effectively promote industrial cogeneration.

Summary

Industrial cogeneration could add perhaps 20 percent to existng U.S. electric generating capacity by using available, economical sources of industrially produced steam. Yet DOE spends only 0.1 percent of its budget on Industrial cogeneration. Although some of this money is used to demonstrate systems using conventional diesels and steam turbines, the principal effort is on systems that do not depend on gas or oil In addition to these needed demonstrations, more emphasis should be given to technical assistance for industrial cogeneration investments. A deeper problem n this connection is that the Fuel Use Act of 1978 and IRS tax regulations on tax credits for cogeneration equipment discourage the use of gas- and oil-fired systems. OIP should work with IRS, FERC, and Congress to promote the use of cogeneration where natural gas and/or esidual oil have to be used.

Questions

1. Would DOE assistance to industry in making technical and economic evaluations of possible systems hasten the adoption of cogeneration?
2. Would **OIP** recommend reviewing current policy about using oil and natural gas for cogeneration to see if systems using these fuels should be allowed the various tax credits now reserved for more abundant fuels?

Background

Industrial cogeneration, according to some sources, could add 100 gigawatts of electrical generation capacity for the United States with the retrofit of existing industrial sites. The use of this capacity would generally produce power at a cost savings of 1 cent or more per kilowatthour. DOE's promotion of industrial cogeneration, at a funding level of $12 million per year, or 0.1 percent of the DOE nondefense budget, is small relative to cogeneration's potential.

Proposed demonstration efforts may be less productive than would be provision of legal, financial, and technical expertise– in short, an extension service — to interested industries and utilities. The rate of acceptance of EADC recommendations for major capital investments for conservation in industry averages about 50 percent, and usually provides saving 10 times as great as the Federal investment in the extension service itself. This service typically consists of about 10 **days** of analyses, including a l-day audit, collection of energy consumption data, and benefit/cost analyses. The EADC service could be invaluable to the market penetration of industrial cogeneration.

Steam turbine and **diesel cogeneration systems are not new technologies,** and are not in need of technical demonstration. Institutional barriers to cogeneration are far greater than technical barriers. Natural gas and oil may be used very efficiently in these systems, and their use may be reasonable in existing industrial plants. The Fuel Use Act, the Energy Tax Act, and the Windfall Profits Tax Act all discourage this highly efficient use of oil and gas, however, either by prohibiting their use of these fuels outright, or by making such systems ineligible for tax credits. The recent IRS decision to make diesel cogeneration systems ineligible for these credits is a prime example of the Federal Governments' inconsistent position on cogeneration. DOE, IRS, FERC, and Congress should arrive at a consistent policy on this issue in order to promote the most efficient cogeneration systems.

Issue 38

Solar Agricultural and Industrial Process Heat

R&D for agricultural and industrial process heat should be focused on lower cost approaches, and should include work on demand analysis and high-temperature storage.

Summary

Continuing efforts should be made to reduce the cost of agricultural and industrial process heat (AIPH) systems through the development and testing of low-cost-collector designs and through R&D on materials, trackers and controls, and other components. A major effort is needed to better understand the demand for process heat — both today and in the future – and to clarify what process heat needs can best be met by solar energy, by cogeneration, and by other energy sources. Exploratory R&D is also needed on the feasibility of high-temperature thermal storage systems.

Questions

1. What R&D areas show the most promise for reducing the installed cost of AIPH systems?
2. What are the actual terminal temperatures required today by different industrial processes? What spectrum of temperatures would be required **if the preheat of process** material from ambient temperature is taken into account?
3. What is the temporal pattern of process heat demand? Could the development of high-temperature storage technologies make **solar systems more widely applicable and cost-effective?**
4. **What process heat needs can be met most** economically by solar energy, cogeneration, and other sources?

Background

Projected costs for solar process heat, even including presently understood opportunities for technical improvement, are considerably higher than industrial costs today. Consequently, the greatest R&D need in this area is for reducing the installed cost of **AIPH** systems. The AIPH program is already working in several important areas related to cost reduction, including the development and testing of low-cost line focusing collectors, large area collectors, dish-type collectors, site-built air heaters for crop drying, improved low-cost trackers and controls, and materials research. This emphasis on cost reduction should be reinforced and extended to every aspect of the program.

Critical to the development of solar systems to meet industrial demand for thermal energy is an understanding of the demand itself, today and in the future. A detailed survey of the temperature spectrum of U.S. industrial process heat should be undertaken by DOE and closely coordinated with the AIPH program and OIP, Since much heat of high thermodynamic availability is wasted today because it is used for low-temperature applications, the survey should identify the actual temperatures required by different processes rather than the temperature at which heat is currently provialed. It should examine not only the termina temperature desired, but also the correspond ing spectrum of temperatures required if the preheat of process material from ambient tern perature is taken into account. Consideration should be given to changes in demand that might occur as a result of waste heat recover} and process modification, I n addition, in order to establish the requirements to be met by thermal storage systems, the temporal pattern of demand should be investigated.

Many systems development and market development activities would eventually benefit from closer cooperation between the Off ice of Solar Applications for Industry and OIP. Joint participation in a major survey of industrial demand for process heat, and cooperation in related research to clarify what process heat needs can be met most economically by solar energy, cogeneration, and other sources, could provide an opportunity for these two programs to begin working together in a more coordinated approach to industrial energy problems.

There is disagreement concerning the need for R&D on high-temperature thermal storage systems. Some analysts believe that the industrial need to have energy available in spite of time of day or weather implies a priority need for R&D on high-temperature thermal storage systems, Others believe that storage is not an important consideration because high-temperature process heat applications will draw heat as fast as it can be provided by solar systems, or because storage would not be cost-effective compared to backup systems. An exploratory research effort to clarify these issues appears advisable. No work on high-temperature storage is being funded at present.

Related General Accounting Office Reports

Twenty Per Cent Solar Energy Goal — Is There a Plan to Attain It?, EMD-80-64, Mar. 31, 1980

Transportation Energy Conservation in the Federal Government, EMD-79-3, Jan. 25,1979

Letter report to the Secretary of Energy on the Off ice of Conservation and Solar Applications, EMD-79-64, May 18, 1979

Evaluation of Four Energy Conservation Programs, Fiscal Year 1977, EMD-78-81, Nov. 21, 1978

The Federal Government Should Establish and Meet Energy Conservation Goals, EMD-78-32, June 30,1978

The Department of Energy's Practices for Awarding and Administering Contracts **Needs to be Improved, EMD-80-2, Nov. 2, 1979**

Commercializing Solar Heating: A National Strategy Needed, EMD-79-19, **July** 20,1979

Federal Demonstration of Solar Heating and **Cooling on Private Residences–Only Limited Success, END-79-55, Oct. 9,1979**

Federal Demonstrations of Solar Heating and Cooling on Commercial Buildings Have Not Been Very Effective, END-80-41, Apr. 8,1980

Letter Report–Views on Legislation to Continue State and Local Government involve**ment** in Promoting National Energy Objectives, EMD-80-15, Nov. 27, 1979

Federal Government Needs a Comprehensive Program to Curb its Energy Use, EMD-80-11, Dec. 12,1979

More Use Should be Made of Energy Saving Products in Federal Buildings, EMD-79-10

The Solar Federal Buildings Demonstration Program, EMD-79-84, Aug. 10,1979

Letter report on Certain Aspects of the Solar Energy Research Institute, EMD-77-67, Sept. 9, 1977

Letter report — Roles and Reporting Structure of SERI and the Regional Solar Energy Network, EM D-78-26, Jan. 24, 1978

Selected Aspects of DOE's Solar Photovaltaic Programs, EM D-79-40, Apr. 19, 1979

The Congress Needs to Redirect the Federal Electric Vehicle Program, EMD 79-6, Apr. 9, 1979

Industrial Cogeneration: What it is, How it works, It's Potential, E MD-80-7, April 1980

A Framework for Developing a National Energy Conservation Program, EM D-79-76, July **1979**

U.S. GOVERNMENT PRINTING OFFICE : 1980 0 - 63-604