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THE ROLE OF DEPARTMENT OF ENERGY FIELD OFFICES IN THE COMMERCIALIZATION  
OF ENERGY TECHNOLOGIES

Thomas K. Glennan, Jr., Walter Baer, Phyllis Ellickson

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## **A Rand Note**

**prepared for the**

U.S. DEPARTMENT OF ENERGY

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PREFACE

In February 1978, the San Francisco Operations Office of the Department of Energy (DOE) established a task force on "The Role of an Operations Office in the Commercialization Process." The Operations Office asked The Rand Corporation to carry out a brief study in support of the task force's efforts. This Note reports the results of the study. The work was carried out as a part of Rand's larger program of research and analysis for the DOE, administered by the Office of Policy and Evaluation.

The study included a brief review of the literature on the government's role in fostering the commercial use of new technologies, as well as interviews with government staff in the Operations Office and in Washington. An initial version of this Note was made available to the Operations Office in April 1978 and was used by the task force in that form. This Note reflects the reactions of personnel in the Office of the Regional Representative for Region IX and the San Francisco Operations Office as well as additional research by the authors.

Although the primary focus of the research was on the role that the various field offices of the DOE might play in the commercialization of energy technologies, the study also considers commercialization in the DOE more generally. In particular the study deals with the manner in which information on energy markets could be reflected in the DOE's program planning. Hence this Note should be of interest to planning staff in DOE headquarters as well as staff in the various field offices.



SUMMARY

During its first 18 months, the Department of Energy (DOE) has devoted considerable attention to "commercialization"--that is, to developing programs and policies to accelerate the commercial use of new energy technologies. This Note discusses the contributions that the DOE field offices can make to commercialization efforts and suggests ways to improve such contributions.

There is no generic commercialization problem; rather, the barriers to commercial use of a technology may include the performance and economics of the technology, the absence of manufacturing capacity, the attitudes of potential users, or an unfavorable regulatory environment. Commercialization policies must reflect the specific factors associated with each technology. Moreover, the policies must be developed in the face of great uncertainties concerning future regulations, prices, and national goals.

Past research indicates that successful commercialization more frequently results from technologies "pulled" into use by competitive forces than "pushed" into a market by government advocacy and support. This suggests some general guidelines for government commercialization planning:

- o Considerations of commercial use should be reflected in the early stages of research and development (R&D) planning by involving individuals with knowledge of commercial markets in such planning.
- o Commercialization programs should be planned and implemented with the participation of all the major actors who will be involved in the production, marketing, and regulation of a new technology.
- o Commercialization programs should include significant cost and risk sharing by private firms to ensure their commitment.

Introducing market considerations in the DOE planning process for R&D may prove more important to ultimate commercial use than direct commercialization programs. In private firms, marketing organizations usually participate in R&D decisions, in order to counter the natural tendency of technical groups to develop the most technically interesting rather than the most marketable products. Although the DOE cannot seek simply to emulate the private sector, it has created two organizational units with marketing functions: the Office of Resource Applications (RA) and the Office of Conservation and Solar Applications (CS). To date, neither the RA nor the CS has played a major role in R&D program planning. Their participation through such departmental processes as the Policy and Program Planning System or the Program and Project Management System could bring more market-oriented views into R&D program decisions. However, it would require that RA and CS build new capabilities for market assessment.

The DOE field offices, including both the offices of the Regional Representative and the Operations office, could support RA and CS in developing such capabilities. The field offices have a number of comparative advantages over DOE headquarters:

- o Their proximity to regional markets, which may give them superior knowledge of user needs, state and local regulations, and other market factors.
- o Their proximity to R&D, manufacturing, and related industrial capabilities.
- o Their proximity to major energy resources, which may provide information about the technical and institutional problems of exploiting those resources.
- o Their comparatively small size, which may permit better internal communication, as well as better communication among field office staff, private firms, and other participants in commercialization.

Despite these potential comparative advantages, use of the DOE field structure is uneven. The Department has sought to clarify

field roles and decentralize operations, particularly in the development of energy technologies. Management plans that carefully define headquarters and field roles have been developed for some projects and programs. Yet, inevitable conflicts have arisen between the desire for organization-wide policies and the need for flexible, adaptive program management. Program officials in Washington are often reluctant to delegate program authority to the field because they feel that field offices do not have adequate understanding of national policy, are too close to local political and industrial interests, or do not provide the information that permits headquarters staff to respond to their superiors or to the Congress. These problems are not unique to the DOE, but generally characterize relationships between government agency headquarters and field offices.

In the near term, the most important contribution that the field offices can make to the DOE's commercialization goals is to manage the technology programs assigned to them in ways that enhance their likelihood of commercial application. For example, private firms, state and local regulators, and other regional actors can be more involved in planning program activities. Program information and results can be disseminated more widely to potential manufacturers and users. Recognizing that any expanded role for the field offices depends on their familiarity with problems and actors in their regions, the offices should identify gaps in their knowledge base as a guide to recruiting new or replacement staff.

Longer-term roles for the field offices in commercialization include:

- o *Participation in R&D Planning.* The field offices' knowledge of regional markets, industrial capabilities, or energy resources should be systematically utilized in the planning of the DOE's R&D programs. Most of this planning will be carried out at the headquarters level, where the Offices of Resource Applications and Conservation Solar Applications should be expected to provide important marketing input. Consequently, the field offices should be

more closely aligned with RA and CS than they are now.

- o *Relating National Laboratory Activities to User Needs.*  
The national laboratory structure inherited from the Energy Research and Development Administration represents a significant national resource. Except in the traditional areas of laboratory expertise (primarily nuclear), however, the private sector has limited awareness of what the laboratories are doing. National laboratory staff may also view potential users as possible sources of interference in their work. The DOE field offices should work to bring users and laboratory staff together, particularly in the planning of laboratory activities.
- o *Implementation of Commercialization Programs.* When commercialization programs require tailoring to regional markets, program planning and implementation should be delegated to the field offices.

These recommendations imply several supporting actions both at DOE headquarters and in the field: continued efforts to carefully define the roles of headquarters and field units in planning and management of specific projects and programs; a review of the staffing of the field offices, with changes, if necessary, to obtain the competencies needed to perform the roles; and providing field offices with authority and resources to conduct small studies and conferences, so that these offices can assist regional commercialization efforts without extensive negotiation with headquarters. Taken together, such actions should both enhance the field office role and generally strengthen the DOE's commercialization capabilities.

ACKNOWLEDGMENTS

Many staff members of the Department of Energy have taken the time to discuss their activities with us, as well as to share their views concerning better ways to organize and manage the DOE's operations. We appreciate their help. William Gough and Dennis Wong, now of the Office of the Regional Representative for Region IX, and Kerry Dance of the San Francisco Operations Office were always helpful in arranging meetings and providing comments on earlier drafts of this study. Among our colleagues at Rand, we are particularly grateful to David Seidman for his review of this Note. This assistance does not, of course, relieve us of the responsibility for the final product.



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## I. INTRODUCTION

When the Department of Energy (DOE) was created, it inherited a number of important field activities. It took over ten regional offices from the Federal Energy Administration (FEA) and more than 60 field facilities from the Energy Research and Development Administration (ERDA), including eight operations offices, eight multi-program national laboratories, Energy Research Centers, project offices, and a variety of other plants and laboratories. These field facilities had been carrying out many of ERDA's research, development, and demonstration (RD&D) activities and have assumed similar roles within the DOE. A major initial task for the DOE has been (and will continue to be) rationalizing and integrating these activities, as well as adapting them to the new missions emphasized in the Department's authorizing legislation.

This legislation, as interpreted by the Department's senior officials, has made fostering the use of technologies developed by the DOE a principal organizational goal. The missions of two major units of DOE headquarters, Resource Applications and Conservation and Solar Applications, emphasize commercialization<sup>1</sup> of new technologies. A position of Deputy Undersecretary for Commercialization has been created and significant staff effort devoted to analyzing opportunities for promoting the use of technologies under development. In light of this emphasis on applying technology, it is appropriate for the Department to consider ways in which field activities can contribute to this mission.

In the spring of 1978, the San Francisco Operations Office (SAN) asked Rand to prepare a brief paper on roles the Operations Office might play in the commercialization of new technologies. This Note

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<sup>1</sup>We define "commercialization" as the market process leading to the routine use of a new technology by the public or private sector. Government commercialization policies or programs seek to accelerate this process beyond the rate at which it would occur in the absence of government action.

is the result of that request. It is based on a selective review of the literature on government efforts to commercialize new technologies, a series of interviews with the staff of the SAN Office, and discussions with personnel in DOE headquarters.

Section II summarizes important insights derived from the literature on commercialization. Section III discusses DOE programs and policies that affect commercialization directly and indirectly. Section IV suggests how the DOE's organizational structure can support commercialization activities more effectively. Section V discusses the relationships between DOE headquarters and the field offices, outlining areas of comparative advantage for the operations and regional offices in commercialization activities. Finally, Section VI suggests policies and program efforts to improve the regional and operations offices' commercialization capabilities. These suggestions are divided into two groups: those dealing with immediate actions that could be implemented by the regional and operations offices themselves, and those requiring more fundamental changes in DOE operations.

The first set of suggestions was made in an earlier draft reviewed by SAN in May 1978. This Note incorporates the comments of SAN staff and goes on to suggest several longer-term changes that could enhance the DOE's commercialization efforts.

## II. STATE OF KNOWLEDGE ON COMMERCIALIZATION OF NEW TECHNOLOGIES

Knowledge about how government commercialization policies affect new technologies is limited. The existing literature makes it clear that commercialization overwhelmingly depends on market forces. Technology is much more often "pulled" into use by competitive forces than "pushed" into a market by government advocacy and support. The literature does not, however, provide government with established guidelines to promote commercialization.<sup>1</sup>

This lack of well-developed policy guidance reflects a number of realities. The federal government has had limited experience with commercialization. Most federally supported research and development (R&D) beyond the basic research stage has been conducted by agencies such as DOD and NASA for their own use. Except in agriculture and a few other cases, federal support to develop commercial products or services has become important only in the last decade or two.

Moreover, as we discuss in the next section, there is no generic commercialization problem and consequently no generic commercialization policy. Policies must be tailored to fit the variety of

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<sup>1</sup>Several recent publications examine a variety of experiences with government commercialization efforts and provide general guidelines for action. Walter S. Baer et al., in *Analysis of Federally Funded Demonstration Projects*, report on a study of 30 technology demonstration projects and suggest guidelines for deciding whether to use a demonstration to promote commercialization (The Rand Corporation, R-1926-DOC, April 1976). Arthur D. Little, Inc., in *Federal Funding of Civilian Research and Development*, reviewed six federal R&D efforts to suggest factors that seem to characterize commercially successful programs (Westview Press, Boulder, Colo., 1976). House and Jones, in *Getting It Off the Shelf: A Method for Implementing Federal Research*, review the literature concerning public and private sector innovation and suggest improved procedures for deriving commercial products from R&D programs (Westview Press, Boulder, Colo., 1977). Norman B. McEachron et al., in *Management of Federal R&D for Commercialization*, review the federal R&D management policies that seem associated with the successful commercialization of R&D projects (U.S. Department of Commerce, Washington, D.C., September 1978).

technologies, potential users and manufacturers, and other characteristics of the market environment.

Policies must also reflect other goals, such as national security, economic growth, equity among income groups and geographic regions, and sustaining desirable industry structures. However, a working consensus among Congress, the executive, and various elements of the public about the *operational* goals for federal energy policy has not yet emerged. Without such a consensus, it is very difficult to decide which technologies to commercialize and what level of social costs to incur.

Finally, uncertainties about future environmental and other regulations inhibit the development of commercialization policies. Possible new health, safety, and environmental regulations, as well as changes in the more traditional economic regulations, add to private sector uncertainties about the profitability of new energy technologies. Uncertainties over future regulations also complicate the DOE's efforts to diagnose the commercialization problem.

These four realities--lack of experience, diversity of problems, multiplicity of goals, and uncertainty over future regulatory policies--inhibit agreement on the government's proper role in commercialization or the best policy instruments to support that role. The absence of such agreement calls for a flexible and pragmatic approach.

### III. DOE PROGRAMS THAT AFFECT COMMERCIALIZATION

There is no generic commercialization process. How innovations enter the market--as well as what government actions are appropriate to promote such entry--varies with the specific technology, its users, its manufacturers, and the institutional environment in which it is used.

For example, the DOE's program for developing a gas-cooled reactor includes an "Associates" group of utilities that can plan, help finance, and carry out parts of the program, thereby taking advantage of government and industry experience with past reactor development. But with the more fragmented, less sophisticated, and less well capitalized users associated with most conservation projects, such an arrangement would not be appropriate. Similarly, the most important environmental regulation of geothermal resource development is at the local (county) level, whereas nuclear power plant licensing involves a complex set of national and state regulations. Both the environmental requirements and the measures taken to meet them vary across technologies and geographic areas, necessitating different actions for different situations.

The diversity of the DOE's commercialization efforts reflects the diversity of commercialization processes. DOE programs directly aimed at fostering the use of particular technologies include:

- o *Programs to establish an industrial base (e.g., government purchases of photovoltaics and proposals to subsidize high-BTU coal gasification plants through loan guarantees, direct support, or favorable regulatory treatment).*
- o *Subsidies for relatively mature technologies whose use is in the national interest but whose costs or risks are too high to attract private sector investment (e.g., tax credits for solar hot water and space heating and home insulation; loan guarantees for some forms of geothermal energy).*

- o *Subsidies to develop and demonstrate less mature technologies whose technical characteristics, economic viability, or institutional effects are too uncertain to attract private sector investment (e.g., proposed demonstration projects for coal liquids and shale oil extraction).*
- o *The production and dissemination of information relating to commercial applications (e.g., the Imperial Valley Environmental Project and the technical conferences associated with the Enhanced Oil Recovery program).*
- o *Advocacy of regulatory changes that inappropriately inhibit commercialization (e.g., new building codes that encourage greater weatherproofing and permit efficient use of solar technologies; licensing procedures for electricity generating plants that provide fair hearing and consideration of all points of view while avoiding unnecessary delays).<sup>1</sup>*

Although these direct programs constitute the bulk of the DOE's commercialization effort, other Department activities that are more closely related to RD&D programs can strongly influence the commercial prospects for new technologies. Our suggestions for enhancing DOE's headquarters' support of commercialization programs pertain to this class of indirect activities, and thus we will discuss them more fully. They include:

- o *R&D planning processes that can make R&D programs more sensitive to market needs.* The commercial success of new technologies depends critically on decisions made during R&D. For example, McEachron and his colleagues found that guidelines associated with the earlier stages of R&D

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<sup>1</sup>This is a delicate policy area, because regulations dealing with "externalities" result from the need to balance energy production goals with health, safety, and environmental objectives. Although the DOE can seek to represent the "energy supply" position, it must recognize the legitimacy of other positions and aid in making tradeoffs and resolving disputes among opposing sides.

planning were most significantly correlated with commercialization success. They conclude that "planning and early project decisions in relation to the intended market strongly affect the eventual commercial application of projects and consequently should receive particular attention."<sup>1</sup>

- o *Demonstration project management that facilitates commercialization.* How the government manages a demonstration project can affect the credibility and use of the information it produces concerning economic, technological, environmental, and institutional outcomes. Too much interference by government project officers in technical details or too deep government involvement in the resolution of environmental conflicts will often lead others to view project outcomes as non-reproducible. Baer et al. emphasized the need to involve all relevant elements of the "technological delivery system" as well as the importance of maintaining flexibility to adapt to unforeseen difficulties by slipping time schedules.<sup>2</sup> McEachron et al. found three administrative predictors of administrative success: (1) seeking advice from R&D performers and manufacturers about the time and financial resources required to complete projects; (2) giving that advice considerable weight; and (3) maintaining effective working relationships between R&D performers, the agency, users, and manufacturers during deployment.<sup>3</sup>
- o *Procurement policies that include prospects for commercialization among award criteria.* R&D procurement policies that explicitly encourage follow-on activities (e.g., consideration of a firm's marketing capability and willingness to share costs and risks) can spur commercialization. Successful commercialization is associated with cost sharing<sup>4</sup> and negatively

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<sup>1</sup>McEachron et al., p. IV-2.

<sup>2</sup>Baer et al., pp. 51-53.

<sup>3</sup>McEachron et al., pp. IV-36-39, 47.

<sup>4</sup>Baer et al., p. 56.

correlated with firm size.<sup>1</sup> Procurement policies that enhance smaller firms' opportunity to compete for R&D activities may conceivably lead to improved commercialization performance.

- o *Patent and other "rights of access" policies that foster early application.* Although there is little documentation of the effects of government patent policies on the prospects and pace of commercialization, it seems likely that patent policies are important in individual cases. They may affect who chooses to bid on a proposed project, the willingness of a firm to commit its own resources to manufacturing and marketing, or the opportunity to withhold an innovation from the market.<sup>2</sup>

Although these four activities are not typically considered "commercialization" policies, they may be more crucial to the successful commercial application of government-sponsored RD&D than the explicit programs outlined previously. Therefore, Section IV focuses on how the DOE's overall organization for RD&D can reflect and enhance commercialization objectives.

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<sup>1</sup>McEachron et al., p. IV-45.

<sup>2</sup>The effect of patent policies on innovation is currently a hotly debated issue within the DOE and elsewhere, and is not further discussed in this Note. See, for example, U.S. Energy Research and Development Administration, *The Patent Policies Affecting ERDA Energy Programs*, ERDA-76-16, Washington, D.C., January 1976, pp. 105-117.

#### IV. MANAGING THE DOE FOR EFFECTIVE COMMERCIALIZATION

Commercialization of a new product or process requires an understanding of markets, regulatory environments, and user needs, beginning at the early R&D stages. Private firms give marketing organizations important positions in the R&D planning process,<sup>1</sup> because they have found that technical personnel tend to base their choice of projects more on technical interest than on the project's likely contribution to the corporation's profitability. Marketing interests counteract this tendency.

Analogous tendencies can be found in the public sector. For example, military technical commands are often viewed as more interested in the new and novel than in more mundane and incremental technical activities that might provide lower-cost and lower-risk means of satisfying an operational need.<sup>2</sup> There is no reason to suppose that the DOE is immune from its technical staff's interest in exploring exciting frontiers of technology at the expense of projects that might make a greater contribution to the nation's welfare.

Moreover, the DOE's "product line" is enormous, requiring a wide array of market expertise. But because the Department does not sell many products directly, it lacks the private sector's mechanism for validating its market information through successful sales. The DOE must develop its own methods for obtaining market information and take it into account during program planning and implementation.

The Department has already taken steps in this direction. DOE designers paid explicit attention to developing a governmental analogue to the marketing function by creating two major line units, Resource Applications (RA) and Conservation and Solar Applications (CS).

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<sup>1</sup>Marketing representatives usually sit on the corporate committees that approve technology development programs and often participate in the early development of R&D plans. Corporate marketing departments often possess virtual veto power over development activities.

<sup>2</sup>Ronald J. Fox, *Arming America: How the U.S. Buys Weapons*, Harvard University Press, Cambridge, Mass., 1974, Chap. VI.

The functions outlined for RA and CS are distinctly line functions. RA is "to conduct energy commercialization activities" as well as "to produce and market energy resources." CS is "to develop and implement conservation programs to improve efficiency and system utilization and reduce energy consumption" and "conduct technology application programs to improve energy efficiency and system utilization and reduce energy consumption in all sectors."<sup>1</sup> However, staff roles for RA and CS in R&D planning have not been emphasized.

In addition, a number of resource managers have been appointed to provide DOE-wide coordination of activities to achieve rapid use of specific technologies in energy markets. The managers, located in RA and CS, are potentially able to influence the plans for technical programs, although, on the whole, the technologies are well along in their development. As these managers develop their functions, they may provide a valuable source of the market expertise needed in R&D planning. However, the effectiveness of the resource manager concept is as yet unproved, and in most instances the managers have not yet developed plans, obtained staff, or developed modes of action.

Although no simple prescription can be given for developing market expertise within the DOE, a few guidelines can be provided. First, the DOE should make the development of an *institutional* market capability an explicit objective (e.g., a cadre of experts possessing market knowledge and ready access to sources of information).

Building such expertise will take time and require experimenting with alternative means of obtaining information. Of crucial importance is the maintenance of continuing contact between DOE personnel and users, regulators, public officials, and various interest groups. That contact should be mutually beneficial, in that both sides gain something that they value. In some areas such contact may be a by-product of normal DOE operations. For example, the staff associated with the Power Marketing Administrations have regular contacts with public and private utilities, and loan guarantee personnel have

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<sup>1</sup>U.S. Department of Energy, *Organization and Functions Fact Book*, Washington, D.C., September 1977.

regular contacts with the financial community. On the whole, however, obtaining market information will require separate initiatives, such as specific market analyses, special efforts to promote review of program plans by the private sector, and the development of regular contacts with state and local regulators.

Second, information on market needs and constraints must be taken into account as DOE programs are planned and implemented. Although detailed consideration of how to accomplish this is beyond the scope of this Note, we briefly describe several possibilities below.

The *Program and Policy Planning System* (PPPS) provides for multiyear program plans that, together with annual budget submissions, are to be reviewed by a Program Review Board (PRB).<sup>1</sup> Although this Board has not yet functioned, a planning system is currently being developed and implemented, and a high-level panel representing line and staff offices is likely to play an important role. RA and CS might well be expected to contribute staff input concerning market factors in these deliberations.

The *Program and Project Management System for DOE Outlay Programs* (PPMS)<sup>2</sup> may provide another opportunity for marketing input. The PPMS provides for several explicit review points as a system progresses from conception through implementation. The system also includes an Energy Systems Acquisition Advisory Board (ESAAB) to advise the Undersecretary on decisions concerning major acquisitions programs. Although the Department has not yet accumulated much experience with the ESAAB, the Board's deliberations may provide an appropriate opportunity for RA and CS input on commercialization prospects for major DOE development efforts.

Major contributions to program planning cannot, of course, be limited to the deliberations of high-level bodies such as the PRB or

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<sup>1</sup>U.S. Department of Energy, Interim Management Directive 203, Department of Energy Policy and Program Planning System, September 30, 1977.

<sup>2</sup>Dale D. Myers, Undersecretary, Memorandum for Line Assistant Secretaries on Program and Project Management System for DOE Outlay Programs, May 31, 1978.

the ESAAB. Such contributions should also occur more or less continuously at the working level, but the technology programs may require an incentive to involve RA and CS in their planning process. Knowledge that senior RA and CS officials will play important roles in high-level decisions on program and project approval (and could adversely affect the future of a technology program) will provide that incentive.

If RA and CS come to be viewed as major sources of input on commercialization, they will need significant staff capabilities. Although their commercialization programs should be an important source of these capabilities, the programs do not cover all relevant markets, and in any case may lack sufficient staff resources to play this role. The DOE's field offices can make important contributions to the needed staff capability. We discuss their possible role in Section VI. The next section, which discusses the relationship between headquarters and the field offices, lays the groundwork for our recommendations.



V. RELATIONSHIPS BETWEEN DOE HEADQUARTERS  
AND THE FIELD OFFICES

In all cases with which we are familiar, the relationships between government offices in the field and headquarters reflect a variety of tensions. The most fundamental is the conflict between the desire for uniform national policies and the need for flexible and adaptive program management. Greater decentralization leads to greater flexibility and adaptability, but with a loss of uniformity in policy. This conflict appears in any large organization, public or private. It presents a particularly difficult problem for organizations that lack clear criteria by which to gauge the performance of decentralized units, as government organizations typically do.

Statements and actions of federal agency staff in Washington often reflect these underlying tensions:

- o Senior personnel in Washington generally want to exercise considerable control over activities in the field, in part because they believe themselves uniquely accountable to their superiors or to the Congress.
- o Headquarters staff frequently distrust the motivations of field personnel, who are thought to be "too close" to local political authorities or contractors.
- o Headquarters staff believe that field personnel have less understanding of policy, a belief that is likely to become a self-fulfilling prophesy if little authority is given to the field.
- o Washington officials sometimes believe that extensive delegation of authority to the field will impede their ability to respond quickly to Congressional inquiries.

These difficulties can be ameliorated by well-developed and frequent communication between headquarters and the field. As a practical matter, however, such communication is often difficult to achieve.

FIELD STRUCTURE

The DOE's situation is particularly complex both because its field components have diverse backgrounds, and because the headquarters organization is changing rapidly. The Department has not yet consolidated or fully rationalized its field structure. These facilities include:

- o The operations offices inherited from the AEC/ERDA whose geographic locations roughly correspond to historically important contractor locations. These offices were established to perform administrative functions, with little planning or policy responsibility. By taking on more extensive responsibilities in recent years, the SAN Office is an important exception.
- o The regional offices inherited from the FEA (now called the Office of the Regional Representative). Staff in these offices are familiar with regional energy needs and uses, as well as the regional regulatory and political climate.
- o The Regulatory Program Regional Offices of the Economic Regulatory Administration and the Federal Energy Regulatory Commission. These offices are responsible for the Department's oil pricing and allocation programs and natural gas regulation, interstate wholesale electric rate setting, and hydroelectric licensing programs in the field.
- o The Energy Research Centers inherited from the Department of the Interior. These centers have in-house research capabilities and were historically charged with furthering the welfare of the coal (and, to a lesser extent, oil) industry. As a consequence, they have developed close and congenial industry relations.
- o A number of project offices set up to administer large individual projects.
- o The AEC/ERDA national laboratories that were created with national security and basic research missions. Some national laboratories that possessed important technical competencies

or could provide ready staff support to headquarters have been given program planning and management responsibilities.

Rationalizing the functions of this heterogeneous group of institutions would be difficult at any time, but it is particularly difficult at present. The DOE headquarters is continually changing as it seeks to match its new functions to the organizations and personnel associated with ERDA, FEA, and the other units brought together by the Department's creation. The field role in commercialization will depend on how the line components of Energy Research (ER), Energy Technology (ET), Resource Applications (RA), and Conservation and Solar Applications (CS) sort out their missions. These offices are in different stages of development and draw on historically different organizations. Not only does each organization have its own development problems, but the separation of the commercialization responsibilities of RA and CS from the R&D responsibilities of ER and ET carries with it obvious coordination problems. Finally, the program structure is changing rapidly in response to the large variety of political pressures brought to bear on the Department.

The design of a field structure and the allocation of staff and responsibilities require careful delineation of the functions that can best be performed in the field. This includes developing methods for communicating policy and monitoring performance; allocating personnel and financial resources; and reaching agreement on the appropriate levels of initiative to be exercised by the field. The design will be largely based on the experience and the preferences of senior policy officials of the Department.

Because the commercialization function is poorly developed within the Department, delineation of field roles presents special difficulties. When the Department as a whole is uncertain about what policies to pursue and which policy instruments are likely to be successful in fostering commercialization, it will be unable to clearly assign functions to the field. Moreover, in the face of uncertainty over the nature of future DOE policies toward commercialization, individual program managers will instinctively retain as tight control

over program activities as possible. In this situation, regional and operations offices will have to adopt a pragmatic approach to developing their roles in commercialization. They must look for opportunities to perform their assigned tasks in ways that improve the prospects for commercial applications. They can help the Department to develop its commercialization policies by testing various approaches and reporting to headquarters those that seem to generate the greatest success.

At the same time, however, it is important to identify those functions for which the regional and operations offices are likely to have a comparative advantage relative to headquarters. Long-term development of the DOE organizational structure depends on reaching a consensus on the comparative advantages of the different parts of the overall organization. The remainder of this section presents some sources of comparative advantage for field units. The final section suggests short-term and possible long-term commercialization activities that field units might perform to support the Department's overall objectives.

#### SOURCES OF COMPARATIVE ADVANTAGE FOR FIELD OFFICES

Regional and operations offices have at least four characteristics relevant to commercialization of energy technologies:

- o Proximity to important markets.
- o Proximity to principal industrial and R&D capabilities.
- o Proximity to major resource bases.
- o Modest scale.

The comparative advantage of field offices lies in their knowledge of participants, processes, and institutions derived from continued day-to-day association with markets, industrial and R&D capabilities, and other local resources. Both DOE headquarters and field offices should make use of this knowledge in planning and conducting commercialization activities.

#### Proximity to Important Markets

Field office knowledge of regional industries, demographics, and other market factors can aid both R&D and commercialization programs. In general, this knowledge seems most important when markets are fragmented, such as those for conservation and solar heating equipment. The Appropriate Technology program is another important example. Even where markets are well-organized, as is the case of electric utilities, there are still important regional market characteristics that must be accounted for in R&D planning. Finally, many energy markets are regulated at the state or local level. Field offices seem more likely than Washington headquarters staff to understand state and local market regulation.

#### Proximity to Principal Industrial and R&D Capabilities

Knowledge about R&D, manufacturing, and related industrial capabilities can be useful in two ways. First, it is potentially an important resource to the DOE as a whole in its planning activities. Regional and operations office staff may be able to provide realistic appraisals of industries located within their region for the DOE planning process. Second, proximity may make an operations office a prime candidate for implementing programs that rely on nearby firms. Current examples in the SAN Office are the gas-cooled nuclear reactor and the Enhanced Oil Recovery programs in California.

Operations offices play an important role in monitoring the operations of the national laboratories. Consequently, they may be able to help the laboratories bring commercialization concepts more directly into R&D planning and operations.

#### Proximity to Major Resource Bases

Developing major energy projects normally involves sensitive relationships with numerous state and local government agencies, industrial firms, consumer and environmental groups, and citizen organizations. The continued association of operations and regional office personnel with these groups seems likely to facilitate the negotiations necessary to exploit the resource. Within the SAN and Region IX

offices, the Geothermal Energy program, the Geothermal Loan program, and the Enhanced Oil Recovery program provide examples of the field office role in developing these relationships.

#### Modest Scale

DOE headquarters is quite large, with numerous line and staff units necessary to its operations. Size, differentiation, and the diverse physical locations of the organizational units make communications difficult. In contrast, operations and regional offices are considerably smaller and provide opportunities for better communications among their constituent line and staff units. This provides the potential for more flexible and less bureaucratic operations, both in dealing with contractors and in adapting departmental policies to the needs of particular programs.

The long-term role of operations and regional offices in the commercialization of new energy technologies should reflect these areas of comparative advantage. An important short-term task is to develop regional and operations office capabilities to exploit these advantages.

VI. IMPROVING THE CONTRIBUTION OF FIELD OFFICES  
TO THE DOE'S COMMERCIALIZATION MISSION

Developing the field office role in commercialization is not a matter of establishing new procedures or planning processes that can be applied more or less across the board.<sup>1</sup> The preceding discussion suggests:

- o Commercialization problems are too diverse to handle effectively with any simple generic planning process.
- o Operational policy prescriptions require a better understanding than we now have of the means by which the federal government can facilitate commercialization of new technologies.
- o The continuing evolution of DOE headquarters, together with the need to develop policies consistent with headquarters activities, makes it premature to adopt general procedures.

In the immediate future, the DOE might best look for modest ways in which the field offices can improve the commercialization prospects for technologies in their current areas of responsibility. We deal with a few examples in the next subsection. In the longer term, more significant changes in organizational structure and function are possible. The final subsection suggests several that the DOE may want to consider.

SHORT-TERM ACTIONS

Program Actions

A first approach is to emphasize commercialization in those activities for which operations offices already have substantial

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<sup>1</sup>Most of our recommendations relate generally to DOE field units rather than to either the Office of the Regional Representative or

responsibility. Not only could such actions have a considerable pay-off immediately, but also they are less likely to raise problems with headquarters. The discussion in Section III provides some relevant guidance. For example, in the case of the SAN Office,<sup>1</sup>

- o The Appropriate Technology program could develop specific technical assistance capabilities to aid grantees in finding venture capital, manufacturing capacity, or marketing expertise. If successful, such assistance could be extended to other small business programs dealing with energy.
- o The Enhanced Oil Recovery program could document and make more widely available its successful market-oriented R&D planning process.
- o The Geothermal Energy program could develop a more active plan to bring the results of its feasibility studies for the use of geothermal heat to the attention of users. The office might develop a program of small planning grants for specific local applications.
- o A program for which the SAN Office has lead responsibility--for example, the small fuel cell--might seek to develop closer links with users (e.g., architect-engineers) and to "scope" the potential markets through marketing study contracts.
- o The Geothermal Loan program has developed a capability for venture analysis that may be of use to other programs. This program's perspective on the appropriate use of loan guarantees seems valuable and should be documented for others at the SAN and the DOE.

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operations offices. Consequently, we use the term "field office" except where the recommendation is directed particularly toward one class of office.

<sup>1</sup>These recommendations were made in the spring of 1978 and reflect the SAN Office responsibilities at that time. The Appropriate Technology Program is now managed by the Office of the Regional Representative, and the Geothermal Program is jointly managed by both offices.

In general, program changes intended to enhance commercialization and their positive or negative results should be documented for the benefit of other field offices and DOE headquarters.

#### Improvements in Office Capabilities

In Section V, we argued that a field office's geographic proximity to markets, industrial capabilities, and resource bases gives it a comparative advantage for some commercialization activities. Field offices could enhance those advantages by strengthening ties with important actors in the region or by creating specialized in-house expertise. In the case of the Office of the Regional Representative for Region IX (ORR IX) and the SAN Office, such activities could include:

- o Continued development of relations with the Electric Power Research Institute to bring electric utility concerns into DOE planning.
- o Development of closer relations between the ORR IX and SAN, in anticipation that they will become part of a more integrated field structure. Because of its responsibilities for energy use regulation, the ORR IX may possess valuable information on regional energy markets. The SAN Office and ORR IX might investigate the feasibility of establishing an energy market information service (possibly with state energy offices, major banks, and other information sources). Such information about energy markets could aid the private sector in market planning and the DOE in commercialization planning.
- o Training program staff about the options available for dealing with rights to data and patents, as well as guidelines to good practice in this area. Data rights and patents affect the commercial prospects for R&D results and represent an important aspect of the negotiations between government and private firms.
- o Identification of gaps in the field offices' familiarity with problems and actors in the region, as a guide to staff

recruitment. The field offices' contributions to commercialization depend on this knowledge base.

#### LONGER-TERM ROLES

Field offices can clearly play even stronger commercialization roles in the future as they develop a different mix of staff and program responsibilities. This, however, will require changes in DOE headquarters as well as in the field. Decentralization, while encouraged in principle, has been difficult to achieve in practice for the reasons noted in Section IV.

We discuss below three specific areas in which field offices could play more substantial commercialization roles:

- o Participation in R&D program planning.
- o Relating national laboratory activities to user needs.
- o Implementation of commercialization programs.

#### Participation in R&D Program Planning

We believe that the DOE can enhance commercialization prospects by explicitly including market information in R&D program planning. As argued in Section IV, RA and CS should be expected to provide this information and should participate in program planning. The DOE field offices, with their knowledge of regional energy markets, can be important contributors to this process.

The major differences in energy markets among regions suggest that many market analyses or reviews of program plans can be conducted in the regions themselves. Staff units within the field offices could be charged with developing appropriate understanding of the regional markets. Program offices might commission specific studies or use field office staff on a consulting basis. The field offices would also need additional resources to develop staff capabilities and conduct some of their own analyses.

In a few programs, such as Enhanced Oil Recovery, regionally based expertise has played an important role in program planning. More recently, the Program Planning and Execution Process (PPEP) has

experimented with obtaining regional comments on plans for a few DOE programs. In its recent reorganization, SAN and ORR IX agreed to create an Office of Program Assessment and Integration within the ORR IX which is charged with, among other functions, acquiring and disseminating information on regional energy markets to elements of the DOE. The effectiveness of PPEP and the SAN/ORR IX reorganization remains unproved. Moreover, these efforts were not intended to provide the independent market assessments that RA and CS would need to participate fully in program planning.

A proposal to develop such field staff capability requires careful assessment. The government may not be able to attract market-oriented individuals with the requisite skills and knowledge. Other sources of expertise, such as consulting firms, may prove more reliable and economical. It may be that the market assessment function would duplicate activities already under way within the technology development programs. One way to assess current capabilities would be to select a few technologies requiring high-level DOE decisions in the near future. RA or CS, with the support of existing staff in the field offices, could be asked to review the program proposals presented to the Program Review Board or Energy Systems Acquisition Advisory Board. If this participation proved useful, a decision to systematically develop such staff capabilities could be made.

#### Relating National Laboratory Activities to User Needs

Much of the DOE's exploratory and advanced technology development is carried on by national laboratories, which have substantial autonomy to plan and conduct R&D programs. The operations offices are now responsible for monitoring national laboratory programs and could use this responsibility to help introduce more market-related commercialization considerations into the laboratories' program strategies.

The national laboratories' role in energy R&D is controversial.<sup>1</sup> Some have argued that in certain instances the laboratories have

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<sup>1</sup>Several recent publications describe and assess the programs of the national laboratories and other field units, their structure,

become self-perpetuating institutions that are more interested in pursuing the parochial interests of their staffs than in contributing to the development of new energy sources. In other cases the laboratories are said to have become job shops responding to the narrowly perceived needs of DOE program offices. Policies toward the laboratories are said to be unclear. This Note cannot assess the validity of such concerns; rather, we suggest new roles for the field offices in dealing with national laboratory programs.

The laboratories' planning is generally driven more by technological than market considerations. This is appropriate for scientific research and the early stages of development, but less so for technological programs directed toward commercial application. Technological characteristics that are important to ultimate users may be ignored simply because the laboratory staff have little knowledge of those users and their needs.

Bringing laboratory scientists and engineers together with potential users during the course of planning the directions of a laboratory program is likely to have numerous subtle benefits. Operating considerations of the utilities may affect the scale of the plants they will be interested in purchasing. Some directions of technology development may lead to fewer production problems than others. Knowledge of work within the laboratory may lead private sector firms to carry out complementary R&D activities on their own in anticipation of their ultimate value in commercializing the technology. However, this kind of continuing consultation and involvement is difficult to bring about. Organizations seem to have a natural instinct to internalize planning and to emphasize serving the needs and interests of

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and federal policies toward them. See *The Multiprogram Laboratories: A National Resource for Nonnuclear Energy Research, Development and Demonstration*, U.S. General Accounting Office, Washington, D.C., May 22, 1978; *The Report of the Field and Laboratory Utilization Study Group (FLUS)*, U.S. Energy Research and Development Administration, Washington, D.C., December 1975; *The Role of the National Laboratories in Energy R&D*, Vol. 1, Hearings before the Subcommittee on Fossil and Nuclear Research Development and Demonstration of the Committee on Science and Technology, U.S. House of Representatives, 95th Cong., Washington, D.C., January 1978; and *Concept Paper on Establishing Technology Centers for Nuclear Programs at Major DOE Laboratories, Final Report*, undated paper prepared in late 1977.

their own members. Without outside pressure, the laboratories may be expected to plan in relative isolation.

The operations offices could work more closely with the laboratories to involve potential users of new technologies in the laboratories' R&D planning. Operations office staff now have regular and continuing relations with senior laboratory staff and review program plans. They could identify opportunities for conferences bringing together laboratory and private sector personnel. Their knowledge of energy markets could help direct laboratory R&D toward the needs of potential users.

To perform this function, the operations offices need individuals with good institutional knowledge who know the relevant markets and potential users. The operations offices must also have a well-developed understanding with headquarters and the laboratories concerning the division of responsibilities among them. Continuity in the activities is required so that private firms can see the results of their participation.

#### Implementation of Commercialization Programs

Some commercialization activities involve national policies, such as tax incentives or price supports. Others confront more local non-economic barriers to commercial adoption, such as conflicting federal, state, and local regulations. Field offices can play useful roles in implementing these efforts.

Where uncoordinated and overlapping regulations exist, federal agencies can support local efforts to resolve the conflicts. Addressing the environmental issues surrounding geothermal energy development in California provides one example, as discussed in a 1978 Rand report.<sup>1</sup> The federal government, which has a legitimate interest in fostering the use of energy technologies, may also be able to bring conflicting groups together without antagonizing them. As another recent Rand study concludes, the DOE field offices can play a major role in this process:

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<sup>1</sup>P. L. Ellickson, S. T. Brewer, and K. D. Knight, *Balancing Energy and the Environment: The Case of Geothermal Development*, The Rand Corporation, R-2274-DOE, June 1978.

been active in each area in recent years, but this activity seems to be more the result of isolated initiatives by knowledgeable staff members than a conscious organizational plan. If the regional and operations offices are to perform these roles in a more coherent and significant way, a number of important changes will have to take place. We list a few of these here.

1. *Field Office Relations with the Offices of Resource Applications and Conservation and Solar Applications.* Resource Applications and Conservation and Solar Applications carry out commercialization programs. As we have suggested, they could also be given responsibility for bringing market information into R&D program planning. Consequently, strong and supportive relationships among RA, CS, and the field offices are essential. Moreover, field offices are more likely to be called on if they possess skills and competencies that are not available at headquarters. This implies that the relative roles of RA, CS, and the field offices must be well defined and then developed in a coordinated and mutually supportive manner.

2. *RA and CS Roles in R&D Program Decisions.* If market information and user concerns are to be more significant factors in determining the DOE's R&D portfolio, systematic means must be found to induce the technology development programs to pay attention to these concerns. The mechanism proposed here is to make RA and CS important parties to the decisions concerning new or redirected technology programs.

The DOE is moving toward systematizing its decisionmaking processes. The next several years should see increasing regularity in these processes as the various organizational entities clarify their roles and come to understand the procedures. We are arguing that an important staff role should be assigned to RA and CS, and that these two offices should move to organize and staff themselves accordingly. Most of that staff might be expected to be in the field.

3. *Relationships with Headquarters.* Although there are many opportunities for misunderstandings between headquarters and the field during program implementation, there are also precedents for

successfully defining roles and responsibilities. For example, the management plan for the Solar Thermal Electric Project seems to define clearly the roles of all actors. Recently an agreement has been reached concerning the division of responsibilities for the Geothermal Loan program. This kind of agreement should be a regular feature of any program activity where there are shared responsibilities between headquarters and the field.

Such agreements will be particularly important if our recommendation for a greater field office role in national laboratory R&D planning is followed. The agreements would obviously have to include the laboratory as well as headquarters and operations office responsibilities. Presumably this means the involvement of Office of Energy Research staff who are responsible for DOE policies toward the laboratories, as well as the leadership of the laboratories.

4. *Field Office Staffing.* Much of the staff activity associated with the proposed roles involves interaction with the private sector. Collecting and using market data or convening planning meetings with firms and local government agencies requires knowledgeable, experienced staff with good communication skills. This suggests that the field offices need to survey their existing staff qualifications before implementing the proposals made here. Additional training will probably be required. A regular system of rotating personnel between headquarters and the field might prove helpful. Careful attention should be paid to developing a grade structure that will attract qualified staff.

5. *Capacity for Initiatives.* An important factor affecting the success of proposals such as those made here is the credibility of the field staff with private firms and other regional actors. The nonfederal participants will want to know how the field office staff relate to headquarters. They will need assurance that the information developed by these offices will be reflected in national actions. And they need to feel that the field office staff can take appropriate action to deal with local problems without extensive negotiation with headquarters.

Negotiating the relative responsibilities in specific program implementation will help clarify the field office roles. Perhaps equally important, the regional and operations offices should have some funds for studies and conferences that support their commercialization missions. If nonfederal participants believe that the field offices are totally dependent on headquarters for funds to support such activities, they will bypass the field office staff and try to deal directly with headquarters.

#### CONCLUSION

We believe that there is a strong case for an important role for field offices in fostering the commercialization of energy technologies. Some part of that role lies in directly implementing commercialization programs. More important, however, is the role in the planning stages of R&D. Perspectives developed by field office staff in their day-to-day contact with developers of energy resources, performers of energy-related R&D, state and local officials, and potential users can be vitally important in R&D program decisions.

The capacity of field offices to participate in planning for energy technology development programs is unevenly developed. The mechanisms for formally involving these offices in planning do not exist. This Note has suggested some of the benefits from such involvement and has proposed general means by which it could be brought about. It is not a simple or a quickly accomplished task. We believe, however, that extending the field office role in R&D planning will improve the commercialization prospects for technologies developed by the DOE.



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