Chapter 1

Executive Summary

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Appropriate technology (AT) involves an attempt to tailor the scale and complexity of a technology to the job it needs to do. AT has been proposed by some of its advocates as an answer to many of the social and economic problems created by large-scale, centralized technology in both the industrialized countries and the Third World. Through greater diversity and decentralization, they argue, it is possible to achieve a "technology mix" that makes more effective use of limited capital and is better adapted to, and less disruptive of, the social and natural environment. Large-scale approaches may be necessary for some tasks, but for others it is possible to scale down existing technology or, in some cases, to replace it with more traditional methods that have been improved on through the application of advanced materials, designs, or techniques. Ideally, AT emphasizes resource efficiency, environmental soundness, community control, and labor rather than capital intensiveness.

AT proponents cannot always agree on exactly what the concept entails, however, and its emphasis has changed and broadened over the last 10 years, depending on where and when it was applied. In one of its earliest forms, AT was proposed as an alternative approach to economic development in the Third World. Observers like British economist E. F. Schumacher noted that when an advanced, capital-intensive technology is introduced into a developing nation, it sometimes crates as many social and economic problems as it solves. What is needed, Schumacher suggested, is an "intermediate technology" that is far more productive than traditional methods but is still more labor intensive (and less capital intensive) than the sophisticated, large-scale technologies of the industrialized nations.

In the past few years, on the other hand, a growing number of appropriate technologists have come to view themselves as pioneers, operating "at the frontier" in several areas of applied science. They argue that much of what is called AT is in fact a particular kind of advanced technology, one designed for changing resource conditions. In response to the current economic environment, for instance, a number of relatively sophisticated technologies have been de~'eloped that are efficient users of energy and material resources. In this view', the main challenge is to integrate numerous applications of AT in efficient, sustainable systems in the local community.

OTA's exploratory study is not intended to be comprehensive. Nevertheless, the AT projects examined in this study exhibit a great diversity in size, complexity, and location. They range from attached solar heating greenhouses built by individual homeowners in New Mexico to a plant that converts municipal waste to steam heat for downtown Akron, Ohio; from a heat-retentive house designed for low-income families in Alaska to a cooperative market for small-scale farmers in Louisiana; and from an innovative sewage treatment plant in California to a pair of recommissioned hydroelectric projects in New England.

Congress has frequently taken the lead in promoting the development of AT. This interest was demonstrated by the creation of the National Center for Appropriate Technology by the 94th Congress and the Office of Small Scale Technology within the Department of Energy (DOE) by the 95th Congress. In June 1978, OTA was asked to conduct an exploratory study to:

- assess the conceptual base for AT;
- assess technologies which are appropriate for local community development; and
- collect information on promising new technologies now being innovated in energy, waste disposal, housing, agriculture, and health that may provide an alternative and possibly more effective approach to community and regional development.

The request for the OTA study came from Senators Ribicoff, Percy, Javits, Humphrey, Leahy, Brooke, McIntrye, McGovern, and Hart, as well as Representatives George Brown, Scheuer, and Udall.

Findings

The projects examined in this study had widely varying objectives, and their significance can be quite different when viewed from the national perspective instead of the local. Thus, no simple judgment of "success" or "failure" can be applied: each case must be examined from both points of view.

Viewed broadly, local development is not always simply a question of economic growth as conventionally measured. Efficient and cost-effective municipal services—the goal of several of the projects—are a necessary underpinning to local development, as is the availability of health care and the affordability of housing.

Creating employment and new industry was not the principal objective of the projects examined. Nevertheless, one project saved local jobs that otherwise would have been lost, and other projects provided help in severely depressed areas by creating temporary jobs and by providing marketable training and work experience. Some of the projects helped to improve the viability of existing enterprises (small farms), and others could create significant opportunities for small business (notably in the construction and home-improvement sector).

From the local perspective, the primary significance of these projects *is their potential for reducing—or at least stabilizing—the real costs of community services.* The following are some examples taken from the case studies:

1. *Waste management and resource recovery.—*
   - reduce the operating costs of secondary wastewater treatment;
   - use municipal solid waste as a fuel to generate steam for use in the downtown area;
   - recover materials from municipal wastes, including compost and water as well as aluminum, glass, iron, and steel;
   - reduce the volume of sludge and other residues that must be disposed of; and
   - reduce the air, water, and land pollution associated with waste management.
2. *Energy.–*
   - reduce the energy consumption of wastewater treatment facilities;
   - develop new sources of energy for municipal services and local industrial use; and
   - recommission abandoned or underutilized energy-generating facilities for local use.
3. *Health care and* social *services.—*
   - *increase the* availability of primary health care;
   - reduce the cost of medical services; and
   - provide community activities for the elderly and the handicapped.

On the national level, projects also address several important and vexing problems that will face the United States during the next 20 *years.* If these and similar efforts are replicated on a nationwide basis, the results could be significant in the following areas:

- greater *energy* conservation in *the* residential sector—which currently accounts for over 20 percent of U.S. energy consumption—could make an important contribution to achieving the national goal of independence from imported oil;
- new Production and marketing techniques *for* small-scale *farmers may* contribute to the retention *of the* Nation's farmland-which is being converted to nonagricultural use at the rate of 1 million acre/yr;
- alternative wastewater treatment technologies could reduce the cost of expanding and upgrading the Nation's *sewage* treatment facilities—an enormously costly process that might otherwise be beyond the available resources of Federal, State, and local governments;
- installing *new* generating *capacity at existing* damsites--many of which are abandoned or underutilized, could greatly increase the Nation's supply of hydroelectric power; and
- community health centers *and prepaid health plans could lead to significant savings in the cost of health care—which* now consumes almost 10 percent of U.S. gross national product.

Given these potential national benefits, the process by which the technologies were adopted and the potential barriers to their replication by other communities become important considerations. Close attention to local needs, goals, and resources was found to be an essential factor in most of the successful projects. In some cases, a significant barrier to transferability was the availability of reliable information on the design, cost, and performance of the technologies themselves. In other cases, the barriers were institutional: opposition from commercial interests; reluctance on the part of engineers, builders, or lending institutions to accept innovative designs; and insensitivity in the application of building codes, waste management guidelines, medical practice laws, and other regulations by various levels of government.

Existing Federal policies and programs have been relatively effective in encouraging the development and adoption of AT projects like those examined in the case studies. Based on these case studies, *there appears to be no justification for a new, centralized Federal effort to promote such projects; existing programs could, however, be improved in four specific areas:*

- *gathering reliable data* on the design, cost, and performance of the technologies, either through modified project design, redirected research, or expanded Federal monitoring efforts;
- *information dissemination,* both through regional "demonstration projects and through the encouragement of networking and other informal, local mechanisms for information exchange;
- *technical assistance,* including both community workshops for individuals and planning aids for municipalities; and
- *financial assistance,* such as tax credits or cost sharing for individuals and risk sharing for municipalities.

The Case Studies

Resource-Efficient Residential Architecture

In 1977, energy consumption for heating and cooling in the residential sector totaled 17 quadrillion Btu, or almost one-quarter of total U.S. energy consumption. Rising energy prices and potential supply shortages have forced architects and builders to develop residential housing designs that are less dependent on fossil fuels. Some houses being built today require less than one-fifth as much energy to maintain acceptable inside temperatures as typical housing stock built in the 1970's. A few new heat-retentive designs promise to all but eliminate the need for backup heating. Several alternatives are discussed in five case studies:

- solar heating greenhouses in New Mexico, which collect heat from the sun for use in both the greenhouse and the house to which it is attached, and which can be built by individual homeowners at a low cost, often with scrap or salvaged materials;
- the "Ark II, " a passive solar-heated house designed by Solsearch Architects for the Cooley family of Washington, Corm., and built by the Cooleys, which incorporates the patented "solar staircase" roof and a number of advanced building materials;
- the "Conserver Home" on Prince Edward Island, Canada, also designed by Solsearch Architects, a low-cost house that uses "Arkansas framing," thick insulation, and other design features to retain the heat given off by the occupants and their activities, thereby greatly reducing the need for supplemental heating;
- the "Bethel House," designed and built by the faculty and students of Kuskokwim Community College in Bethel, Alaska, another low-cost heat-retentive design that uses superinsulation and a number of innovative design features that conserve building materials as well as energy in a demanding climate; and
- the "thermal envelope" house, built by Tom Smith near Lake Tahoe, Calif., which consists of a "house within a house" that combines a solar greenhouse, convection currents, and a buffer space to produce a house that is less expensive to heat in the winter and cool in the summer.

These and similar designs promise considerable energy savings for individual families, but the costs of the solar and thermal-envelope houses are such

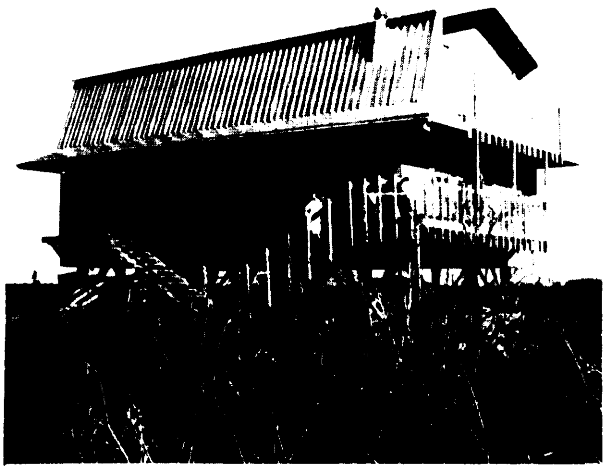

Photo credit: Office of Technology Assessment

Bethel House, Bethel, Alaska

that they are being built primarily for the middle- and high-income custom housing market. The attached solar greenhouse offers a low-cost retrofit that can be applied to existing homes in many locations, and the Conserver, Bethel, and other heat-retentive designs show considerable promise for new low-income housing. At present, however, there is a lack of reliable data on the cost and performance of some of the designs, and no "preferred" solutions have gained general acceptance from financial institutions or the building industry.

Food-Producing Solar Greenhouses

Solar greenhouses have two features of special interest: they can provide a year-round source of fresh, locally grown produce, even in the coldest climates; and, unlike conventional greenhouse production or the mass distribution of remotely grown winter vegetables, they do not require large quantities of oil or other fossil fuels. By combining these two benefits, solar greenhouses may be able to reduce the food budgets as well as the energy budgets of individual families, community groups, and the Nation as a whole.

The 5,000-ft^2 Cheyenne (Wyoming) Community Solar Greenhouse is the largest freestanding solar greenhouse in the United States. Funded by grants from the Community Services Administration, the project was notable for the degree of community participation in the planning, construction, operation, and management of the greenhouse. It has also provided job training for students, alternative service for youth offenders, educational opportunities for children, and activities for elderly and handicapped members of the community. Produce grown in the greenhouse is distributed to low-income and elderly volunteers who work there and through local meals programs.

The project has been less than successful when evaluated strictly as a food-producing enterprise. It has encountered a number of design and operation problems, crop yields have been low, and it has yet to become self supporting. Although the project was successful in delivering social services, there has been no study of whether this kind of project is the most cost-effective way to deliver those services.

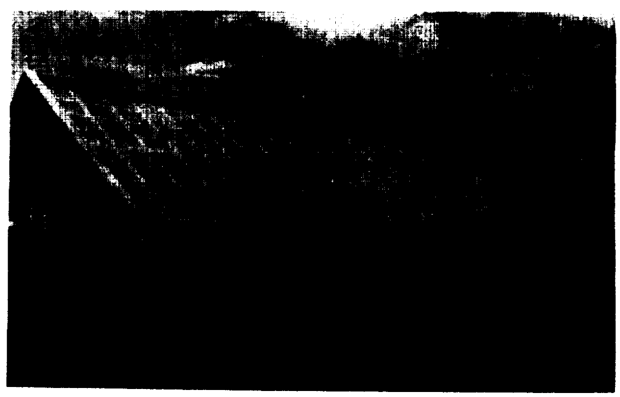

Photo credit: Office of Technology Assessment

Cheyenne Community Solar Greenhouse, Cheyenne, Wyo.

Small Farm Systems

The three major operating costs associated with farming–feed for livestock, fertilizer for fields, and fuel for machinery and buildings–have all been affected by rising petroleum prices. These factors have endangered the economic viability of the small family farm. The New Life Farm (NLF) and Small Farm Energy Project (SFEP) are two attempts to reduce the energy costs and increase the self-sufficiency of small-scale agriculture in their regions.

NLF is developing a "system" of alternative energy sources and energy-conserving farming techniques suited to the needs of low-income farmers in the Ozark Mountains of Missouri, a region of thin and badly eroded topsoil. Their principal innovation has been the biogas digester, in which the anaerobic decomposition of manure or plant wastes produces a gas that is 60 percent methane. This gas can then be burned to heat the farmhouse, to generate electricity, or to distill alcohol as a fuel for farm machinery.

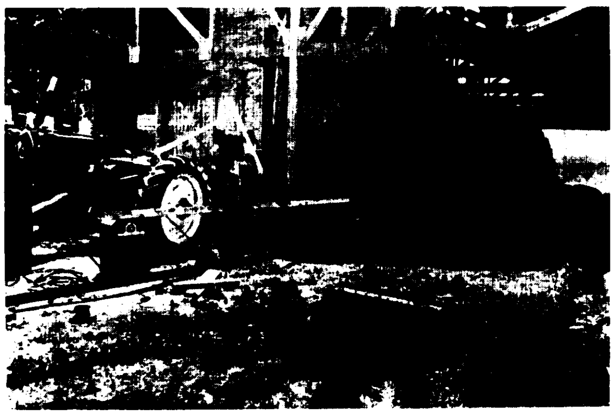

Photo credit. New Life Farm

Digester building, New Life Farm, Drury, Mo.

SFEP, in Cedar County, Nebr., is a 3-year program to demonstrate how far a group of low-income farmers can progress toward energy self-sufficiency when provided with technical and cost-sharing assistance. The farmers were introduced to proven, primarily solar technologies through a series of seminars, hands-on workshops, and lectures by farmers from other areas who had undertaken similar projects. They were then allowed to select the projects that would best suit their farming operations. About half of the projects involved conservation measures, a few involved improved farming methods, and a third involved applications of renewable energy sources, including a wind generator, a portable solar collector, two solar grain dryers, and a solar-heated farrowing barn.

Both of these projects promise considerable benefits to the small-scale farmer, but SFEP had a far greater impact on the local community, largely because it made a greater attempt to involve the community in the planning and execution of its programs. Self-selection by the innovating farmers was a particularly valuable feature, and the project seems to have had a considerable effect on non-participating members of the community, many of whom undertook similar conservation steps.

Farmers' Markets

Cutting production costs is one way to improve the profitability of small-scale agriculture; another is the time-honored practice of marketing produce directly to the consumer. Case studies of six farmers' markets–in Rutland, Vt., Morehouse Parish, La., Ravinia, Ill., Boston, Mass., Baltimore, Md., and Seattle, Wash.—show that this food-marketing technology can still benefit farmer and consumer alike. The markets were organized by a variety of local groups, including farmers, consumers, businessmen, municipal governments, and local extension agents. All of them, however, depend vitally on the participation of farmers and local consumers, and when the needs and convenience of these groups were given greater attention the success of the market was more assured.

Most of the farmers' markets contributed to local development, primarily by expanding the local market for fresh produce or creating markets where none had existed before. The profitability of direct marketing led local farmers to diversify their crops and improve their farming methods, and several of them said that the farmers' market had influenced their decision to keep their land in production. Nationwide, the availability of similar local markets may help to prevent the further "paving over" of farmland near urban centers.

Resource Recovery From Municipal Solid Waste

The United States generates over 135 million tons of municipal solid waste (MSW) each year, and its disposal is a rapidly growing problem in many areas. Conventional methods, such as open dumping, landfill, incineration, and ocean burial, are either too expensive or environmentally unacceptable. Interest is also growing in methods of recovering valuable resources of MSW, which contains two-thirds of the national consumption of paper and glass, one-fifth of the aluminum, and over one-eighth of the iron and steel. In addition, the combustible portion of this waste could, if burned, provide almost 2 percent of the Nation's annual energy consumption. Improved resource recovery technologies could, therefore, contribute not only to inexpensive and environmentally sound waste management but also to energy conservation and the more efficient use of material resources.

In Akron, Ohio, the steam that heats many of the downtown buildings is now being provided by the Recycle Energy System (RES), a centralized recovery facility that uses combustible MSW as fuel and also recovers ferrous materials for sale. The project has contributed to the revitalization of the previously deteriorating central business district. To assure itself of an adequate supply of MSW, however, the city was forced to pass a controversial ordinance requiring private haulers to dump at the RES site. The ordinance is currently under legal challenge, and if the decision goes against the city it may jeopardize the future of the project.

Photo credit: Teledyne National

Recycle Energy System, Akron, Ohio

In New York City's South Bronx, the Bronx Frontier Development Corp. has established a comporting operation that converts vegetable wastes from a nearby produce market into humus, an essential soil conditioner. Some of the humus is sold commercially, but most of it is donated to various community groups that are turning rubble-strewn lots into parks and gardens. The project has encountered some difficulties with State sanitary codes and with funding; it may, however, be able to become self-supporting if it increases its tipping fees and its commercial sales.

Both projects demonstrate promising alternatives for resource recovery from MSW, but they also demonstrate the problems associated with the control of the "waste stream' '—RES with an adequate quantity of waste and the Bronx project with waste quality. Federal initiatives may be required to resolve this issue.

Community Wastewater Treatment

The General Accounting Office has recently concluded that, due to the scope and enormous costs of upgrading the Nation's sewage treatment system, it is imperative that lower cost approaches be found for providing this community service. The Solar AquaCell treatment facility in Hercules, Calif., is one such alternative. The facility consists of a series of lagoons, enclosed in a greenhouse cover, in which wastes are consumed by water hyacinths, duckweed, small marine animals, and bacteria. The system is still too new to make a definitive evaluation, but it promises to use less energy and chemicals than conventional systems. The biological components of the system are fairly hardy, which may also give the facility increased flexibility in adapting to varying types and concentrations of wastes.

The AquaCell facility was a municipal undertaking with relatively little community input, but

Photo credit: Office of Technology Assessment

Solar AquaCell Treatment Facility, Hercules, Cal if.

it has subsequently received widespread support from local citizens, many of whom have taken steps to reduce their water consumption. The city's unique revenue base made development possible without Federal funds, and this has freed Hercules from the constraints on its growth that might otherwise have been imposed by regional sewage planning. However, it also raises questions about the transferability of the technology to communities that lack similar financial resources, although the Environmental Protection Agency's (EPA) Innovative and Alternative Technologies Program has made some funds available for this purpose.

Photo credit: Elizabeth Pezzoli

Tremont Dam, Wareham, Mass.

Community Energy Generation

Hydropower, which represents 13 to 15 percent of U.S. electrical generation, is currently the most widely used renewable source of energy in the United States. Price increases for fossil fuels, as well as environmental considerations, have made hydroelectricity increasingly attractive over the last 10 years and have stimulated interest in developing the Nation's hydropower potential. A recent survey by the U.S. Army Corps of Engineers suggests that current capacity could be greatly increased simply by upgrading current facilities or by installing generators at existing damsites that do not currently produce electricity. Small-scale dams, with their lower capital costs, are particularly attractive for this purpose; about two-thirds of these dams are located in New England.

Woonsocket, R. I., is converting an existing dam to generate electricity. The project was undertaken at the encouragement of the State Energy Office and was initially supported by a feasibility study grant from DOE; the voters subsequently approved a municipal bond issue to fund the major part of the construction. Electricity from the dam will be used to run the regional sewage treatment plant and the city waterworks, surplus power will be sold to the local utility company. A similar project in Wareham, Mass., has run into trouble because of the city's insistence on funding the project entirely through grants, Wareham plans to sell all of its power to the local utility company.

The Wareham project demonstrates the difficulties that can arise from dependence on the grant's economy, but both projects illustrate the benefits of developing underutilized local resources. Power from these and similar projects elsewhere can be applied to local energy needs, either for cutting the costs of municipal services, for sale to the local utility company, or for attracting industry to the area. Both projects received general support from local residents, although widespread misconceptions about the size and uses of the projects existed in both communities.

Community Health Care Systems

The Hyde Park-Kenwood Community Health Center was organized by local residents as an alternative to the fragmented and often inadequate health services on Chicago's South Side. Initial funding was provided by a Federal grant and the sale of $110,000 in debentures to members of the community. The center is currently operating in the black. Located on the second floor of a rehabilitated building, it provides primary health care for three types of patients: private patients who pay on a fee-for-service basis; those who are covered by medicare and medicaid; and those who belong to prepaid health plans through their employers or unions.

The center is managed by a board of directors elected by its dues-paying members, but Illinois law requires a separate medical group; as a result, the issue of community control is still unresolved. The center has increased the availability of primary health care and reduced its costs, however, and its programs of preventive medicine and health education could help to improve the gener-

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al health of the community. Widespread creation of similar health maintenance organizations in other communities could have a significant impact on the enormous cost of health care in the United States. However, the human and financial resources found in Hyde Park-Kenwood would not be available in most inner-city areas, and entirely different approaches will probably be required in rural areas.

Critical Factors

The uniqueness of some of the projects, which might limit the transferability of the technologies to other communities, was largely the result of special conditions or resources—human, financial, or material. Nevertheless, a number of lessons were learned about those factors most likely to affect the success or failure of individual projects and their transferability to other communities.

Public Perception and Participation

Public participation was not a major factor in the municipal projects, although greater citizen involvement might have encouraged the consideration of alternative approaches in the planning stages. Participation by local residents was more important in projects undertaken by community groups, such as the health center and the various farmers' markets. A high degree of public interest and involvement was essential—almost by definition—in individual projects like the small farm systems and passive solar houses.

Technical Information and Expertise

The availability of technical information and expertise was found to be essential for the successful planning, construction, and operation of all of the projects. In the larger projects, city planners and engineers demanded reliable data on the capital costs and technical performance of the technology; where this information is lacking, professional resistance and financial difficulties can be expected. In the less complicated community undertakings, the need for information can often be met through "networking" among groups that have similar interests. In the individual undertaking, on the other hand, the greatest need is for personal hands-on experience in design and construction; community workshops and individualized technical assistance were successful in transferring these skills and information.

Essential Resources

The availability of essential resources–material, capital, and institutional—was most commonly found to be unique to the community and therefore most likely to affect the transferability. An apparent lack of resources was often overcome by determined and imaginative organizers working from within the community. Some of the most promising technologies—the manure digester, for instance—were based on what might to outsiders seem to be the least promising resource base.

Financing

The forms of financing used by the projects were almost as varied as their financial needs. Grants were most effective as initial seed money, either to attract conventional financing or to allow the projects to become self-supporting; projects that continued to depend on grants, contracts, or subsidies were less successful. Cost-sharing assistance and grants for community workshops were effective mechanisms for encouraging widespread adoption of some of the small-scale technologies, such as farm energy systems, solar greenhouse retrofits, and residential conservation strategies. Large-scale municipal projects, on the other hand, may require Federal intervention to reduce financial risks and attract conventional financing.

Institutional Factors

Some of the projects encountered resistance from commercial interests, who feared competition, or professional interests, who were leery of innovative but unproven approaches. The development of the AquaCell was impeded by the current state of the venture capital market. Financial institutions generally were hesitant to underwrite innovative projects. Some of the projects also experienced opposition or insensitivity from regulatory and other government agencies. Building codes, waste management guidelines, and medical practice laws were a particular source of difficulty.

Options for Federal Policy

A variety of Federal policies have contributed, directly or indirectly, to the development and adoption of these technologies, and existing Federal programs, for the most part, have seemed effective. However, a number of criticisms have been raised concerning their extent, coordination, and management. There appear to be four principal areas in which Federal programs for local development might be modified and improved:

- data gathering;
- information dissemination;
- technical assistance; and
- financial assistance.

Data Gathering

The technologies examined in the case studies were at varying stages of development, but most of the projects would have profited from more reliable data on the design, cost, performance, and/or reliability of the technology itself, as well as on the experience of other communities in applying it. Some of the case studies, however, involved technologies that were being applied for the first time in a full commercial- or municipal-scale facility; in other cases, the local development project involved an innovative application of a proven technology. The future dissemination of both types of technologies could be assisted by comprehensive evaluation and comparison with more conventional approaches.

There are a number of steps that can be taken by Federal funding agencies and local project organizers to ensure that adequate data-gathering is in fact carried out. These steps include, but are not limited to, the following:

- *modify project design* to include a strong data-gathering component, where possible, by providing additional funding or earmarking a portion of the project's funds specifically for data gathering;
- *redirect existing research* to gather not *more* data but a different *kind* of data, particularly where human behavior is a significant variable (e.g., solar-heated houses and resource recovery); and
- *support and expand cur-rent Federal monitoring programs,* like 'those undertaken by the National Center for Appropriate Technology, to provide assistance in assessing the performance of existing projects for energy-efficient housing and agriculture.

Information Dissemination

Even when a technology is fairly well developed in one project, its diffusion can be impeded if other potential developers are unaware of the project or unable to obtain detailed data on design, costs, and performance. In some cases this will cause communities to overlook a promising alternative, in other cases it will result in resistance from engineers and financial sources who consider the project too risky, and in a few cases it might cause the failure of a project because its organizers were unaware of the problems, and solutions, that have been discovered in similar projects elsewhere. This problem can be compounded if Federal activities in the field of AT are not explicitly identified as such.

The problem of information dissemination can be addressed through a number of measures—local, regional, and national–including but not limited to the following:

- *encourage networking* between local and regional groups with related interests. This was effective in organizing farmers' markets in Boston and disseminating information on small farm systems in Nebraska. Federal agencies, particularly those like the Agricultural Extension Service and the Community Services Administration that have extensive local representation, are in a good position to encourage the establishment of such networks throughout the Nation;

- *establish regional demonstration projects,* which were particularly effective in stimulating public interest and promoting further adoption of proven, cost-effective technologies by local residents in Nebraska, Wyoming, and New Mexico; and
- *encourage information exchange* between different levels of government, and between government and private industry, by creating and funding a more extensive program of regional panels, seminars, and workshops at which interested parties could be exposed to recent developments in their fields; both EPA and the Federal Home Loan Bank Board have established such programs.

Technical Assistance

Even when reliable design and performance data are available, the development of a particular project will not be possible unless an adequate skill base exists, or can be developed, in the local community. This can be a problem even with the simplest of the projects, although the skills needed for planning and building an attached solar greenhouse, for instance, can be taught rather easily. In the case of the larger municipal projects, even the expertise needed for planning the project or determining its feasibility may be beyond the means of a given community.

There are a number of approaches to this problem. Direct, project-related technical assistance usually involves greater Federal involvement and greater expense; skill transfer and other indirect assistance usually cost less and benefit the community more, since the skill base they develop will remain in the community after the completion of the project. The following represent a range of options for technical assistance:

- workshops were highly effective for the simplest of the projects, particularly those that are to be built by individual homeowners or farmers, and were also successful in demonstrating the technology in the local community and stimulating additional installations;
- *training programs and seminars,* like those of the Small Farm Energy Project, can expose local residents to a wide variety of potential applications and provide valuable skills;
- *one-on-one technical assistance* from organizers and outside experts was useful in helping farmers to build solar installations in Nebraska and organize a farmers' market in Louisiana; the existing extension program of DOE and the U.S. Department of Agriculture could be used as a mechanism for this form of assistance;
- *computer models and other planning aids* allow small communities to conduct low-cost site evaluations and feasibility studies for small-scale hydropower projects, farmers' markets, and community health care centers; similar technical and organizational guides for energy-efficient housing and farm systems, resource-recovery systems, and wastewater treatment facilities would allow other communities to conduct their own evaluations and planning, without the need for extensive Federal involvement or funding; and
- *expert assistance panels,* like the teams of technical, financial, -marketing, and institutional specialists provided to State and local governments through EPA's Technical Assistance Panels Program, might be useful in promoting the consideration, adoption, and construction of local projects for wastewater treatment, energy generation, and health care.

Financial Assistance

Some of the technologies had the virtue of low cost, which allowed them to be developed by local communities. In several of the case studies the costs of the project were minimal and the project rapidly became self-supporting. This was particularly true of the farmers' markets and some of the energy-saving retrofits for residential and farm buildings. Some of the large projects, however, involved initial investments or economic risks that could be too great for some communities to bear without governmental assistance. Given the potential expense of these municipal services and the potential benefits to the Nation of developing innovative methods of delivering them, it might be appropriate that the Federal Government intervene to reduce the financial risks and burdens they might impose on local communities.

Several of the projects examined in the case studies could be replicated by other communities without Federal financial assistance. However, where assistance is necessary there are several ways in which the Federal Government can help hold down the cost to the local community and encourage adoption. These measures include, but are not limited to, the following:

- *technical risk reduction,* through efforts to gather and disseminate reliable information on the technologies (particularly cost-benefit and lifecycle cost data), can reduce the financial risks of the projects and prevent costly planning errors;
- *financial risk sharing,* including risk guarantees for the correction of facilities that do not work properly (available under EPA's Innovative and Alternative Technology Program) or tax-free bonding for municipal projects, might encourage the consideration of alternative technologies;
- *tax credits and other incentives,* such as the Residential Energy Credit, might encourage the adoption of several of the smaller technologies (current Internal Revenue Service guidelines do not allow credits for attached solar greenhouses; extension of credits to include farm installations might also promote the more rapid adoption of biogas digesters and onfarm solar installations);
- *investment tax credits and accelerated depreciation* might encourage the commercialization of some of the technologies and the creation of small local businesses to produce and/or install necessary equipment; and
- stimulating markets through Federal procurement guidelines, like those for recycled steel, might ensure a market for locally grown produce or for materials recovered from municipal waste.

Options for direct Federal financial assistance include the following:

- *provide short- and medium-term loans and grants* for long-term planning and front-end costs (i.e., feasibility and market studies);
- *provide long-term financing options* for community projects with favorable lifecycle costs, projects that might otherwise have to be financed with short- and medium-term debt: and
- *establish financial intermediaries,* authorized to make direct loans to community-based AT projects, in order to spread risk and reduce information and transaction costs.