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Satellite Power System (SPS) Public Acceptance

October 1978

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Office of Energy Research
Satellite Power System Project Office
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DOE/NASA
SATELLITE POWER SYSTEM
Concept Development
and
Evaluation Program

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Prepared by:
Arrie Bachrach
Environmental Resources Group
Los Angeles, California 90048
for the
PRC Energy Analysis Company
McLean, Virginia 22102

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Dr. J. Bruce Gerding
TRW, Inc.

Mr. James Moyer
Consulting Scientist, Research & Development
Southern California Edison
P.O. Box 800
Rosemead, California 91770

Dr. Donald Bright
Director, Environmental Affairs and Commerce
(Director, Sohio Study Project)
Port of Long Beach

Dr. Bacow
Massachussetts Institute of Technology
Cambridge, Mass.

Dr. B. J. Bluth
Sociology Department
California State University, Northridge

EXECUTIVE SUMMARY

The purpose of this report is to develop a preliminary perspective on the public acceptability of the Solar Satellite Power System (SPS) Program, and a means to monitor it. The report begins with a discussion of various recent trends that have made public acceptance of large-scale programs more important - and also more difficult - to achieve. Some elements of the public acceptance process are described: an issue or program becomes known, opinions form and evolve, coalitions often develop and the public debate heats up. Interests (usually organized groups) who feel most directly affected learn and develop viewpoints about a given proposal before the general public does. In terms of this process, the SPS program's existence currently is virtually unknown to the American public. Environmental and energy interest groups know about the program, although many of these groups have as yet taken no official position. Increasingly, the SPS concept, once considered fanciful, is being taken more seriously by energy planners, public officials and concerned interest groups.

A literature review and informal contacts with interest groups likely to take a position on the program reveal a number of concerns (anti-SPS arguments), as well as potential benefits (pro-SPS arguments). The concerns expressed include: environmental issues (microwaves, high altitude air pollution from space launches, land use), the program's cost in dollars, energy and other resources; communications interference; military implications; ownership and control of the system (particularly strengthening the power of utility monopolies); SPS as representing a centralized, high technology "hard" energy policy (rather than a decentralized smaller-scale "soft" approach); and the fear that SPS might dominate solar R&D budgets at the expense of decentralized solar technologies. Pro-SPS arguments stress its efficiency compared to terrestrial solar applications (i.e. virtually continuous exposure, no atmospheric attenuation). The program could be a major contributor to solving America's (and the world's) long-term energy crisis. It would improve our balance of payments; create many jobs both directly and through technology spinoffs; advance the space program; strengthen the U.S. position as a world leader in high technology; provide a great boost to American national pride; and would be environmentally preferable to alternative power generation technologies (e.g. coal, nuclear).

International non-governmental public acceptance is discussed. The growing internationalization of the environmental movement is noted; the focus of this movement presently is dominated by opposition to nuclear energy. In Europe, the environmental movement has succeeded in causing cutbacks in many governments' plans to expand nuclear power; the bitter battle over the Narita International Airport near Tokyo indicates a new level of political activism in Japan.

A discussion is presented of techniques that may be available to help clarify and achieve consensus among the conflicting impact perceptions, priorities and values of interests who may be affected by SPS. Techniques such as Cost-Benefit Analysis, are considered as not useful for public acceptance efforts, because they do not involve active dialogue between the analyst and those whose views are of interest. Recently emerging conflict avoidance and resolution techniques (e.g. environmental mediation, multilateral policy negotiation) should be considered for use by the SPS program.

Several key issues in SPS acceptability are: the outcome (and credibility) of future research into program environmental and non-environmental impacts, and the comparison of SPS impacts with those of alternative energy options. The report concludes with recommendations for future research.

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I. INTRODUCTION

BACKGROUND

The Department of Energy and the National Aeronautics and Space Administration are investigating a potential new source of energy called the Satellite Power System (SPS). The SPS concept involves placing a satellite equipped with large (roughly 100 square kilometers) solar cell arrays in orbit around the earth. The energy collected by the satellite is converted to microwaves and then beamed to a receiving antenna (rectenna) on the ground. The rectenna facility, including a microwave buffer zone is estimated at roughly 200 square kilometers in size. Each rectenna will provide 5000 megawatts (five gigawatts) of electrical power to the utility grid. This paper, which is being prepared for the Department of Energy under subcontract to PRC Energy Analysis Company, constitutes part of a broader assessment of the potential societal impacts of the SPS program.

OBJECTIVE AND TASKS

This paper has as its overall objective, the development of a preliminary perspective on the public acceptability of the SPS concept and a means to monitor it. To achieve this, the report will:

1) delineate the primary ways in which SPS would tend to influence the "quality of life",

2) describe those specific SPS benefits and impacts that are likely to be critical to public acceptance,

3) describe possible procedures for judging how the public (both domestic and foreign) may balance SPS impacts and benefits,

4) recommend additional areas for future study.

SCOPE

This study includes sections that discuss:

1) why public acceptance is important to SPS,

2) the process of public acceptance of large-scale programs,

3) the present status of the SPS program in terms of this acceptance process,

4) the major issues and arguments that are offered on both sides (pro and con) regarding SPS,

5) SPS and non-governmental public acceptance abroad,

6) the techniques that are available to better understand the conflicting impact perceptions, values and priorities of affected interests and also to attempt to resolve these differences and achieve a concensus of views,

7) the areas of additional research that could be performed to clarify the public acceptance issues raised by the SPS program.

CONSTRAINTS

The study of public acceptance of a project that will first become operational roughly 25 years from now poses an inherent problem in trying to extrapolate from current conditions to the state of public attitudes at some future time. The future context for public attitudes will almost certainly be considerably different from the current context in ways that cannot be predicted. Nonetheless, since developing a preliminary perspective on a project's acceptability is advisable if unnecessary obstacles are to be avoided, one has no choice but to deal with current conditions and trends that are emerging or appear likely to emerge.

In terms of specific data about its characteristics and potential impacts, the SPS program is still more on the level of a "concept", than a well-defined project. For purposes of this study, the two systems definition studies prepared for NASA's Marshall and Johnson Centers, and the July 1978 reconciliation of the two, served as our "Project Description." No comprehensive assessment of SPS program impacts yet exists. Thus no thorough comparision was possible of predicted impacts (based on technical analysis) vs. impacts perceived as likely to occur by concerned interest groups. A listing of anticipated areas of impact, based on a review of program documents, is included as an appendix to this report.

For the above reasons, as well as because the state-of-the-art in attitude prediction does not yet permit it, no conclusion is offered as to whether the SPS program ultimately will be "acceptable" or "unacceptable".

WHY PUBLIC ACCEPTABILITY IS CRUCIAL

A number of trends in American society have combined to make the consideration of public acceptability an increasingly important part of the process of developing large-scale (and private) projects. These include: the realization in recent years of limitations in the natural environment's capacity to absorb the impacts of an industrial society; the passage of the National Environmental Policy Act (NEPA), as well as other Federal (e.g., the Clean Air Act) and state and local laws and regulations to control and reverse environmental degradation; the requirements of environmental legislation for direct public involvement in the project review and approval process; the passage of public disclosure

legislation such as the Freedom of Information Act; trends in the judicial/regulatory arena that have made it easier for those interests who perceive themselves as adversely affected by a project to use the legal system to protect their interests ("standing to sue"). Other factors that deserve mention include: a general decline in the reservoir of trust and goodwill towards government, the rise to prominence of public interest organizations (e.g., Common Cause, the Nader organizations) to lobby and otherwise serve as watchdogs of the public good as they define it; and the growth of single issue political organizations and behavior as illustrated by adherents of the consumer, or environmentalist movements.

Increasingly, trends such as those noted above have resulted in vigorous opposition and often in delay or outright cancellation of controversial projects and programs. Achieving a broad consensus of support for major projects has become, at the same time more important- and more difficult - to achieve. Thus, identifying and understanding the concerns of interests who perceive themselves to be affected by a specific proposal, and then establishing mechanisms for attempting to resolve conflicts that arise from competing values and perceptions, are of great importance to a project such as SPS.

Some projects or programs do not become controversial except in the context of siting a particular facility or set of facilities. However, when large-scale commitments of public funds are required to develop a particular program well in advance of facility siting, significant controversies can develop surrounding the R&D commitment, as competing viewpoints on policy and priorities for resource allocation come into play. SPS can expect to encounter opposition both in the near-term, when the debate concerns policy, priorities for appropriations of public funds and general issues (environmental and non-environmental), and also later, when site-specific regional and local issues become more prominent.

The emphasis of this White Paper is heavily on the more general, pre-siting-related issues. However, we also will attempt to identify some of the siting-related issues that will become more important as the SPS program proceeds.

THE PROCESS OF PUBLIC ACCEPTANCE

Public acceptance is a dynamic, and fundamentally political process. It begins with the discovery that a given proposal exists at all, followed by growing recognition that the proposal is under serious consideration (as opposed to a fanciful dream). Information is gathered sufficient to develop an initial position (sufficiency of course being in the eyes of the beholder); then, over time, these initial viewpoints are modified (or reinforced) so that they become more solid and firmly held. Allies and opponents are identified, coalitions of some sort often develop; the debate can become quite heated and adversarial in nature.

As the debate crystallizes and polarizes, a political consensus may form on either side, which is sufficiently powerful to either advance the project or achieve its delay or outright cancellation. Often, an indication of whether this consensus yet exists is the fate of appropriations measures, i.e., if the political consensus is anti, then appropriations bills are defeated, if the consensus is pro, appropriations bills pass. Compromises between the go/no-go extremes often occur, in the nature of larger or smaller appropriations, accelerated or delaying funding and development schedules, etc.

Recent history has demonstrated that neither side of a controversy simply gives up the fight after a particular skirmish, no matter what the outcome. Opposition often extends all the way through project development into and through construction, and even into operation. The ongoing battle over nuclear power is an example of this: the Seabrook nuclear project is partially constructed, yet the battle continues. In California, the Diablo Canyon nuclear plant is completed - and the battle continues; in Oregon, anti-nuclear interests are trying to achieve revocation of operating licenses of functioning facilities such as the Trojan nuclear plant.

The distinction between the general public and organized interest groups is crucial to the entire public acceptance process (and to this White Paper). The process of gathering information and forming viewpoints clearly spreads out from those who perceive themselves as having some interests directly at stake in a particular proposal. This can be an economic interest (e.g., profits, or alternately, business losses), or a strongly held value perceived as affected (e.g., environmental protection). Organized interests get involved first, be they "public interest" groups or "special interests" (e.g., trade associations). The "general public's" knowledge of and viewpoints on proposed projects or programs develop later than those or organized interest groups. In crude terms, the analogy of the courtroom can serve to illuminate the dynamics of this process. Groups representing the various affected interests argue their case before the court of public opinion. For federal projects involving public funds, Congress and the Executive may be regarded as the trial judges, presiding over the debate, and by their actions (in supporting or opposing appropriations) issuing their rulings. The general public serves as the appellate court system, through the electoral process, endorsing or refuting Congressional/Presidential decisions in the polling booth. Often, at some point in the development process, the legal analogy becomes more directly appropriate, as projects and programs are challenged in court.

PUBLIC ACCEPTANCE AND SPS: WHERE DOES THE PROJECT STAND NOW?

In terms of the crude model of public acceptance described above, where does SPS stand at present? Is SPS' existence known to interest groups and/or the general public? Is it taken seriously?

As Dr. Peter Glaser, SPS' inventor recalls, when he first proposed the solar satellite in 1968, the idea "elicited a polite smile and total disbelief". (110)*. Other journalistic accounts of the project use phrases such as "pie in the sky" (123) or "ludicrous" (68) to describe initial reactions a decade ago. However, this clearly has changed. In a May 1978 article, the Christian Science Monitor's natural science editor indicates that "the Sunsat concept has begun to outgrow the phase in which most power engineers, energy planners and Congressmen tended to dismiss it as a futuristic vision... Although "the Sunsat concept has faced considerable skepticism... sun-power satellites, beaming solar energy from orbit, may be a far-out idea whose time is beginning to come". (44) Interestingly, SPS is included in a recent article about how "far-out" ideas often cannot be dismissed out of hand because changing conditions make something appear feasible that once looked absurd; SPS is treated as an example of "a previously cockamamie idea now in the throes of becoming respectable". (110)

*Text references throughout this report are indicated by the number in parentheses. Thus, (110) refers to Reference Number 110, which is found in the References and Bibliography section of this report.

Among the factors that must be considered responsible for SPS achieving a measure of respectability are:

1) the dramatic increase in energy prices that has stimulated the search for alternative energy forms, and

2) the emergence of "an enthusiastic rooting section... in Congress for the concept" (92), stimulated in part by "aerospace and nuclear power suppliers... lobbying in favor of Sunsat on Capitol Hill since the early 1970's." (92)

The commitment of $15.6 million by the Department of Energy and NASA for study of the SPS concept is indicative of the distance SPS had come by the beginning of 1978.

However, 1978 clearly is the year when SPS has begun to come into its own. Three major events substantiate this, each of which has contributed to public awareness of SPS. These are:

1) the introduction, committee hearings, floor debate and eventual passage by the House of Representatives (by a margin of 267-96) of the Solar Power Satellite Research Development and Demonstration Act of 1978, which would add $25 million above existing funding levels for SPS R&D in fiscal 1979,

2) the formation in April of this year of the pro-SPS lobbying organization, the Sunsat Energy Council, headed by Dr. Glaser and with representation on its board of directors of many leaders in the high technology industrial and scientific community, and

3) the growing popular interest in solar energy as reflected by widespread participation and support for Sun Day, the Carter Administration's announced commitment (on Sun Day) of an additional $100 million for solar research and by the ongoing high level solar policy review. This review included a series of eight public meetings in different cities (the last held in mid-July 1978), to get public input to the formulation of a comprehensive national solar energy policy. SPS apparently was only lightly mentioned by DOE speakers at these meetings (17). In the materials distributed in this public participation effort, roughly one page (out of 70-odd pages) describes SPS as one of the solar energy options.

In summary, there is no available evidence to date that would indicate anything more than a minimal level of awareness of SPS as a specific proposal by the general public. It is likely however, that a threshold of basic awareness among certain interest groups (such as the environmental and solar energy community) has at least been crossed in recent months. Representatives of a number of these interest groups were contacted informally in the course of this study. All those contacted had heard of SPS; several indicated that they felt SPS was already

fairly well-known within the solar field, based partly on a surprisingly (to the respondents) large number of comments (reportedly mostly negative) offered by attendees at the Domestic Policy Council public meetings (165). Unfortunately, the report on the DOE public meetings is not yet available.

Because public awareness and opinion spreads outward from interest groups to the general public; because the general public has not yet begun to deal with SPS as an issue, whereas interest groups are beginning to address the issue, and because it is through organized groups that public viewpoints will be most vigorously expressed (through press releases, lobbying activities in Congress and perhaps ultimately in the courts), the study of SPS acceptability (as well as activities to influence program acceptability) must focus on the views of organized interests, expressed in the media (including interest group publications) and through personal communication.

II. LITERATURE SURVEY AND ANALYSIS

WHAT ARE THE ISSUES?

The following section describes the various project impacts and policy issues that are likely to be critical to the public acceptability of the SPS program. This classification and description of issues (both adverse project impacts and potential project benefits) is based on a review of published sources dealing directly with SPS and/or with issues related to potential program impacts. It also is based on informal personal contacts with interest groups and individuals concerned with issues raised by SPS, and to a limited extent with people involved in the project (such as Dr. Peter Glaser).

Articles, papers, etc. by SPS advocates were central to developing the description of SPS benefits, in effect pro-SPS arguments; expressions of opinion by SPS opponents were equally important in developing the list of adverse impacts or issues of concern. General interest media reports (e.g., newspaper articles, Time Magazine articles) as they reflect a (relatively) unbiased selection of the issues to be highlighted for the general public, and because they reach by far the largest audience, were perhaps the most important source of information as to what is viewed as significant about the SPS program.

A discussion of the concerns, or issues that pose potential problems for SPS acceptability, are presented first; the discussion of beneficial impacts, or pro-SPS arguments, follows. Issues of concern are summarized in Table I (p. 8); potential benefits are summarized in Table II (p.20).

ENVIRONMENTAL CONCERNS

The dominant issues of environmental concern, acknowledged by proponents and opponents alike, relate to potential impacts of the microwave power transmission system.

Microwaves -- Health and Safety (Normal Operations)

Microwaves' potential for damaging living organisms (people and non-human biota) is an issue that has been growing since microwave ovens began to be sold in increasing numbers in the early 1970's (41). Public concern has increased in the last several years with the publication and "unexpectedly large sales" (41) of Paul Browder's "alarming" (22), The Zapping of America, and with widespread publicity over the irradiation of the U.S. embassy in Moscow, with suspicions of adverse health effects on some Embassy personnel and dependents. Since March of this year alone: the General Accounting Office issued a report expressing concern about microwaves because of rapid increases in their use in American society and their potential for harm to public health (158); the popular CBS television program 60 Minutes presented a microwave risks segment in June, 1978 (a repeat of an earlier

TABLE I SPS PUBLIC ACCEPTABILITY - ISSUES OF CONCERN

Environmental Issues

- o Microwaves - Health and safety
- o Microwaves - Ionosphere impacts
- o Launch Vehicle Emissions - Ozone depletion, increased terrestrial UV radiation
- o Land Use - (Particularly rectenna facilities)
- o Noise/Sonic Booms - Launch and recovery operations

Non-Environmental Issues

- o Microwaves - Communications impacts
- o Microwaves - Accident potential
- o Potential for Military Applications/Vulnerability (Primarily international acceptability)
- o Program Costs - Financial and resource commitment
- o Ownership and Control - (Including centralized control of energy)
- o Energy Policy - "Hard" vs "Soft" technology
- o Potential Internationalization - (Effect on domestic acceptability)

broadcast with additional commentary), that included considerable coverage of the view that exposure levels below current U.S. standards are potentially hazardous; ABC Television's program 20/20 presented a series of program segments in July, 1978 on low-level radiation problems, in general; Newsweek included a microwave risks article in the July 1978 issue; Time in the August 28, 1978 issue. It is clear that the microwave health issue is a growing and potentially powerful one. Exposure standards are at the heart of the debate; "there is also mounting pressure to reduce the limit for human exposure (74)." Almost without exception microwave articles mention the disparity between U.S. and Soviet exposure standards. (Soviet standards for occupational exposure are 1000 times stricter than current U.S. standards; general exposure standards in the USSR are stricter still while there is as yet no U.S. general public exposure standard.) (15) However, there is little mention in the American media concerning enforcement of the Soviet standards; for example, the military reportedly is exempt from the official standards in the U.S.S.R. (86).

As currently conceived, SPS microwave exposures at the edge of the rectenna and its buffer zone would be 0.1 mw/cm^2, which is 100 times lower than the current U.S. exposure standard (10 mw/cm^2), but still 10 times higher than the Soviet occupational standard of 0.01 mw/cm^2. However, it must be noted that Dr. Glaser argues that SPS could be designed to meet whatever future exposure standards are developed; that it is fundamentally an engineering problem that can be solved (174).

All of the environmental/energy interest groups contacted expressed concern about the SPS microwave issue. However, while environmental groups are generally cognizant of the "electronic pollution" issue, not much serious attention has yet been devoted to it. (171) Environmental Action published a microwaves article in early 1977; Environmental Action and the Sierra Club Bulletin both published reviews of Brodeur's book, with considerable (and essentially uncritical) acceptance of Brodeur's thesis of a widespread governmental (particularly military) coverup of the dimensions and implications of the problem (57). There also have been a number of recent (and current) cases where microwaves (or other forms of low-level, non-ionizing radiation) have been central to the project's development or ultimate disposition. To cite several relatively minor local battles: the town of Wilton, Connecticut prevented construction of a 370-foot microwave radio tower on grounds of its negative environmental impact and possible safety hazards (40); in Portland, Oregon, local citizen protests blocked a proposed television broadcasting tower (74). More important, however, are several military projects that have encountered problems because of non-ionizing radiation: the SANGUINE/SEAFARER submarine communications project and the PAVE PAWS early warning radar system project.

SANGUINE/SEAFARER

The SANGUINE/SEAFARER project would use extremely low frequency (ELF) signals to communicate with our strategic nuclear submarine fleet while the submarines remained deeply submerged to avoid detection. Since the early 1960's the Navy

has tried to develop a number of ELF communications systems: SANGUINE (hardened against attack, near-surface deployment), SEAFARER (soft, near-surface deployment) and SHELF (super-hardened, deep underground deployment. The SHELF system will not be discussed here. Although ELF and microwave signals are not identical, both SEAFARER/SANGUINE and SPS represent low levels of non-ionizing forms of electromagnetic radiation, and there is concern about the health effects of ELF as well as microwave radiation.

SEAFARER/SANGUINE was controversial from its inception. Originally proposed for a Wisconsin site (as SANGUINE), Wisconsin was then dropped as a potential site by the Secretary of Defense in 1973 in the face of environmental opposition. When a modified version of the project (now called SEAFARER) was proposed in 1975, it was tentatively sited in the Upper Peninsula of Michigan, with sites also considered in Texas, New Mexico and Nevada. Although none of the latter three sites was selected, public opposition was strongest in Texas, partly because of concerns that ELF radiation would sterilize cattle and ruin the beef industry (54). However, the Michigan site was the Navy's first choice and aroused by far the strongest opposition. While other issues also were controversial (the possibility of the area becoming a nuclear attack target, wilderness impacts), possible ELF radiation health effects was a major issue. Various ad hoc local citizens groups were formed; in a May 1976 referendum in five affected counties the project was voted down by margins varying from 2.5 to 1 to 7 to 1. (135).

Significantly, the Navy was accused of suppressing studies that showed potential adverse health effects (27). In an attempt to resolve the issue, a special panel was convened by the National Academy of Sciences to review ELF health effects. This panel produced a report that stated that the likelihood of serious adverse health effects was very small. However, the composition of this panel was attacked because three of its 16 members were accused of being biased before the fact in favor of the minimal adverse impact position because of previous work they had done (26).

It is noteworthy that President Carter announced after he was elected that the project would not be developed in Michigan if the people of the areas affected did not want it located there. In August 1977, Governor Milliken of Michigan announced that the system was not welcome in Michigan. Thus is this case a single state was given the right (informally) to reject a program that, because it is a national security project, affects all states. As of this writing, ultimate disposition of the project (now called ELF) is unknown; it is still receiving appropriations for development, but no site has been approved.

PAVE PAWS

This project is a microwave radar system proposed by the Air Force for long range (3000 miles) detection of airborn objects. Two sites were chosen: Beale Air Force Base near Yuba City, California and Otis Air Force Base on Cape Cod in Massachusetts. The installation at Otis AFB began initial testing and alignment in April 1978. Although the Air Force contends that PAVE PAWS will beat the U.S. 10 milliwatt standard "by a factor of 1000"

(90), citizens groups in both Massachusetts (the Cape Cod Environmental Coalition) and California (Citizens Concerned about PAVE PAWS) filed lawsuits in both locations. The microwave health issue is the substance of the controversy. Although the California suit was abandoned after the judge refused to allow a change of venue to consolidate the California and Massachusetts lawsuits, the Massachusetts lawsuit has not yet been resolved. The Air Force has agreed to prepare a full Environmental Impact Statement on the project; its ultimate disposition is unknown at this time.

The potential adverse effects of the SPS microwave beam on non-human biota (e.g., birds flying thorough the beam) should also be mentioned as a possible public acceptance issue. While it may be secondary to the human health issue, the existence of numerous interest groups concerned with wildlife and ecology issues renders it a likely source of future controversy.

An additional point must be made about the radiation issue. There is a growing concern about the health effects of low-level ionizing radiation in American society. The Department of Health, Education and Welfare is leading a study of this issue, "a project that may turn out to be the biggest medical research program since the smoking studies of the 1960's." (114) The focus of this investigation will be on 300,000 to 400,000 military and civilian personnel who participated in nuclear weapons testing from the late 1940's to the early 1960's, and on several hundred thousand employees of government nuclear facilities (114).

What is important for the SPS program is that the public recognize and understand the distinction between ionizing radiation (gamma rays and X-rays), which has the capacity to dislodge orbital electrons, thus creating cell-damaging ions, and non-ionizing forms of radiation (e.g., microwaves), which do not. If this distinction is not grasped by the public, then SPS may unnecessarily be caught up in a controversy which does not apply. This is a problem that can only be addressed by educational and informational activities.

Microwave (Environmental) Impacts on the Ionosphere

The possible adverse impact on the ionosphere of the microwave power beam (thermal effects) is frequently mentioned as a concern. Program proponents, such as Dr. Philip Chapman of Dr. Glaser's staff, concede that much remains to be learned about the ionosphere, and that the implications of ionospheric modifications are not well understood and require careful study (167). Some SPS critics talk of possible climatic modifications, perhaps on a hemispheric scale, and of possible "greenhouse" effects and increased rates of skin cancer (36). This concern may reflect some confusion between the ionosphere and the ozone layer, which are at different altitudes (the ozone layer is much closer to the earth's surface). There is thought to be a connection between depletion of the ozone layer and increased levels of ultraviolet radiation and consequent higher skin cancer rates. However, Dr. Chapman contends that there is no connection between possible SPS ionosphere impacts and the ozone layer.

There is, nevertheless, an acknowledged (by proponents and opponents alike) potential SPS-related ozone problem, stemming from launch vehicle emissions.

Launch Vehicle Emissions and High Altitude Air Pollution

The large number of launches required to carry SPS materials into earth orbit will produce high altitude emissions that are a legitimate cause of serious concern. Ozone depletion and the associated increased biologically harmful UV levels is an issue that was significant in several recent controversies. The possible threat to the ozone layer of chlorofluorcarbon emissions from aerosol sprays has resulted in the removal of such propellants from many commercial products over the past several years. However, this issue, while it may appear to have died down at present, amy be only temporarily dormant. A June 1978 article in Environmental Action notes that aerosol sprays represent only 25 percent of the U.S. chlorofluorocarbon (CFC) production; that only Sweden joined the U.S. in restricting CFC use (while about 20 other countries did not); and that increased ultraviolet exposure possibly may have genetic effects in addition to the skin cancer problem. (126) Thus, at least within the environmental community, there are forces trying to keep the fluorocarbon/ozone issue alive.

A more directly relevant (to SPS) controversy regarding ozone destruction is the debate in the late 1960's and early 1970's over developing an American SST. The ozone issue (as well as other relevant issues such as noise, sonic booms and economic viability) was widely used by environmental organizations such as the Sierra Club and Friends of the Earth, in their successful effort to block the American SST's development (31).

Land Use Concerns

SPS land use impacts are a frequently mentioned concern, particularly among environmental groups. The focus of this concern is largely on the large land areas required to site rectennas for a 60-SPS (or more) system. Both the size of the total land area that would have to be committed and questions about committing land to SPS that could be better put to alternative uses are emphasized (165). Possible broader SPS land use implications (e.g., relocating energy intensive industry near rectenna sites to minimize transmission distances, altering current land use patterns to permit use of desirable rectenna sites) have not yet been raised explicitly either in the popular press or by concerned interest groups. However, this land use aspect might be subsumed in a more general concern about SPS' centralizing implications. Further, given that land use issues receive close scrutiny by regulatory agencies as well as environmental interests in the environmental review process, this issue can be expected to emerge as SPS develops. Land use issues are likely to become most prominent, however, in the context of SPS facility siting rather than in the near term debate over policy and R&D priorities.

It is noteworthy that most expressions of concern about SPS land use impacts did not attempt to compare SPS to alternative power generation technologies.

NON-ENVIRONMENTAL CONCERNS

Microwave Impacts on Communications

SPS microwave interference with a wide range of communications, including radio and television broadcasts, CB and police radios, and radio location and navigation systems is one of the most frequently expressed concerns about SPS.

The popular press usually focuses on radio and TV broadcasts and CB and police radio to characterize the problem, perhaps because these affect the general public most directly and immediately. There is little indication of a detailed understanding even within the environmental/energy community of many of the specific problem areas (e.g., ionospheric changes and potential effects on communications systems that use the ionosphere to propagate radio waves, interference with users of frequencies near the proposed SPS operating frequency, competition between SPS and communications satellite systems that also use geostationary orbits and possible localized interference near rectenna sites). However, the pervasiveness of potentially affected communications systems in modern society (domestically and abroad) render this a potentially crucial public acceptance issue.

As yet, communications interference in general has not become a major political issue, although there are indications that it might increase in importance, for reasons such as the astounding proliferation of CB radio use (an estimated 30 million CB units in current use in the U.S.). Communications interference legislation was introduced in the Senate this year by Senator Barry Goldwater, and hearings were held in June. Federal Communications Commission (FCC) staff indicate no knowledge of any major programs that have provoked major controversies because of communications interference (166) although some concerns about television and telephone interference were expressed by groups opposed to siting the Navy's ELF communications project in Michigan (see earlier discussion of SANGUINE/SEAFARER). FCC staff indicates that the Commission receives frequent complaints from individuals whose automatic garage doors open mysteriously in the night, or whose TV programs are interrupted by a CB radio user shouting "Breaker, Breaker", etc. (58).

The construction of high-rise buildings in urban locations has provoked citizen anger over interference with the quality of television reception. For example, in Los Angeles in 1972, homeowners near several new 44-story skyscrapers in Century City were up in arms over the degradation of their TV reception. Cable television was available as an alternative for these residents, so the problem was resolved through negotiation with the skyscrapers' developer, rather than through litigation (55). The preceding cases are cited not to trivialize the SPS communications problem (all of these cases represent small scale/local controversies); they merely indicate public sensitivity to interference with communications systems that play a major role in their lives.

Accidents/Military Applications/Vulnerability

SPS critics talk about the microwave beam's "potential to cook the entire world's population" (36). Both the possible inadvertent irradiation of a populated area caused by accidental misdirection of the beam and the possibility of the beam being used as a weapon are mentioned. In April, 1978 Congressional committee hearings both of these issues were raised, as was an SPS-dependent America's vulnerability to destruction of its power satellites. "SPS proponents had no guarantees that either event might not somehow come to pass, as opponents were at pains to point out." (41)

The accidental misdirection risk was not heavily emphasized in informal discussions with concerned interest groups, although this concern might have been subsumed under the broader microwave risk issue. The potency of the accident risk issue with other energy technologies has been amply revealed in the nuclear power and LNG controversies. Many analysts feel that there is a growing tendency toward risk aversion regarding new technologies (171). This suggests that the microwave accident issue may well play a role in the future SPS debate.

Concern about perceptions of SPS as a potential weapon is shared by advocates and opponents alike. SPS is characterized as "a potentially lethal weapon" in a strongly anti-SPS article in the "counter-culture" magazine Mother Jones (78). The article cites Dr. Aden Meinels of the University of Arizona, who argues that "you don't have to convert an SPS into a weapon, it is a weapon already" (78).

SPS proponents respond that the low power density of the SPS microwave beam renders it useless as a weapon (167). However, they acknowledge that the mere existence of such a major power source in space, and the space technology capabilities implied by the program (heavy lift launch capability and large-scale space construction), as well as the possibility of concealing a weapon in such a large space structure, render the military implications a potentially serious issue (167). This military implications issue obviously is most powerful in terms of international acceptability; foreign governments and populations would have to be satisfied that SPS posed no threat to their security and sovereignty. Because it is difficult to imagine the international community accepting on faith that SPS poses no military threat, Dr. Glaser and others feel that some form of internationalization of the program, be it merely international inspection, or international control, probably is unavoidable (174).

Congressman Richard Ottinger argues that because SPS is so vulnerable to the presumed Soviet ability to destroy orbiting satellites, it would have to be viewed by the Soviets as having a first-strike capability, and would create a new level of problems with arms control (36). Although this aspect of the issue was not raised by any of the interest groups contacted, the existence of powerful constituencies concerned about the arms race, suggests that this may be a powerful future public acceptance issue, domestically as well as internationally.

Cost Concerns

Along with microwaves, program cost issues are the most commonly expressed concern about the SPS program. The total capital investment in developing SPS is recognized as extremely large by advocates and opponents alike, although advocates emphasize the fact that the size of the SPS investment must be compared to the massive investment required to generate equivalent amounts of energy by alternative means. Further, SPS opponents are skeptical about the cost estimates thus far developed, feeling that they underestimate the ultimate development cost. The uncertainties inherent in long-range predictions of costs render these estimates "ridiculous" (165). "There is nothing that they (the space industry) propose that does not end up being two to three times more expensive than their estimates." (36)

Beyond the total number of dollars required, SPS critics emphasize the size of the "up front" investment -- the dollar (and energy) commitment that would be required before any energy and revenue would be produced. (165) The assertion that an operational SPS system would produce large profits is disputed as unrealistic, and is compared to the overly optimistic "projections made two decades ago for nuclear power" (138); the projection that the cost of SPS-generated electricity will be competitive also is questioned (76).

However, the most common cost-related concern, which was expressed by almost every solar/environmentalist organization contacted, is the fear that SPS will drain a large proportion of the limited resources that could otherwise be spent on R&D and commercialization of decentralized terrestrial solar technologies. As a staff member of the Solar Lobby put it, "we can't afford to develop SPS and at the same time do the other things that need to be done" (173). Put another way, "every dollar spent on solar satellites will not be spent on terrestrial solar research and commercialization (36). This argument about financial priorities, is directly related to the arguments about energy priorities that will be discussed later.

SPS opponents are quite cynical about the motivations of the large corporate business interests that support SPS. "The industry itself sees the solar satellites as a potential boon...it would call for a long-term commitment of billions of dollars in industry contracts for hardware. It therefore came as little surprise when a coalition of the concerned companies recently formed a non-profit corporation called the Sunsat Energy Council to 'educate' federal decision-makers about the benefits of solar satellites." (138) SPS is "a collosal boondoggle"; it is big business' "way of cashing in big on solar energy's popularity", according to Congressman Richard Ottinger (160).

Ownership and Control (Including Centralized Control of Energy)

Most interest groups contacted, particularly "appropriate technology", solar and environmental groups, are concerned with who would control the SPS system, and specifically the centralization of control of energy that would be implied.

Decentralized energy, particularly solar applications (e.g., collectors on every roof) is seen as potentially liberating individuals from the power of centralized utility systems (78). The so-called "soft" energy path, which emphasizes community-based smaller scale energy systems has a strong political component. To quote from Mother Jones, "Their (SPS) development would make utility monopolies even stronger than they are now. At a time when solar power holds out the promise of decentralized energy emanating from people's rooftops and local windmills, SPS would generate energy that must be centrally distributed." (78).

A more conspiratoral view is expressed by Norman Burnett in a Washington Star article titled "Who Owns the Sun." After describing solar advocates views that solar energy is the people's energy source... just waiting to be harnessed in a non-exploitative way, immune to the predations of big business and big government.", he goes on to say that "I realize that if a way can be found to confiscate the sun's rays for private gain, Big Power is already in the best position to find it", even though "the sun is ours, not the power company's." (30).

Interestingly, not all the environmental/energy interest groups contacted expressed this conspiratorial view. For example, the Energy Issues Coordinator for the Sierra Club Legislative Office in California expressed the viewpoint that the utilities and centralized energy systems in general "are here to stay" and must be expected to play a role in solar energy's future (171). A solar expert who serves as a consultant to the National Center for Appropriate Technology indicated the view that centralized energy is a fact of life, and that the vision of a totally decentralized solar society contains a large element of myth (181). Even Mother Jones concedes that Dr. Glaser is correct when he says that "some degree of centralized electrical distribution will be needed indefinitely, even if all our houses sprout solar panels." (78).

Our literature review and informal group contacts, suggest that not much is yet known about possible SPS ownership and control arrangements, beyond the recognition of a "problem area--namely that of control and centralization by large industrial concerns." (143) This same report defines the "problem" by claiming that in Dr. Glaser's "big picture", industry would be the primary developers and beneficiaries of the entire system." They attribute to Glaser the suggestion of some sort of arrangement akin to Comsat, with Congress chartering a corporation "to own the entire system and sell stock to utilities and other companies interested in cashing in on space electricity". (143).

Although Mother Jones attributes to Dr. Glaser the view that SPS somehow must be international to cope with possible foreign perceptions of SPS as a weapon, neither this article nor any of the others reviewed (or any interest groups contacted) commented in any way on the possibility (or desirability) of international ownership or control.

Nonetheless, if international acceptability forces some form of internationalization of SPS, this could create complications for SPS in terms of domestic acceptability. Several recent and ongoing situations suggest that this may be a sensitive issue: 1) The vehemence with which a large segment of American society opposed the Panama Canal Treaty as a "giveaway" of something that belonged to the U.S.; and 2) the reluctance of the American government (among others) to accept the Third World position (in the UN Law of the Sea Conference) that all nations must share in the benefits of the exploitation of the ocean's mineral resources, regardless of who has the capability to actually exploit those resources.

Energy Policy Concerns

The arguments discussed previously about spending priorities (SPS will drain funds from R&D on other energy technologies, particularly decentralized solar) and about centralization of control of energy supply by large utilities, all relate to a fundamental disagreement about the energy policy which American society should pursue.

There is a body of opinion that is increasingly critical of centralized, high technology, capital intensive energy systems. This view disputes the argument that the quality of life is directly linked to the size of our GNP, which in turn is dependent on high (and increasing) levels of energy consumption. The link between high energy consumption and GNP has been challenged (122); the measurement of quality of life only in terms of energy consumption is held by some to overlook factors such as environmental quality (122). Centralized energy with its extensive distribution network is attacked as inefficient and costly (96). Development of renewable sources of energy; energy technologies that are decentralized, locally based and on a scale appropriate to end-use needs; and increased emphasis on conservation (through less energy-intensive life styles and through more efficient technologies) are offered as alternatives to the present energy policy (96). It should be noted that some analysts contend that foregoing arguments ignore the role of abundant energy supplies in ensuring opportunities for upward economic and social mobility among the lower socio-economic strata. (122)

To proponets of the "soft" energy path (in which renewable solar energy obviously would play a major role), SPS is a corruption of the promise of solar energy. It is called "the worst possible way to use solar energy" by a staff member of Solar Action (173); "a perversion of the present concepts of solar energy" (36). To quote Amory Lovins, "Brooklyn Bridge--like satellites in outer space do not satisfy our criteria, for they are ingenious high technology ways to supply energy in a form and scale inappropriate to most end-use needs." (96).

Other critics couch their objections to an energy policy which includes SPS on practical, rather than philosophical grounds. Relatively simple and low-cost decentralized solar technologies offer more immediate short-term benefits because much of the technology is already available "off the shelf" (168), and represent a better use of limited funds available for energy research (165). The fear that a large scale commitment to SPS can only come at the expense of decentralized solar research budgets is a recurring theme of SPS critics, as previously mentioned.

However, it must be remembered that SPS represents renewable energy and is a solar project. Thus, even within the environmentalist/appropriate technology community, some who take the view that a degree of centralized energy production is unavoidable, do not have their minds closed to SPS, because the alternative centralized technologies (coal, nuclear, including breeder reactors and fusion) are seen as having potential drawbacks (e.g., CO_2 buildup, nuclear proliferation) that may outweigh the perceived adverse impacts of an SPS system (181).

Even among SPS opponents in the solar community, there is a recognition of the possibility that SPS may be viewed favorably by Congress and the public because it is a solar project (173). The general popularity of solar energy, as evidenced by the response to Sun Day, is thought to have played a major role in the House passage (by a wide margin) of HR 12505, the SPS RD&D Act of 1978.

Other Concerns

Several other potential issues are mentioned by various SPS critics, although less frequently than those already discussed. These include:

1) SPS will contribute to the perceived emerging problems concerning the environmental and health impacts of high voltage power lines that would be required to distribute SPS electricity (173).

2) Too much of the SPS resource commitment is for space technology and operations rather than for energy production (173).

3) The noise and sonic boom impacts of launch and recovery operations (165,171).

4) SPS will lead to increased American dependence on imported mineral resources (36).

5) International complications -- usually phrased in terms of the need for international agreements concerning orbits, frequencies and assurances that SPS could not be used as a weapon (143).

SPS BENEFITS

Advocates and opponents alike concede that the most compelling arguments for SPS stem from the fact that it exploits a renewable and effectively inexhaustible energy source (the sun) and that it uses solar energy more efficiently than do terrestrial applications because of almost continuous exposure and because the intensity of solar energy in space is not reduced by the earth's atmosphere.

Beyond these inherent technical characteristics, potential economic, political, technological,social and environmental benefits are described.

SPS as a Solution to the U.S. (and World) Energy Crisis

SPS could be a major element of the solution to the long-term energy supply problem that faces American society, as well as the rest of the world. The system could directly supply a substantial portion of U.S. energy needs. This would reduce our reliance on imported energy supplies and improve our balance of trade, with obvious political and economic benefits. Dr. Glaser offers a further argument: merely proceeding with the development of SPS could help slow oil price inflation, even in advance of SPS operation, by putting the oil cartel on notice that alternatives are on the horizon (67).

The fact that an SPS could be directed to beam energy to much of the world allows SPS, conceptually at least, to help solve energy problems everywhere. Thus, SPS might allow the United States to export electrical energy or at least to export energy technology. The balance-of-trade benefits of energy and/or technology export are obvious. However, SPS advocates also suggest political benefits. For example, SPS conceivably could be used to supply energy to the world's "have nots', and thereby help provide the energy resources required to improve the standard of living in the developing world (75).

SPS as Baseload Solar Energy

SPS advocates argue that, with the possible exception of ocean thermal energy (OTEC), which has geographical limitations because of the need for relatively high ocean water temperatures, SPS is the only solar technology that can supply true baseload power. Even centralized terrestrial solar applications are inherently limited by the diurnal cycle and consequent energy storage problems (although the argument is often made that energy storage is an engineering problem that eventually will be solved). This is also directly relevant to the discussion of SPS potential for aiding economic development abroad. Decentralized solar energy cannot supply energy in sufficient quantities to support heavy industrial use, whereas SPS obviously could. This factor might be particularly important to large, developing countries, such as India, whose industrial development is hindered by the lack of domestic oil or high-grade coal reserves (45).

TABLE II SPS PUBLIC ACCEPTABILITY - POTENTIAL BENEFITS

- Most efficient use of renewable solar energy
- A solution to the U.S. and world energy crisis
- The only true baseload solar energy system
- Would generate large number of jobs
- Energy development and utilization of outer space combined in one program
- Potential for technology spinoffs
- Enhances U.S. position as leader in high technology
- Environmentally preferable to alternative technologies such as coal and nuclear
- Psychological Benefits - Boost for morale from solving energy crisis

Interestingly, 60 percent of the respondents to this survey "were hopeful that electric power could be generated in space for use on earth" (24). Among the 49 justifications for the space program to which reactions were solicited, power generation in space was the tenth most popular.

Surveys conducted for NASA in 1974 reveal that attitudes toward the Space Program are slightly more favorable than unfavorable, although space technology ranks fairly low on the public's list of important priorities. Programs dealing with the environment, earth resources and energy appear most attractive to the general public; programs dealing basically with space exploration (e.g., manned space flights to Mars or the moon) receive relatively little support (113). These findings are generally consistent with Dr. Bainbridges findings. Both the NASA study and Dr. Bainbridge found some support for "communication with intelligent beings from other planets". Although it is speculative, it may be that the popularity of two recent movies "Close Encounters of the Third Kind" and "Star Wars" has, at least temporarily, increased popular interest and curiosity about non-terrestrial intelligent life.

Of interest is the fact that favorable survey responses to specific NASA programs, and to the space effort in general, increase with increased knowledge. That is, when specifics about the space program are explained to individuals, then responses become more favorable. "A brief description of NASA and its accomplishments" given to respondents prior to asking for an opinion on the space program in general increased favorable ratings from 41 percent (without any description) to 65 percent (with description) and reduced unfavorable ratings from 35 percent (without description) to 15 percent (with description). (113)

Space Industrialization

Another element of the pro-SPS arguments that stem from the benefits of program space activities is the program's stimulus to the industrialization of space. Space industrialization is seen by some as a field with great economic potential. A recent study for NASA by Science Applications, Inc. predicted that by the year 2010, new space industrialization (including satellite power technology) could produce close to 2,000,000 jobs, add from $200 to $800 billion to the GNP, improve the U.S. balance of trade by as much as $50 billion and produce tax revenues of $20 billion. (134) Advocates of space industrialization also argue that this is a field that the United States cannot afford to ignore, because other nations will not ignore it, and thus 'if we don't, somebody else will.' (75)

Technology Spinoffs

Space industrialization also embodies the notion of beneficial SPS technology spinoffs, another common justification for space activities in general and for SPS in particular. Among the most visible practical applications of

space technology developed from the space program are miniaturization of electronic components, improvements in computer technology, plus a variety of new products such as heat resistant coatings, synthetic lubricants and light, high strength metals. (137)

Specifically related to SPS, the argument is offered that the improvements in solar photovoltaics required for SPS would be directly beneficial to the development of terrestrial solar photovoltaic technology. Some critics are somewhat skeptical of this, arguing that direct R&D investments are a much more efficient way to achieve desired technological advances, than relying on spinoffs (181).

Surveys of public attitudes toward space programs indicate that spinoffs or "side benefits", while important, are not decisive in overall views toward space activities. The 1974 NASA study cited earlier revealed that 42% of those surveyed feel that side benefits are important, but "that the money would be better spent directly in the areas where the side benefits have been obtained. Eight percent feel the side benefits are not important compared to NASA's primary objectives; and 35 percent "feel the side benefits have made the Space Program worth the money." (113) Dr. Bainbridge's 1978 study found that "Although they accept the notion of spinoffs, Americans do not seem very excited about other benefits to industry and employment." (24)

SPS and the U.S. as a Leader in High Technology

Closely related to the space utilization arguments are the views that SPS would be a stimulus to the U.S. position as a world leader in science and technology. Our technological leadership, in this view, is central to the health of the American economy, as well as a great source of national pride. There is growing concern that our position of technological leadership has been slipping, as other nations outspend us in research and development. Between 1971 and 1976, patents granted to Americans declined by 21 percent, while at the same time, the number of people involved in non-defense R&D in Japan grew to a level approaching the U.S. total--with a population base less than half our size (73).

This perception of the potential consequences of an emerging "R&D Gap" was forcefully expressed by Rep. Wyler during the House debate on the SPS R&D Act of 1978. In responding to critics of the bill, Rep. Wyler argued that if every energy proposal is rejected, "then our nation is going to end up on the international junk pile because all the nations in the world are moving ahead of us in technology. And if there is one thing that is true of our country and that is the one thing that can set it apart in maintaining our standard of living, it is our technology." (36)

Public Attitudes Toward Science and Technology

Of direct relevance to public response to the SPS technology argument are public attitudes toward science and technology in general. There is an element of American society that is becoming increasingly concerned that

the science and technology are a mixed blessing. This view holds science and technology responsible for having unleashed the nuclear genie from the bottle, and having made genetic tampering possible through recombinant DNA. The recent annual Science Indicators report of the National Science Board to the President noted a "growing concern about their (science and technology) cultural side effects, e.g., on life styles and values, and especially about the effects of new technologies." (106) A representative of the Sierra Club offered the view that new technologies, in fact, do seem to be subjected to closer scrutiny for their potential adverse implications than ever before. (171)

However, the NSF study finds that "the public continues to have an overwhelmingly positive reaction to science and technology. Over 70 percent of the public expressed favorable views in 1976, the same percentage as in 1972 (a 1974 survey revealed even more favorable attitudes). Thus, even though much of the public feels that science and technology have caused at least some of our problems (106) there apparently is still a reservoir of positive sentiment.

Positive Environmental Factors

SPS advocates see the program in favorable environmental terms, in contrast to the strong environmental concerns expressed by many critics. While some of this apparent contradiction relates to disagreements about the potential SPS impacts, the heart of the disagreement rests on a comparison of potential SPS impacts with the impacts of alternative energy technologies (e.g., coal and nuclear). SPS proponents argue that SPS operations, in contrast to alternative technologies, would produce no wastes or toxic products, would not use up scarce natural resources, would radiate waste heat of power generation to space and not to the terrestrial environment, and while SPS land area requirements (i.e., rectenna sites) appear large, they are comparable to alternative technologies (e.g., for comparable power output, less land would be required for an SPS than would be required to strip the equivalent amount of coal). (71)

Some proponents, recognizing the uncertainties surrounding microwave environmental issues couch the environmental issue in somewhat more conditional terms. For example, Representative Gammage in the House floor debate on the Flippo bill (the SPS R&D bill passed recently by the House) states: "If the energy can be safely beamed to Earth, their (solar power satellites) environmental impact may be the lowest of any currently envisionable energy source." (36)

Some SPS critics take exception to a favorable environmental evaluation of SPS relative to other energy options. This is not because they prefer coal or nuclear technologies, but because they consider an alternative energy policy based on conservation, terrestrial photovoltarics, solar heating, biomass conversion, windmills, etc. to be preferable to SPS or the other centralized high technology options. (78)

Psychological Benefits

Other arguments offered by SPS proponents are more emotional and psychological in nature. William Gordon of Rice University argues that SPS can be an inspiring goal for the people of the United States and that its accomplishment would be a great source of national pride (69).

Peter Glaser sees SPS as having the potential for changing public perceptions of the future by demonstrating that the energy crisis can be solved and by opening up the possibility of the industrialization and eventual colonization of space. The SPS program even in its early stages "may help dispel current gloom and restore the classic American confidence in the future." (67).

The Consequences of Not Proceeding with SPS Development

Some SPS proponents stress that not developing SPS may threaten the basic economic viability of American society, holding that SPS may be the only viable energy alternative for the U.S. for the next 30 to 40 years. (99) This view rests on a comparative evaluation of SPS with the other conceivable energy alternatives, and is based on an apparent conclusion that the other alternatives have more severe technological, environmental and/or societal problems associated with their large-scale implementation.

A less extreme version of this position holds that we cannot affort not to pursue SPS as an option, at least until its benefits and costs can be more clearly established. Thus, SPS should receive sufficient funding so that the go/no-go decision can be made in a timely fashion. Then if other energy technologies do not prove out, for whatever reason, the U.S. will not face economic disaster because of catastrophic energy shortages.

Siting-Related Issues

Thus far we have considered only issues that deal with public acceptance of the SPS program as a whole. The impacts and issues of concern discussed so far deal largely with national policy and priorities and with broad environmental factors. These issues are fundamentally independent of where specific SPS facilities (e.g., rectennas, launch and recovery facilities) may be sited. The land use concerns previously discussed deal with the size of the total land commitment, and merely note the concern that land areas desirable for SPS may also be desired for other uses. This is considered appropriate because, in the near term, the debate over SPS will be in terms of whether or not the program should proceed at all, rather than specifics of where program activities should take place. Siting-related controversies will certainly arise when the program evolves to the point where facilities must be developed. However, the nature of the specific controversies that can be expected to arise in the context of SPS facility siting will be considerably different than the national debate. Although some of the

substantive issues will be the same (e.g., microwave risks, communications effects, accident potential, jobs, centralized control of energy supply), the focus will be much more heavily on the specific regional and local implications of these issues. Further, much more attention will be focused on more localized air quality, water quality, growth, life style, etc. implications.

It clearly is premature, and is in fact impossible, to attempt to assess the likely acceptability of siting SPS facilities in specific areas, as specific sites have not yet been identified. Public reaction is assumed to be a function, in part, of impacts in the specific area in question. Unavoidably, project impacts depend on ambient conditions in the siting area, as impacts, by definition, are incremental effects on a preexisting situation or "environmental setting." For example, the same amount of air pollutant emissions would have a different impact in an area where air quality already is degraded than in an area where the air is clean. Further, attitudes differ in different areas; impacts that are "acceptable" to the population of area X, may be "unacceptable" to the population of area Y. For example, Area X residents could have strong pro-economic growth attitudes and could decide that the jobs produced by a given project were more important to them, than the associated air pollution. The Area Y population could make the opposite decision--that maintaining environmental quality was more important than a project's economic stimulus.

It is likely, however, that the following kinds of issues will have to be included in assessments of the local and regional acceptability of siting SPS-related facilities:

1) Air quality

2) Water quality and availability (particularly in the aird and semi-arid areas of the Western U.S.)

3) Habitat impacts, including alteration or destruction, food chain disruptions, flora and fauna species diversity, effects on migration patterns, and endangered/threatened species.

4) Land use effects, including land use competition, alteration of existing land use patterns and compatibility with existing land use plans.

5) Economic effects, including jobs and public revenues produced, possible disruptions to the existing economic base, the economic effects of increased energy supplies and local attitudes toward growth and development.

6) Social effects, including effects on rural lifestyles of population growth (particularly during construction phases), i.e., "boomtown" effects.

7) Aesthetic effects, both of project facilities themselves and of project-related growth.

8) Cultural resources, including archaeological and historically significant sites and, particularly, impacts on Native American interests.

Regionalism is likely to play a part in the context of SPS rectenna siting, as individual state governments or regional groupings of states (e.g., the Rocky Mountain states) decide whether SPS fits into their own regional, as opposed to national (or local) perspectives of a desirable energy, environmental, economic and socio-political future. Increasingly, as part of a broad trend toward decentralization noted by analysts such as John Naisbitt of the Center for Policy Process, individual states and regions are insisting on developing their own policies on energy and resource issues (34). Examples of this trend are widespread; the Rocky Mountain states fighting the rapid development of their coal and oil shale resources on environmental, social and water resources grounds; the Rockies opposition to siting large power plants in their states to serve the needs of distant urban centers in the northwest and/or in Southern California; California's laws that are making it virtually impossible to develop new nuclear facilities there, as well as California's insistence on making its own LNG siting decisions, regardless of federal agency wishes.

This regional perspective has not yet surfaced regarding SPS. However, it is likely to be important as this policy decentralization process continues (if it does).

INTERNATIONAL PUBLIC ACCEPTANCE (NON-GOVERNMENTAL)

Environmental activism outside of the United States has become increasingly widespread in recent years. Paralleling domestic interest group formation in many ways, citizens in a number of other countries have joined forces to advocate or oppose policies and projects on environmental grounds. Their effectiveness has been noteworthy, and includes: a widely acknowledged role in voting a government out of office after 44 years (Sweden), serious interference with the opening of a $2.6 billion dollar airport and causing reconsideration of planned airport expansion and of related projects (Japan) and stalling the construction of nuclear facilities throughout Western Europe.

SPS raises a variety of issues of international concern which must be resolved at an early stage of development. Many of these issues can only be treated through formal intergovernmental negotiation or via channels provided by international agencies (e.g., the International Telecommunications Union). Among these are the assignment of geostationery orbital slots and transmission frequencies, the sharing of resources, costs and benefits, control and sovereignty, etc. Of concern here, however, are non-governmental aspects of international public acceptance; legal, diplomatic and political issues involving formal governmental relations are presently being addressed in other reports.

Foreign populations are potentially as diverse as the American public in their responses to SPS. Their effectiveness in advocating their points of view on other projects was indicated above and will be further documented in these pages. The importance of international public opinion can be overlooked only to the detriment of a balanced assessment of potential SPS contributions to mankind's energy budget.

For our purposes, foreign populations can be usefully divided into several groups, permitting us to identify shared general characteristics within these groupings which may influence the development of governmental and and non-governmental attitudes towards SPS. As a primary condition, responses to environmental issues are of present interest where these responses are judged to be of a spontaneous, or at least independent nature. Excluded, therefore, are public expressions organized by governments to show support for official policy. On this basis, the public acceptability of SPS to the populations of Eastern bloc countries is regarded as more appropriate for diplomatic and legal analysis, and will not be considered here.

The range of countries broadly grouped as Emerging, Less Developed, Third World, Non-Aligned, etc. is too great for useful analysis. Some (e.g., Cuba) share an approach to domestic policy with the Eastern bloc, and will not be considered. More important, however, is the relative economic development of the countries and the sheer size of their populations. Brazil and India, for example, with rapidly growing industrial bases, have a vastly different potential for public response to SPS than do Chad or Guatemala. Countries of limited size and level of development are held to be of lesser interest

only from the perspective of non-governmental public acceptance. Observation suggests strongly that public expression regarding international issues is of limited significance in comparison with governmental opinion, which has been excluded from present consideration.

The larger and richer nations in this group have to date exhibited relatively little public interest in environmental issues. In the absence of a better model, it is useful to assume that environmental movements will eventually develop in response to actual or perceived imminent impacts resulting from technological development. Such movements will probably be patterned in some way after those in North America, Western Europe and Japan, although the earliest expressed concerns may come from governments rather than private citizens (e.g., Iran, where the major impetus for development of air pollution control has come from official sources). Almost certainly, there will be differences among nations with respect to tactics and style of expression, reflecting differing traditions and present conditions. Just as likely, however, is the probable similarity of the types of issues around which movements will coalesce, as anti-nuclear movements in Germany turn to the courts to delay unacceptable nuclear projects, and Japanese activists hotly contest developments which threatens rural lifestyles. We conclude, therefore, that public responses in larger developing countries cannot comfortably be predicted to differ in many significant ways from those in countries where activist movements already exist. Although environmentally-oriented public attitudes in these countries will probably have little influence during the early stages of SPS development, a decision to implement SPS at the rate of two satellites per year beginning around the year 2000 would probably allow enough time for environmental movements to develop in some countries where they do not yet exist.

The citizens of the industrialized nations of Western Europe, Japan and Canada constitute the public outside of the United States which is likely to take a position for and against SPS in the relatively near future. The level and tenor of public awareness of SPS will obviously be critical to the acceptability of the concept and the implications of its development.

Awareness of SPS in the United States is still rather limited, as noted elsewhere in this report. In other industrialized nations, even less has been published or broadcast. An article in a recent issue of the British publication of New Scientist (123) notes that satellite solar collectors are more efficient, that output is less interruptible, that land use problems would be smaller than with ground based collectors. SPS is described as suitable for international participation, both for research and construction of components. Briefly mentioned are the problems of impacts of repeated shuttle launchings, effects on the ionosphere, and possible radio frequency interference (123).

Reportedly, an article earlier this year in Die Stern exposed the German-speaking public to SPS in similarly favorable terms, including references to the possibility of German industrial participation, and the existence

of a German SPS design; a BBC-TV program called "Spaceships of the Mind" included a favorable segment on SPS during 1977; and a Japanese publication on Japan's involvement in space programs listed SPS as an area of potential involvement, including the possible contribution of substantial funds for R&D (167).

Critical mass media descriptions of SPS in non-U.S. publications are not known to the author, though it is reasonable to conclude that this is due more to the lack of knowledge about SPS than to the possibility that none will appear. Criticism such as those in the Mother Jones article (78) (cost, microwave risks, military potential, increased centralization of energy distribution, etc.) will almost certainly find some, perhaps a great deal, of support in other countries.

In the absence of significant international public awareness of SPS, the possible responses of foreign populations can only be extrapolated from known responses to other issues and trends now emerging. Several examples are cited below. The reader is urged to keep in mind the uncertainties in predicting public behavior, while at the same time respecting the weight of evidence of past behavior as an indicator of possible future actions.

Pan-Nationalism

Of growing importance to an understanding of international public acceptance issues is the formation of interest groups with membership drawn from several countries. As with single-nation groups, such international coalitions can form around a single issue, such as the proposed French fast breeder reactor at Creys-Malville. Several thousand of the 30,000 demonstrators were reported to be German, Belgian, Swiss and Scandanavian (89). Their opposition to nuclear facilities in their own countries (see below) presumably motivated these demonstrators to offer support to their French colleagues. Of significance here is the possibility that a public response in one country, pro or con, to SPS, may generate active support in other countries, and not merely passive sympathy.

Of more potential significance in the long run is the still small Friends of the Earth International (FOEI). Sixteen countries were represented at the seventh annual meeting, held in Brussels in November, 1977, including Great Britain, France, Sweden, Australia, New Zealand, the United States, Belgium, Canada, Holland, Italy, Japan, Spain, Germany, Mexico, Switzerland and Greece (100). Most of the countries represented have functioning Friends of the Earth (FOE) organizations, although some appear to be quite small (the Mexican group claimed 30 members); the Greek participant reported that public interest at home was emerging in response to proposed nuclear facilities, and that "this is an auspicious time to establish FOE/Greece" (100).

This loose coalition of national FOE's is a precedent-setting example of international cooperation among private citizens who share common values

and priorities. The motivation to activism is heavily dominated by opposition to nuclear energy; the 1977 meeting issued a resolution which concludes: FOEI "Resolves: To use all means at its disposal to promote the orderly abandonment of nuclear power and the adoption by the peoples of the world, by national governments, international agencies, and other institutions, of soft energy strategies - inspired by principles of freedom and autonomy". (100).

It is probable that FOEI will express itself on SPS when a larger percentage of its members become aware of it, and will concern itself both with policy as well as specific implementation issues.

European Nuclear Energy Programs

Following the abrupt rise in oil prices in 1974, Western European governments accelerated or drafted plans for developing nuclear energy to cushion their reliance on oil from abroad. Despite the lack of conventional energy sources, these same governments have been forced to curtail their ambitious development programs in the face of energetic, sometimes violent protests with substantial grass-roots support.

Nuclear power was a major issue in the Swedish national elections in 1976. A year earlier, it was already recognized as a key issue (190); Olaf Palme's Social Democrats lost control of the Swedish government after 44 years in power following a campaign in which the victors, led by Thorbjorn Falldin, vigorously attacked the government's pro-nuclear policies. Palme attributed his defeat to the nuclear issue (190), although other observers give weight to a variety of domestic issues, of which nuclear energy was only one.

In Germany, the government has cut back its plans by a third (from 45,000 megawatt capacity by 1985 to 30,000 megawatts) following a series of protests and demonstrations (162). One such demonstration, in Grohnde, resulted in injuries to 80 demonstrators and 237 of the reported 4,000 police who were there (162).

Opposition to nuclear energy in France has already led to one death and at least 20 injuries at Creys-Malville (89). The Socialists, led by Francois Mitterrand, have suggested holding a national referendum on nuclear energy, although President Giscard d'Estaing has declared that to be unconstitutional; the Communist Party has lined up with the Government on this issue, and against the Socialists (89). A Dutch public opinion poll indicates that more than half of the Dutch population is against nuclear energy; opposition to government plans for three nuclear plants and the burial of wastes was reported in the NY Times (89).

Italian opposition, while partly based on cost, also draws on fears of a population made sensitive to pollution by the explosion at a chemical plant in Seveso in 1976, 30 miles from a proposed nuclear site (88). FOEI reports that 50,000 signatures were obtained urging modification of siting laws (100).

In Great Britain, Sir Brian Flowers, the former head of the Atomic Energy Authority, has called for caution in developing new facilities. A Royal Commission headed by Flowers has expressed serious doubts about the plutonium-fueled reactor now under development (146).

The evidence cited above leads to the conclusion that activists in Western Europe have effectively advocated an anti-nuclear viewpoint, and that governments have responded by scaling back their nuclear programs. While other factors have probably also contributed to this response (cost, effective energy conservation, waste storage uncertainties) the lack of acceptability of nuclear power to many Europeans is clearly a contributor.

The capacity of Europeans to mount an effective campaign on an energy issue, and the fact that energy generation is by far the most sensitive environmental issue in Europe, suggests strongly that these same groups will take a position regarding SPS, if they feel that their values and priorities would be affected by SPS.

Land Use and Quality of Life

The stormy opening of Tokyo's Narita International Airport on May 20, 1978, is merely the most recent episode of an 18 year long controversy. The increasing momentum of post-war recovery, symbolized for many by the opening of the 125-mph Bullet Train between Tokyo and Osaka, apparently led to a governmental decision to build a completely new airport for Tokyo rather than to expand Haneda Airport, which some officials favored (120). The site was selected in 1966; the first demonstrations in opposition took place in the same year (120).

Objections to Narita include resentment of forced expropriation of land from local farmers, objections to the noise of both aircraft and the new Bullet Train line needed for the 41-mile commute to Tokyo (it has not been built; needed land could not be acquired), concern with the risk of shipping jet fuel to Narita by rail until a pipeline can be laid (residents have accepted an agreement with airport authorities limiting shipments to a maximum of 28,000 barrels/day, but for only three years).

Narita was to open in 1971; it opened in 1978. Two additional runways - needed if Narita is to accommodate the increased traffic for which it was developed - cannot be built because 20 landowners refuse to sell their land. The government has had to promise to refrain from forced land expropriations. Objections to aircraft noise have been met, at the cost of an 11 pm to 6 am curfew for airport operations (35).

A significant outcome of the Narita dispute, which is far from over, has been the forced recognition by officials of the need to consult with local citizens - a major departure from Japanese tradition (120). Another is the development of broadly based interest groups with an awareness of their power to influence the government (35). A third is the

emergence of a movement espousing the values of a rural, agricultural life, and demanding the preservation of prime farmland (120).

Japan's great dependence on imported oil could be expected to generate interest in SPS, and perhaps the desire to participate in order to receive its benefits. The selection of a rectenna site could lead to a controversy of the sort Narita is facing, and thus serve to diminish both official and public interest.

Political Considerations and International Public Acceptance

The image of the United States in the eyes of the citizens of other nations will have an unpredictable, but probably substantial, influence on public acceptance of SPS. If SPS is organized on an international basis, other governments will be aware of and presumably sensitive to the attitudes of their citizens on the same issues likely to be of concern to Americans. If SPS develops as a solely American program, foreign non-governmental responses can still be anticipated, but they are likely to be based on a different assessment of costs, risk and benefits.

To the extent that the United States is seen as a large domineering power willing to use its economic weight to its exclusive advantage, the necessary international agreements for frequency and orbital assignments could be difficult to negotiate. Resentment in some quarters of the influence of giant multi-national corporations could, under certain conditions, expand to include resentment of SPS. The current criticism in Europe of America's lack of a coherent energy policy that could lead to substantial reductions of oil imports contains a lack of sympathy for our large balance of payments deficit - the problem is to a degree seen as self-created. The need for SPS could also be seen so, whether or not the parallel is appropriate. The use by the United States of a finite resource - geostationary orbital slots - could then be resented by those who see them being "wasted" by an energy-extravagant America. Other world-wide impacts, such as depletion of scarce resources to build SPS, upper atmosphere impacts, or communications interference could be viewed similarly.

Examples of responses on the part of non-Americans to our actions are well known. The success of the Apollo program was widely admired. On the other hand, visits of American nuclear-powered naval vessels provoked demonstrations in Japan; our involvement in Viet Nam was bitterly opposed in many countries, although the governments of those countries may have been more politic in their statements.

Any effort to influence international public opinion toward SPS, even in the most benign ways (dissemination of low key, conservatively phrased informational materials, for example), must be approached with extreme caution. Foreign governments can be expected to react very unfavorably to any American effort to influence their citizens on issues of such a political nature as SPS, as did the Government of Israel recently when President Carter was accused of trying to force the current Israeli government from office. Such

an effort could easily have the exact opposite effect to that intended. The citizens of foreign countries themselves can be expected to react equally negatively to any hint that the American government, or a private institution as large as that which would need to be involved in SPS, is attempting to manipulate public opinion in favor of American interests.

TECHNIQUES FOR DEALING WITH PUBLIC ACCEPTANCE

The following section addresses the question of what techniques may be available to the SPS program to assess the multiplicity of impacts, values and perceived interests that are certain to be affected by the SPS program. Understanding the concerns and values of the various interests that may perceive themselves as affected by the program and developing mechanisms for attempting to resolve the conflicts of competing impact perceptions, values and priorities must be considered crucial to public acceptance of SPS.

Two fundamentally different types of techniques are discussed: "passive" techniques that do not involve dialogue between the analysts and the public at large, and "active" techniques, which involve procedures for directly interacting with the public or representative groups for the purpose of resolving perceived differences of opinion and achieving concensus. Table III summarizes both the active and passive techniques discussed in this section, and describes their strengths, weaknesses and applicability as techniques for use by the SPS program.

Passive Techniques

Cost-Benefit Analysis

Cost-Benefit Analysis (CBA) is probably the best known and most frequently used method for evaluation of major programs (171). CBA reduces all factors which are included in the analysis to economic terms. Factors which can be assigned a value directly are evaluated by standard accounting procedures. Factors such as impacts on human health (e.g. accident rates) or recreational value (as in a dam project with recreational benefits) are evaluated by resort to indirect indicators. All inputs to the analysis are summed to establish the positive or negative net impact (commonly termed net present value) of the programs; frequently, a figure of merit in the form of benefit/cost ratio is also developed as a useful parameter for the evaluation of alternative proposals.

Cost-benefit analysis is a very useful technique for narrowly defined programs with easily identified effects. It is popular, primarily because it is easily understood and yields very simple results.

There are a number of difficulties with traditional applications of CBA as a decisionmaking tool for complex programs with wide-ranging impacts. These include:

1) The inability of the procedure to cope with factors which cannot be readily quantified,

TABLE III PROGRAM EVALUATION/CONFLICT MANAGEMENT TECHNIQUES

PASSIVE TECHNIQUES

Name:	Cost-Benefit Analysis/Risk-Cost-Benefit Analysis
Description:	All impacts, both positive (benefits) and negative (costs), are quantified and summed to establish net impact (positive or negative).
Strengths/Weaknesses:	Primary strength is that it reduces all impact to common terms (usually monetary) and produces results that are easy to understand (usually benefit-cost ratio). Weaknesses include inherent difficulty in quantifying subjective impacts (e.g. aesthetic effects); does not deal with effects of differing values and priorities on impact perceptions; does not address distribution of costs and benefits.
Applicability/Timing:	Minimal as public acceptability technique.
Name:	Public Opinion Polls
Description:	Not needed.
Strengths/Weaknesses:	Primary strength is that it addresses public response directly. Weaknesses include: choice, structure and sequence of questions asked can affect validity of responses; more useful for current and immediate issues than for long-range future issues; gives attitudes at single point in time and only repeated polling can address dynamics of attitude formation and change.
Applicability/Timing:	May be useful as adjunct to other techniques at various program phases to deal with specific and immediate topics.
Name:	Delphi
Description:	Formal procedure relying on opinions of experts, arrived at in relative isolation, to estimate future value of parameters of interest. Involves feedback (providing each participant with mean and standard deviation of previous group evaluations) and repetition of expert evaluation. Mean of values obtained in final round serves as best estimate.

TABLE III (continued)

Strengths/Weaknesses:	Allows interaction of opinions while avoiding risk of strong personalities dominating group discussion. Weakness (as public acceptability tool) is that it avoids "real world" of achieving consensus through negotiation and compromise.
Applicability/Timing:	May be useful in near-term policy program formulation phases before level of knowledge of affected interests becomes sufficient to use interactive consensus-building techniques.
Name:	Priority Tradeoff Scanning (PTS)
Description:	Interactive technique involving affected interest groups that relies on mathematical analysis of inputs with feedback of results to participants in successive rounds of evaluation. Outputs are: a matrix showing tradeoffs between goals; a matrix showing tradeoffs between evaluation criteria; and a matrix indicating where there is willingness to compromise.
Strengths/Weaknesses:	Strengths are direct involvement of interested parties and identification of areas where compromise is possible. Most effective use would be in conjunction with techniques that involve direct negotiation and compromise to build consensus.
Applicability/Timing:	A useful tool in near-term policy/program formulation phases, both preparatory to and together with more interactive conflict management techniques. Also may be useful later in resolving siting-related conflicts.
ACTIVE TECHNIQUES	
Name:	Arbitration
Description:	Most significant point is that findings of arbitrator must be accepted in advance as binding on all parties.
Strengths/Weaknesses:	Insurmountable weakness for use in SPS program is fact that public (interest group) representatives cannot bind their memberships to comply with negotiated settlement.
Applicability/Timing:	Not useful.

TABLE III (continued)

Name:	Mediation
Description:	Main difference (vs arbitration) is that mediator cannot impose a solution to conflict and that participation is voluntary.
Strengths/Weaknesses:	Strength is direct interaction and negotiation among affected interests and that process allows clarification of underlying issues. Weakness is that mediation will not work if any party is unalterably opposed.
Applicability/Timing:	May be useful in resolving specific siting-related conflicts during facility siting phase. Related technique, bilateral or multilateral policy negotiation, considered preferable in policy formulation phase.
Name:	Bilateral or Multilateral Policy Negotiation
Description:	Involves bringing together interested parties in workshop setting. Objective is to define important issues, reach consensus where possible and to clarify remaining areas of disagreement. Differs from mediation in that there are no formal mediators, although facilitators may be used.
Strengths/Weaknesses:	Affected parties negotiate directly; rule of reason (as opposed to adversarial courtroom tactics) used throughout. Some environmental groups, however, criticize approach as representing co-option of environmentalists.
Applicability/Timing:	Useful in near-term policy/program formulation phase of SPS program.
Name:	Impact Compensation and Site Selection by Competitive Bid
Description:	Negotiations undertaken with community organizations of several communities while alternative sites still being considered and with each community knowing that the other negotiations are ongoing. Each community can negotiate for what it perceives as acceptable compensation in money, civic improvements, impact mitigation, etc. Project applicant can then select agreement they find most favorable.

TABLE III (continued)

Strengths/Weaknesses:	Avoids problem of distribution of costs and benefits, where residents of site vicinity oppose project because of feeling that costs fall most heavily on them, while benefits are more broadly distributed. Weaknesses include difficulty to arrive at enforceable agreement that will bind all parties and avoid later opposition and technique not yet tried in a major program and fact that technique has not yet been tried in a major problem.
Applicability/Timing:	May be useful to resolve conflicts regarding SPS facility siting (i.e. rectennas); irrelevant to policy/program formulation.

2) The inadequacy of money as a common denominator. Individuals vary in their valuation of costs or benefits as a function of their earning or asset position in the society of which they are members.

3) The inability of the procedure to define distribution of costs and benefits. This failing permits abuse of CBA to benefit a few at the expense of many, or to benefit many at a cost which is intolerable to the few who bear that cost.

4) The application of economic discounting principles which emphasize the present at the expense of the future and which may be inappropriate to some of the factors required for a responsible decision.

5) Failure of the technique to fully consider the impact of irreversible commitment of resources. In the case of the New River Pumped Storage Project in North Carolina, for example, the reservoir would have flooded an area of great historic significance, with an indigenous population which had occupied the area since the 1700's. Both socially and culturally, the reservoir would have imposed an irreversible change which cannot be monetarized. This example applies also to item 3 above.

6) The deterministic nature of the procedure. The factors incorporated in the analysis are predicated on the assumed set of occurrences. The procedure cannot cope with probabilistic risks of failure or project-induced catastrophic costs. It also does not deal well with external costs, which may have to be internalized if litigation is successfully undertaken by injured parties or opposing interest groups.

Risk-Benefit or Risk-Cost-Benefit Analysis

This technique is an extension of Cost-Benefit Analysis, in which costs (determined in the same manner as for CBA) that are associated with an impact of the program that is uncertain either in magnitude or in frequency of occurrence, are weighted by the estimated probability of occurrence. Uncertainties to which an analytical procedure and a history of consequences can be applied can thus be incorporated to yield both a mean figure of merit and a range of variance around that mean.

The technique works best with technology-oriented activities in which the risks are associated with program success or failure in monetary terms, and in which there is some history of performance in similar programs. Most of the difficulties encountered in straight CBA also apply to RCBA.

Both procedures are in essence very weak in assessing public response to a proposed program. This is because of the primary underlying assumption that a program with a high benefit/cost factor, and therefore good value in economic terms, will meet with approval. While that assumption is generally

valid in business terms, it cannot be extended to the question of public acceptance or favorable response by interest groups, whose concerns may have little to do with economic factors or who may perceive themselves or their constituents as recipients of costs but not benefits from the program.

Public Opinion Polls

The public opinion poll is a well-known technique for taking the public pulse on an issue. The procedure basically involves the use of questionnaires and trained survey personnel to establish the responses of specified publics to the questions asked, relative to the characteristics (age, sex, income, etc.) of the individuals surveyed. Usually, relatively small numbers of carefully selected individuals are contacted who are presumed from past survey results to be representative of much larger segments of the public.

Surveys of this sort may address the topic of interest directly, or may ask questions designed to elicit responses which will indicate the respondent's attitude toward the topic of interest without directly exposing that topic. Often, both types of questions are used in an attempt to cross-check for positive or negative responses to semantic cues, to indicate subconscious reactions or to determine, for example, specific brand loyalties. The most sophisticated forms of this type of surveying fall into the category of motivational research, which has from time to time received bad marks as an unethical tool for the manipulation of public opinion.

The obvious advantage of public opinion polls is that they address directly the responses of the public to the topics surveyed, and if properly designed, also address the reasons for those responses. They can be used either broadly or very selectively. Obviously, the more complex the poll and the more people surveyed, the more expensive the technique. A simple poll with a minimal sample size can be relatively inexpensive; conversely, there is no limit to the amount which can be spent.

The opinion poll, however, has several disadvantages:

1) Selection of the public sampled. The applicability of the responses obtained to the real response to the program is a function of the people interviewed. They do not select themselves, but are selected instead by analysts. The decisionmaker is thus dependent on the judgment of the analysts.

2) Structure of the survey. The responses of those interviewed can be affected by the questions asked, and by the way in which those questions are phrased. Again, the decisionmaker is dependent on those who assemble the survey.

3) Knowledge of those interviewed. Public opinion polls work best for topics on which the knowledge of those interviewed is less important than their opinion or intent, as in an election poll. When the attitude of the interviewee is not based on knowledge of the topic, and greater knowledge could affect his opinion, the value of the

survey is limited. In a recent poll of Wyoming residents concerning the risks to them of coal mining in their areas (84), those questioned showed that they did not understand the nature of boomtown growth problems. This occurred even though the state had experienced boomtown problems (in Gillette and Rock Springs) which were well publicized. The respondents showed a belief that it could not happen to them, and failed to react to specific questions in a manner consistent with their reaction to general lifestyle questions, even though a number of the specific questions were phrased in a manner which would prompt the expected response. Understanding of SPS and its potential impact requires an extensive knowledge of the concept which few members of the public are likely to have.

4) Immediacy of the topic. Opinion polls are most useful when the topic discussed is one of current and serious interest. A study of response to crisis situations as a function of the distance of the crisis from the respondent, either geographically or in time (94), showed an inverse correlation. The further away the event was from the respondent, the less concerned the respondent was about the event. The same phenomenon is true of questions about events which will not occur for a significant period of time; respondents are not much interested and have correspondingly hypothetical attitudes toward them.

5) The dynamics of attitude and changes in attitude. At best, an opinion poll provides a "snapshot" of public opinion; that is why political polls are taken so frequently before elections. In an election campaign, of course, the changes from week to week are as important to the candidates in running their campaigns as are the absolute numbers of percentage support. Evaluation of public response to SPS would require a continuing series of polls if this technique was attempted.

The opinion poll could be a useful tool if applied in a specific area of interest as a preliminary step to other procedures. As an example, if one of the consensual conflict avoidance techniques (to be discussed later) was to be attempted relative to rectenna emplacement in a certain locale, an opinion poll might be used as one means of developing an agenda of concerns.

Goals Achievement Matrices, Judgmental Impact Matrix

A number of other analytical techniques have been developed in recent years that attempt to evaluate interest group responses without reducing all factors to monetary terms. These techniques, such as Goals Achievement Matrices (77) and Judgmental Impact Matrices (112), however, still rely on the insight of the analyst, essentially without direct involvement by those interests whose viewpoints are of interest.

Delphi

The Delphi technique (46) relies on the opinions of experts, arrived at in relative isolation, to provide estimates of the future value of objective (measurable) parameters. It is a formal procedure which follows a fixed set of steps, as follows:

1) Individuals are identified whose knowledge or expertise in the area of study is adknowledged.

2) Each individual's opinion about the parameters of interest in the study is solicited, without any interaction (to the extent possible) with other experts involved in the analysis. For example, each person might be asked his opinion on the price of crude oil on the world market in 1990 or 2000.

3) The mean and standard deviation of the opinions obtained are calculated and submitted to the participants and they are asked, again individually, to adjust their opinions as they find it appropriate to do so. Some versions of Delphi also circulate without attribution a list of written comments from all of the participants in support of their individual opinions.

4) The process of opinion gathering and feedback of results is continued for several rounds, or until the changes observed in the mean and variance of the results become small.

5) The mean of the values obtained in the last round of inquiry is employed as the best estimate, for the parameter studied.

As an analytical tool for estimating the value of a broad range of variables which cannot be measured, or whose future value is subject to unknown changes, Delphi has been relatively well demonstrated to be superior to the "committee" procedure for arriving at such estimates, because it permits the interaction of opinions while avoiding the risk that stronger personalities will dominate a face-to-face discussion. It has little value as a decisionmaking procedure, but can be usefully employed in support of decisionmaking procedures.

Priority Tradeoff Scanning (PTS)

PTS (48) is an interactive technique aimed at maximizing the probability of achieving agreement on a course of action by all the parties involved in the proposed action. It relies on a mathematical analysis of the inputs to the process from parties to negotiation, with feedback of the results of that analysis to the parties in successive rounds of program evaluation and to the decisionmakers who must pursue, modify or abandon the program studied.

The first step in this process is identification of three sets of information:

1) The objectives of the program, which will form part of the criteria which will be used to evaluate the program;

2) The options available to the decisionmaker in modifying the proposed program to achieve all or part of the objectives of the program;

3) The groups likely to be impacted by the program. This list must be as complete as possible, and must include proponents and groups which are likely to be impacted, either beneficially or negatively, by the program.

The groups which are involved are provided with information about the program and the options identified and are asked to rank the options in two ways: an "uncompromised" ranking, which scores their attitudes toward each option without regard to any overall goal of the program; and a "compromised" ranking, which recognizes the goals of the program. For example, in an energy facility siting study which utilized PTS (154), the participants were asked to rank different ways to generate electricity at a series of typical sites (coastal, inland, desert, etc.). In the uncompromised ranking, opponents of nuclear power generation could state their dislike for the process without regard to the need of society for electrical energy. In the compromised ranking process, the same parties had to take into account those needs and the advantages and disadvantages on their own terms of providing that power in various ways in various places.

The results of this survey process are assembled in three matrices: one relating to tradeoffs between goals, which establishes the priorities which the various groups assign to those goals; one relating to tradeoffs between evaluation criteria, which similarly displays the importance of those criteria to the individual groups; and an interest priority tradeoff matrix, whose function is to display the places and directions in which the groups would each be willing to compromise their positions. This information is potentially of great use to the decisionmaker in negotiating a final set of options and actions which, while it may only achieve a portion of the original program goals, will maximize the acceptability of those actions, and therefore, the likelihood of achieving them.

The technique has not been tested in a real "go-for-broke" program negotiation, but shows promise as an analytical tool in extending the information value of other mediation or conflict avoidance procedures if used in combination with them.

All of the above assessment techniques have one aspect in common: they do not involve an active dialogue with the public or public interest spokesmen in an interactive sense. Techniques which incorporate several rounds of opinion solicitation with intervening feedback to the experts whose views are solicited (the Delphi procedure (46) and techniques which incorporate it) do allow for some modification of opinion in response to exposure of the

opinion-makers to the views of others, but the procedures all avoid the "real world" of negotiated agreements involving compromise. This may seem to be a major shortcoming of these techniques, and in terms of the total process of goals achievement it is. But the direct evaluation of public response to a program cannot proceed until the program development process has evolved to a point where the public and its spokesmen have become aware of the program and its perceived effect on them. Until that time, the essentially pedagogical techniques which rely on the opinions of well-informed experts are the best available source of information on the probable public response to a program such as SPS.

Active Techniques

There are a number of techniques for dealing with conflicting goals and attitudes and resolving disputes. Some are well established; others are new and are still being tested. The newer techniques have arisen primarily in response to the environmental and land use management laws that have been passed in the last ten years and the confrontations and litigation which have occurred in the administration and testing of those laws.

Legal challenges in the courts are of course one means of resolving disputes. The process is expensive and time-consuming. In addition, the process has the shortcoming that it results in a winner and a loser; in other words, there is very little middle ground in a court suit and the resulting ruling. Either the environment or the proposed program which is challenged on environmental grounds will lose. Worse, a favorable ruling for the program does not achieve acceptance of the program by the public or interest groups which oppose it. They will continue to oppose it, and frequently employ other means of disrupting construction of facilities or implementation of the program, with inevitable increases in cost, delays in completion and sometimes failure to achieve the goals of the program. Finally, the true conflicts of interest which induce court action are frequently not tested in the courts because, though real, they are not litigable. The court action will be joined and argued on grounds which are litigable. In those situations, it is certain that regardless of the ruling of the court, nothing will be settled and, very probably, no one will win.

It is in part these flaws in the traditional court route of conflict resolution that have resulted in the search for other means of resolving disputes, means which can expose the true bases for conflict and which can utilize the room for compromise by all parties and avoid the adversary aspect of legal action. Those techniques are discussed in the following sections.

Arbitration

Arbitration is a well-established procedure for resolution of conflicts of the sort which arise in labor-management relations. The arbitration of contract disputes in the settlement of strikes is a familiar occurrence, and is indeed embedded in some legislation. In the process of arbitration, the findings of the arbitrator or arbitration panel have the force of law, and the disputants must agree in advance or be required by law to submit to the rulings of the arbitrator.

It is precisely this requirement to abide by the rulings of an arbitrator on which the arbitration process founders in issues involving pubic concerns. The public at large cannot be brought to the arbitration table; their interests must be argued by representatives who, because they have no authority to enforce the resulting settlement on the public, cannot guarantee compliance with the rulings. Further, arbitration works best with only two, or at most a small number of disputants and a relatively narrow and well-bounded set of reasons for disagreement. Arbitration of wage disputes, arguments over work rules and the like, in which subsequent enforcement can be achieved by means of a contract between the parties, is the typical use of the technique. Where there are many points of view and participants and very little chance to enforce on all interested parties the negotiated settlement (such as is the case with SPS), arbitration becomes an empty exercise.

Mediation

The mediation process differs from arbitration in one significant respect and several lesser ways. The major difference is the lack of authority of the mediator to impose a solution on the parties to the mediation. Another potential difference is the number of parties to the action. Arbitration generally involves at most three or four parties (typically only two) and involves a binding contractual outcome. Mediation activities can involve many more factions, and can successfully result in an agreement which binds only a few of the parties in exchange for the acquiescence of the rest to the negotiated outcome. Finally, mediation is a voluntary process on the part of those involved.

The greatest volume of experience in mediation rests in the labor field. Recently, several attempts have been made to extend the mediation process into the area of environmental disputes, with variable success. In a recent conference on environmental mediation (121), a serious attempt was made both to define environmental mediation and to establish a set of criteria which could be used to identify mediable disputes. Neither effort was totally successful. One of the more accepted definitions is that of Gerald Cormick, Director of the Office of Environmental Mediation, University of Washington:

> Mediation is a voluntary process in which those involved in a dispute jointly explore and reconcile their differences. The mediator has no authority to impose a settlement. His or her strength lies in the ability to assist the parties in resolving their own differences. The mediated dispute is settled when the parties themselves reach what they consider to be a workable solution (121).

At that same conference, Jerome Barrett, Director of Professional Development for the Federal Mediation and Conciliation Service, put forward a series of eight requirements for a mediable dispute. That list, which was by no means accepted by all participants in the conference, is as follows:

- o Clearly identifiable parties to the dispute with authority to make changes and to bind others;
- o A willingness of all the parties to the dispute actually to bargain on at least some of the issues;
- o A desire on the part of the bargainers and their constituencies to reach an agreement;
- o An understanding and acceptance by the bargainers and their constituencies of the concept of representative bargaining;
- o Bargainers who understand and keep current with the parameters of their authority from their constituents;
- o Responsible bargainers who are willing to lead as well as follow their constituency;
- o Issues which the parties are able to view not as rights but as implementations of rights; and
- o Some degree of trust in the bargaining process and in the parties' ability to negotiate successfully (121).

Clearly, mediation will not work if a group is unalterably opposed to an activity. Another situation which is not mediable occurs when one faction has elected to seek a landmark decision by opposing in court the specific activity presented for mediation.

One advantage of the process is the opportunity it affords to clarify the real issues which underlie opposition to a proposed program. Frequently, the visible arguments of disputants mask the real causes of the dispute, either because the spokesmen choose to emphasize a popular stance in public or because they themselves are unaware of the implications and potential consequences of the stance they have taken.

A classic example of the potential for issue clarification and resolution of conflicts through mediation is the Snogualmie Dam dispute mediated by the Office of Environmental Mediation of the University of Washington (38). In this dispute, a farm community and others which had suffered flood damage supported a flood control dam project which was opposed by an environmental coalition which feared further uncontrolled urban development in the area. In the mediation process, the farming representatives and environmentalists both discovered that neither wanted uncontrolled growth and conversion of farmland to other uses. The environmentalists also discovered the extent of

their liability in the event of more flood damage as a consequence of their opposition. A package of conditions for the construction of the necessary flood control improvements was negotiated which the State of Washington, the Army Corps of Engineers and all parties to the negotiations endorsed, and which resulted in a land use management program which satisfied everyone.

In sum, when environmental or public interest conflicts do arise, the process of mediation if carefully applied can be a very useful tool for conflict resolution.

Impact Compensation and Site Selection by Competitive Bid

One approach to environmental and social impact conflict resolution which has received considerable study and discussion is the concept of direct compensation. Most proposed programs require the placing of facilities of one sort or another in specific locations. The acquisition of the necessary facility sites and the impact of placing those facilities commonly forms the bulk of the discussion found in environmental impact studies. It follows, then that most controversies arise over those impacts and are raised by the individuals and groups which will be impacted.

The successfully mediated dispute in which the program developer gives up certain goals and/or undertakes mitigation procedures is in fact an example of indirect compensation, in the sense that the local community accepts certain impacts and agrees not to oppose the compromise program in exchange for the cost to the developer of not achieving all of his goals and paying for the agreed mitigating measures. The White Flint Mall in Maryland (124) is an example of this situation. In that successfully mediated dispute over construction of a shopping mall, the developer agreed to a lower height limit on buildings than was permitted by the local zoning ordinances, designed larger setbacks and an isolation berm around the mall, and agreed to provide 24 hour security control of the mall property, among other concessions.

The competitive site selection procedure goes beyond the type of compensation described above. In this procedure, which has been studied by the Energy Impacts Project at MIT (127), negotiations may be undertaken with a complex of community organizations (as complete as possible) by a developer before a final site has been selected, i.e., while several potential sites are still being considered. The groups concerned with each site are negotiated with simultaneously and with the knowledge that other negotiations are also in progress. Each group can negotiate for what it perceives as reasonable compensation in any form it wishes, including such items as monetary reimbursement, construction of civic improvements, restrictions on the proposed project, etc. The proponents of the program can then select the agreement which they find most favorable.

This process potentially has the advantage that the local citizens in the area selected for the program have the opportunity to make their best deal (which presumably they will be satisfied with) and the social costs of the program are both internalized and, within the context of internalization of social costs, minimized.

There is one major risk to this approach. It is very difficult to arrive at an enforceable contract of agreement which will bind all parties and avoid later opposition. For example, a coalition of environmental groups may agree to the bargain struck, only to reform into a different configuration which is not bound by the agreement; or one group may split off and sue the developer on its own behalf or on behalf of individuals not represented in the agreement who feel that they have been inadequately compensated or unjustly impacted.

Notwithstanding this drawback, the procedure appears to hold considerable promise in some situations. It has not yet been tried in a major program; only time will tell whether it is a feasible approach to conflict resolution. Further, in terms of SPS, this technique is designed to deal with facility siting conflicts. While it may therefore be useful in specific SPS rectenna siting proposals, it is not relevant to the overall pre-siting SPS debate.

Bilateral or Multilateral Policy Negotiation

The title applied to this process is based on the definition of the process in the recent RESOLVE Conference on Environmental Mediation (121). The technique involves the bringing together in a workshop or task force context the various parties who hold, and are willing to discuss, differing points of view and priorities concerning a program or major developmental area. The objective of the process is definition of those issues which the participants view as important to the activity and to the society, and the development of solutions to those issues on which the participants can agree. A secondary benefit of the process is calibration of the issues on which the participants fail to agree in the sense of defining the dimensions of and reasons for the disagreement.

There are in this form of negotiation no formal mediators, though facilitators may be employed, whether they function at large in a workshop environment or are designated as chairmen of individual task forces or subcommittees. The rule of reason is invoked for all discussions; this means that all parties to the discussions abandon all adversary tactics (such as attacks on each other, withholding of information, arguing out of context and hiding personal biases) and proceed as if they share a common goal.

A recent example of this process which appears to have been a notable success is the recently concluded National Coal Policy Project (103). Even though the NCPP was formed after years of confrontation and litigation between environmental groups, the coal industry and the Federal government, a great deal of progress was made, both in healing old wounds and in achieving consensus on over 150 issues relating to coal extraction and use in the United States. While a number of issues remain unresolved, those issues and the reasons why various groups consider them serious are better understood by all parties to the continuing controversies, which may assist in final resolution of them in the future. One of the most important results of the project was significant depolarization of attitudes by the participants. Both industrial and environmental participants in the program now see their opponents as far more reasonable and responsible individuals.

The process cannot guarantee an avoidance of all opposition to a proposed program; indeed, that is not its function. What it can do, if successful, is assist in mapping a course of action which maximizes the likelihood that the major goals on which agreement is reached can be achieved with a minimum of unnecessary cost or delay. It can also create an atmosphere of cooperation among the responsible representatives of major national and regional groups which minimizes the opportunity for hard core opponents of the activity to form alliances and thus weakens any efforts to obstruct what has been agreed upon as socially progressive activity. Finally, the process yields a source of policy recommendation to legislators and regulators to which they can give serious consideration. Indeed, if the base of participation in such negotiated agreements is sufficiently broad, the results can serve as a partial mandate to elected officials.

It should be noted that the NCPP approach is not without its critics in the environmental movement. Some groups, such as the Environmental Policy Center, refused to participate in the NCPP, arguing that it represents cooption of environmentalists by industry and that the adversarial relationship between these two forces is essential (108). Nonetheless, the NCPP has spurred talk about trying a similar approach to other issues such as "power plant siting, energy pricing policy and even nuclear power controversies." (108).

The various techniques discussed above for conflict avoidance, assessment or resolution obviously have different modes of applicability. Methods for conflict avoidance are appropriate very early in the developmental history of a program, when a potential for controversy about the proposed activity has been identified and enough information on the program has been developed for a meaningful discussion between factions to take place, but before there has been much polarization or public taking of hardened positions pro or con. Conflict assessment procedures, if necessary, apply when a conflict has arisen, but still prior to the development of serious polarization of opinion. Conflict resolution techniques apply to hardened situations in which the alternative is court action.

The SPS program has elicited both positive and negative responses in this country (as described earlier in this paper) and is being taken seriously by more and more spokesmen for special interests. Little polarization has occurred to date, and the public support for hardened positions pro or con is very limited. There is thus no basis for the application of conflict assessment or resolution techniques. There is, however, a sufficient base of knowledge about SPS on the part of developers of the program and well-informed commentators for a conflict avoidance activity to proceed in the very near future.

III. KEY ISSUES AND GENERAL OBSERVATIONS

It is undeniable that the SPS program can have profound economic, environmental, social and political implications both for American society and for the international community. The American public is not yet really aware of the program's existence, much less of some of its possible impacts and implications. The public abroad almost certainly knows even less about SPS.

Interest groups concerned with energy and environmental issues are becoming aware of the program's existence and, at least on the level of the staff of these organizations if not their membership, have an idea of at least some of the project's implications. Some of these groups (e.g. the Citizen's Energy Project, the Solar Lobby) have already taken positions opposed to SPS; other groups, such as the Sierra Club, have taken no position as yet, although representatives contacted have expressed concerns about various program aspects.

Many of SPS's natural constituencies (e.g. the aerospace industry, the pro-space groups) certainly know about SPS, and, as evidenced by the recent formation of the Sunsat Energy Council, have begun to organize to support the program.

SPS is a mixed bag to groups and individuals opposed to our historical and current energy policy. Although it is renewable solar energy, at the same time it is undeniably a centralized, high technology. "hard" energy source. It is an alternative to nuclear power, which is increasingly unpopular, yet it certainly is not the decentralized, "appropriate" scale alternative that many anti-nuclear groups argue for as alternatives to nuclear energy. It avoids many of the pollution problems associated with fossil fuels and nuclear energy, yet it creates other environmental problems (e.g. microwaves, high altitude air pollution). It requires vast amounts of capital, yet so do its alternatives (including widespread use of decentralized solar technologies (119). If there is one single point that SPS advocates and opponents can agree on, it is that many of the potential impacts of the SPS program (both environmental and non-environmental) are not yet well understood, and require further study.

In a number of substantive areas, it is clear that if further research reveals potentially severe impacts, then SPS is likely not to be a viable energy option. Communications effects are but one example of this, microwave thermal effects on the ionosphere are another, high altitude air pollution is a third. If further research into long term, low level microwave health effects reveals serious problems, then SPS may not be "acceptable" (although, given the proliferation of microwave uses in modern society, the implications of this realization will extend far beyond the energy field).

In the international arena, beyond the anticipated lengthy and difficult negotiations regarding orbits and frequencies, the perceived military implications of SPS may make the price of developing SPS too high in terms of the totality of our international relations. If some form of internationalization of SPS must occur in response to the perceived threat to foreign security

and sovereignty, this might arouse nationalist sentiment in the United States, so as to make domestic acceptability a dubious proposition.

The centrality of the outcome of ongoing and future research into SPS related issues (particularly environmental, health and safety issues) is unquestionable. However, questions of the credibility of the research findings (as well as disagreements about thresholds of significance for adverse impacts) may well arise. The Navy encountered such problems with its SEAFARER/SANGUINE Extremely Low Frequency submarine communications project, in a relevant (to SPS) area -- radiation health effects. The Navy was accused by project opponents of suppressing unfavorable research findings; even a National Academy of Sciences research panel was criticized as biased in its composition. This case, particularly the NAS panel's problems, also reveals another important point: no matter how open, objective and rigorous the research effort, some committed opponents of a project will not accept its results if the findings do not support their overall positions. In the long run, unless future research leads to the conclusion by advocates and opponents alike that the program is not viable (or an unforseen energy research development renders SPS unnecessary), the key to SPS acceptability is likely to be the comparison between SPS and alternative scenarios for our future energy supply.

Clearly, all large scale energy technologies have advantages and drawbacks. Decisions on the SPS program, as does every major energy policy decision, touch on the fundamental questions of how much energy we really need to achieve a particular desired future life style. Further, we must decide what price we are willing to pay to achieve this desired future. Inevitably, difficult choices must be made in weighing the costs and benefits of SPS, both in its own terms and in comparison to other energy alternatives.

Involvement in the decision process by interests who perceive themselves as potentially affected by SPS is essential, if for no other reason than to achieve a sufficiently broad political consensus to support these decisions. Traditional applications of techniques used to evaluate projects, (e.g. Cost-Benefit Analysis, Risk-Benefit Analysis) founder as public acceptance evaluation techniques, in part, because they do not directly involve in the analytical process those whose views are of interest. Cost-Benefit Analysis also cannot deal effectively with differences in impact perceptions that stem from differences in values and priorities and from how costs and benefits are distributed (i.e. interests who feel they must absorb a disproportionate share of project costs relative to benefits received). It is important that a public participation program developed for the SPS program be truly educational, as opposed to public relations-oriented. This requires that public participation be based on balanced, factual and timely treatment of the scope, objectives, principles and uncertainties of the SPS program. A prime objective of public involvement in the decision-making process is to ensure that the commitment of resources (financial and other) required by the program is for a program the public really wants, rather than to "sell" the program to the public.

Timing

A problem in applying consensus-building interactive techniques to evaluate public acceptance issues is that they cannot be used effectively until a sufficient level of knowledge about the program in question is acquired by affected interests.

For this reason, it may be advisable to begin near term (i.e. 1979) public acceptance activities with techniques that involve outside experts (rather than representatives of affected interests), but that incorporate several rounds of opinion solicitation with intervening feedback to allow modification of views in response to exposure of the views of others. The Delphi approach and the Priority Tradeoff Scanning (PTS) system,which also uses feedback mechanisms, are examples of this approach, which was discussed earlier.

The second major effort appropriate to the near-term is a study program similar to the National Coal Policy Project (NCPP). Such a program should involve environmental and public health advocates, social commentators on technology impact, the proponents of SPS from industry and the scientific community, labor representatives, and governmental representatives from pivotal federal agencies, if that is possible. As with the NCPP, the rule of reason (as opposed to the adversarial rules of the courtroom) should be applied, and the objective of the study should be consensus on the policies for implementation of SPS and the focusing on issues which it is not possible to resolve without further study.

Obviously, the unresolved issues will have to be examined further, both to satisfy the concerns of public interest representatives and to provide inputs to the program-level environmental impact statement which will be required when Congressional authorization and appropriation of funds is sought for large-scale development.

At such time as funds are sought for large-scale development of SPS component technology, which is scheduled at present to proceed throughout the 1980's, an environmental impact statement will have to be prepared and public hearings held. This is an appropriate time to initiate periodic seminars or symposia for the purpose of public education about SPS. The state of development of the technology, approaches to resolution of potential issues of interest to the public and the probable impacts of the system (adverse and beneficial), are the appropriate topics of these symposia. The U.S. Government will be continuing its efforts to obtain agreement internationally on orbital assignments and communications frequency considerations during this period. The symposia will serve the additional purpose of identifying additional public concerns and the reasons for them, and will aid in training a cadre of personnel in the skills required for negotiation of conflicts. While the focus of the symposia will still be primarily national, the regions which are impacted by elements of the SPS development program, and those regions likely to be affected by future deployment, are appropriate areas in which to hold general interest sessions.

The finalization of a design for SPS and definition of the program to manufacture, transport into space and deploy a prototype system will mark the beginning of a new phase in the SPS system. A site will have to be selected for construction of a rectenna to receive the energy transmitted by the prototype SPS, as will a site for launch and recovery operations. A new EIS and public hearings will be required at the beginning of the prototype deployment phase. In addition to any ongoing national discussion of SPS, there will be a new local focus associated with site- or region-specific impacts of the system.

Community conferences are an appropriate step in candidate rectenna siting areas. It may be possible, in the event of opposition in those areas, to apply the "competitive bid" techniques being studied at MIT in achieving acceptance of a site for the rectenna. Alternatively, a mediation activity may be required to isolate the reasons for opposition and to establish a course of action which will satisfy the concerns of the local public and local/state organizations.

The same problems will have to be faced in all deployment areas in the post-2000 period as were encountered in the prototype phase. The techniques and skills which were developed in coping with problems will have to be applied in each new deployment configuration. Hopefully, a trained cadre of personnel will be available to administer the public acceptance aspects of the full deployment phase.

IV. RECOMMENDATIONS FOR FURTHER STUDY

The potential for ultimate public acceptance of the SPS program can not be properly assessed on the basis of currently available information. To enlarge our understanding of the issues involved, areas appropriate for additional research during the coming year are identified below. It should be noted that many of these research areas cannot lead to conclusive answers during FY 79; they will, however, provide valuable data on evolving public attitudes toward matters directly relevant to SPS.

1) A further refinement of public acceptance issues should be made, with the goal of more clearly understanding the source of the potential controversies. Distinctions should be made among controversies stemming from differing values and priorities, genuine technical uncertainities, perceptions based on a lack of information, misinformation, skepticism of published information, etc. Changes in public perceptions as a result of newly available data, altered social, political or other conditions, and for a variety of other reasons, will require ongoing reassessment of the nature and degree of interest group concerns.

2) Current public controversies surrounding the development of other major projects and programs that involve relevant (to SPS) impacts/acceptance issues should be examined. Major energy projects are an obvious example; other controversial projects such as dams and various military programs (PAVE PAWS, the MX missile system) also are relevant. The focus of these studies should be on the relevant substantive issues, the participants (e.g. interest groups, public agencies) involved, the behavior of the groups involved (the project sponsor, supporters and opponents), and the nature and forum for the resolution of the conflict. In the context of international projects, the success of, and public reaction to, the joint U.S./European Space Lab project should be monitored as an indicator of the workability of international cooperation on complex space projects.

3) Public attitudes and governmental response to a number of issues should be monitored and analyzed. These include:

   a) The radiation health issue. Both the microwave issue and the low-level ionizing radiation controversy must be studied. Important questions include: how serious does the public perceive each of the two low-level radiation problems to be? does the public recognize the distinction between ionizing and non-ionizing radiation, or are they seen as the same problem? what should be done about microwave exposure standards?

   b) Communications interference issues (e.g. Senator Goldwater's recently introduced bill on the subject and subsequent committee hearings).

c) Potential man-caused damage to the ozone layer. This issue first surfaced with the U.S. SST, became more prominent with aerosol sprays, and, although currently dormant, may well reemerge to prominence.

4) Emerging developments in the field of conflict management and resolution should be examined carefully. Both successful and unsuccessful applications of these techniques to actual controversies should be studied to see what lessons they may hold for the SPS program.

5) The evolution of public attitudes toward space exploration/utilization and towards science and technology in general should be studied. Of primary interest here is the movement in society that increasingly sees technology as a mixed blessing.

6) The progress of the ongoing internationalization of the environmental movement should be monitored. The emphasis should be on where environmental movements are emerging, what issues these movements coalesce around (such as nuclear power) and how the U.S. is viewed by environmentalists abroad in terms of environmental and energy issues.

7) A comprehensive plan of SPS program public acceptance activities over the next two years should be developed. This should include systems for monitoring media (print and electronic) reports on SPS and related issues (including the foreign press). It also should include such activities as developing a detailed roster of interests (interest groups and individuals) potentially affected by the SPS program. Such a roster can serve to identify potential participants in a non-adversarial, consensus-building program similar to the National Coal Policy Program.

A longer term study might focus on anticipated public reaction to the siting of SPS-related facilities (particularly rectennas). A more detailed list of potential site-specific impacts and issues would be developed. Studies of potential acceptability in several representative sample siting areas (in different geographical regions) and, perhaps offshore could then be carried out.

A second long-term study effort that may be usefully undertaken relates to the possible reaction of the American public to proposals that SPS should be internationalized in some way. For example, public reaction to Third World proposals that ocean bottom mineral resources must be shared by all nations regardless of who can exploit them, can provide valuable insights.

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APPENDIX

POTENTIAL SPS PROGRAM IMPACTS ON "QUALITY OF LIFE"

Following is a preliminary list of the ways in which the SPS program could affect the "quality of life". Both environmental and non-environmental factors are included. This list was developed from a review of the SPS program documents (e.g. the 1977-1980 Program Plan, studies performed under contract to DOE or NASA). Because the SPS program is a "concept" rather than a well-defined "program" or "project", comprehensive evaluations of actual program impacts (environmental and others) do not yet exist. Thus, this list represents areas where impacts are anticipated; the nature and magnitude of these potential impacts is as yet unknown. Further, additional analysis may uncover impacts beyond those included here. Thus, this impact list should not be considered definitive. For these reasons, a thorough comparison of impact predictions developed through technical analyses and impacts perceived by concerned interests as likely to occur is not yet possible. The tension between actual and perceived impacts is crucial to public acceptability; thus this kind of comparative assessment should be performed as the program impact analyses become available.

The list of impacts was developed prior to the review of non-program literature and informal contacts with various concerned interest groups that provided the basis for the description of public acceptance issues presented in Section II of this report. Generally there is close correspondence between the general areas of anticipated impacts and the major acceptance issues reported in Section II, in the sense that no major acceptance issues were discovered which were totally unanticipated.

The impact list in this Appendix, however, contains many potential site-specific impacts associated with various phases of program development such as resource extraction and processing, manufacturing operations, transportation of raw materials and finished products, and development of launch and recovery and rectenna facilities. As was indicated in the body of this report, public awareness and concern about siting-related issues will become most important when the SPS program approaches the facility siting stage. At present, both program-related studies and public concerns are focused much more on broad policy and impact issues that relate to the fundamental viability of the SPS program, rather than on issues such as precisely where and under what conditions program activities should occur.

Ecosystem Effects

Stemming from:

- Resource extraction
- Economic/population growth in areas where resource extraction occurs
- Development of new or expanded manufacturing facilities for SPS components, etc.
- Economic/population growth in areas where manufacturing takes place
- Transportation infrastructure improvements to transport materials and products
- Transportation operations effects
- Development of launch and recovery facilities
- Economic/population growth in launch/recovery vicinity
- Microwave rectenna facility construction
- Economic/population growth in rectenna area(s)
- Launch and recovery operations (impacts on species/habitats)
- Microwave exposure (within beam and nearby) from SPS power beam
- Climatic changes (rectenna "heat island" in desert)
- Development of power transmission corridors from rectenna sites
- Ozone depletion leading to increased terrestrial ultraviolet radiation levels

Air Quality Impacts

Stemming from:

- Resource extraction
- Economic/population growth in resource extraction areas
- Manufacturing operations
- Economic/population growth in manufacturing vicinities
- Transportation infrastructure improvements for materials and products
- Transportation operations
- Development of new or expanded launch and recovery facilities
- Economic/population growth in launch and recovery areas
- Rectenna construction
- Economic/population growth in rectenna vicinity
- Launch and recovery operations emissions

Climatic Changes

Stemming from:

- Ground clouds and local heating from launch operations
- Localized heating in area of rectenna sites
- Possible regional and global climatic changes
- Modifications to atmospheric electric fields caused by microwave beam, leading to"enhanced local thunderstorms"

Noise Impacts

Stemming from:

- Launch and recovery operations (including sonic booms)
- Resource extraction and processing operations
- Materials transport infrastructure improvements
- Materials product transport
- Ground facilities construction (manufacturing, rectenna, launch and recovery facilities)

Water Quality/Availability

Stemming from:

- Resource extraction and processing
- Manufacturing operations
- Transportation infrastructure improvements
- Population/economic growth in areas of:

    1) resource extraction and processing
    2) launch and recovery
    3) manufacturing
    4) rectenna sites (conceivably could be big problem for relocating industry to rectenna areas)

- Launch and recovery operations - toxic substances

Waste Disposal (Solid, liquid, toxic)

Stemming from:

- Resource extraction and processing, manufacturing, transportation, infrastructure improvements, transport operations, launch and recovery facility development, launch and recovery operations (toxic), rectenna construction and operation
- Growth (economic and population) associated with each of the above activities

Land Use Effects

Stemming from:

- Resource extraction
- Growth in resource extraction and processing areas
- Manufacturing operations
- Growth in manufacturing areas
- Transportation infrastruction improvements (materials and product)
- Power transmission Rights of Way
- Launch and recovery facility development
- Rectenna development and operation

- Disruption to existing and planned land use patterns in areas of each of above program activities

Economic Effects

Stemming from:

- Employment/business stimulus in areas of:

    1) resource extraction and processing
    2) manufacturing
    3) launch and recovery
    4) rectenna(s)

- Disruption of existing economic base in above areas and strain on public finances to cope with rapid growth
- Productive utilization of high technology/aerospace industrial base
- Development of space industrialization - a new industry
- Improved balance of trade (reduced energy imports and possibly export)
- Increased import dependence and degraded balance of trade during development and construction for materials that must be imported

Social Effects

Stemming from:

- Relocation of population (away from rectenna sites)
- Centralization of society stemming from centralization of energy supply
- Social disruption from growth/urbanization in rural areas (e.g. expanded resource extraction, construction and operation of rectennas)
- Degraded quality of life (amenity levels) in rural areas (e.g. aesthetics, environmental quality, perceived increased risk levels near rectennas)
- Denial of access to rectenna sites previously used for recreation (e.g. desert and Off Road Vehicle users)
- Priorities for resource (money) use affected, i.e. large sums spent on SPS mean other priorities foregone

Cultural Resources (including Native American issues)

- Related directly to land requirements for each of the following activities:

- o Resource extraction and processing
- o Manufacturing
- o Materials transport and associated infrastructure improvements
- o Launch and recovery site
- o Rectenna sites

Public Health and Safety (Non-Microwave)

- Ozone depletion (leading to increased UV radiation and increases in skin cancer rates) from launch, flight and recovery operations
- Climatic modifications coupled with launch vehicle emissions in launch and recovery area
- Exposure to toxic exhaust emissions from launch operations
- Health effects of outer atmospheric changes (free electron destruction from orbital transfer operations, reaction control and station keeping)
- Water quality, air quality, waste disposal, hazardous materials transportation - from mineral extraction, processing, manufacture and fabrication and ground facility activities
- Lower level electromagnetic radiation from power transmission lines from rectennas to utility grid

Public Health and Safety (Microwave)

- Microwave beam loss of control leading to irradiation of people in beam path
- Long-term/low level exposure in rectenna vicity (outside buffer zone)
- Side lobe and grating lobe microwave radiation from power beam

Worker Safety

Stemming from:

- Resource extraction and processing
- Manufacturing
- Exposure to toxic/hazardous substances at launch and recovery site
- Space construction personnel (cosmic and microwave radiation)
- Rectenna operations personnel

Cost Issues

- High capital cost for whole system
- High front end costs before any system power output
- High cost risk - many dollars must be invested before feasibility/practicality of concept proved (shared with, but less than fusion)

- In intervening time before SPS operational, there might be technological breakthroughs that provide significant energy at lower cost, making SPS economically unviable
- Although initial investigations indicate economic feasibility in terms of competitive (with other sources) electricity costs to consumers, uncertainities in cost of system (and consequently of SPS power) - cost risks - may be an issue. Opponents say SPS cost analysis is unrealistic and biased

Resources (Availability, Cost, Import Reliance, etc.)

- Resource availability to other users (competition) both regionally for materials such as concrete, and potentially nationally for critical materials
- Resource cost impacts to competing users
- Resources which require increased production
- Resources requiring increased import levels - effect on balance of trade, increased import reliance, and decreased assurance of supply (e.g. imports from South Africa, Rhodesia international pariahs - or from unstable LDC's)
- Public funds? Public and private funds in an undefined mix? - undefined at present

Financing and Management

- Potential impact on capital markets of raising required capital
- Publicly managed? quasi-public chartered corporation? utility consortia? intermittent public or private consortia? undefined

Communications Effects

Stemming from:

- Ionosphere changes caused by launch vehicle emissions of H_2 & H_2O
- Ionosphere changes caused by emissions from Orbital Transfer Vehicle (OTV) of either H_2O & H_2 (if chemical) or argon ion and other charged particle electron interactions (ir argon)
- RFI/EMI from microwave beam

    o incidental energy falling outside beam; possible hemispheric wide electronic effects

    o Spurious emissions outside beam frequencies

    o Interference with users of frequencies at/near SPS center frequency at 2.45 GH and at/near first several harmonics of center frequency

- Ionosphere changes caused by microwave beam thermal effects (effects on signal propagation (outages) scintillations impacts on satellite communications (fading)
  (Problems may stem from 30 year continuous "on" microwave beam and from geostationary orbit that means no dilution because of fixed location)
- Competition for geostationary orbital assignments and frequency allocations with other <u>domestic</u> users (private and public)

<u>International Acceptance Issues</u>

- Geostationary orbital assignments (including assurance of long-term availability). Must be done through International Telecommunications and other international agencies. Competition with international and foreign satellite systems.
- Frequency allocations - must be obtained through ITU. Competition with other users in crowded 2.45 GH (and its harmonics) frequency bands
- Uniformity of standards for microwave exposure
- Safety-microwave beam control to prevent accidental irradiation from beam; range safety/space debris impacting other countries
- Communications interference (RFI/EMI for international and foreign systems; from ionosphere changes, and from satellite monitoring and control procedures)
- Possible international perception of system as potential weapon (or secretly adaptable to military use)
- International participation, e.g. possible international (multi-national) involvement in financing and operational management and control

<u>Other International Issues</u> (International implications, not necessarily international acceptance)

- Vulnerability of system to attack by foreign country (or terrorists)
- Balance of trade - potential for export of energy by beaming to rectennas in other countries, or for export of SPS technology

<u>Other Issues</u>

- National energy policy (with major social implications)
  - o Hard (centralized) vs. soft (decentralized) energy future; SPS represents "hard" alternative, but at same time is renewable energy
  - o Use of renewable energy source (solar) on largest (currently conceivable) scale
- Stimulus to space exploration/utilization programs

- o the "high frontiers"- a challenge/opportunity for the national species, for mankind

- o a way to capitalize on past and current investment (e.g. Apollo Space Shuttle) in space programs to address a vital societal need - energy supply

-Maintenance of U.S. as a leader in high technology (the emerging "R & D Gap"); also utilization of national human and organizational resource (aerospace establishment)
-Corollary issue - anti-technology movement; high technology as dehumanizing
-Technology spinoffs - e.g. improvements in solar photovoltaic technology
-Regional competition potential - which regions get SPS power (rectenna sites) alternatively, which areas avoid rectenna siting